Croquet Learning Environments: Extending the Value of Campus Life into the Online Experience

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Abstract

Croquet is a broadband communications platform with a 3D user interface and peer-to-peer network architecture that provides educators with a new expressive "meta-medium that is capable of replicating – and in certain ways, surpassing – the most valuable features of campus life. By comparing the campus to a collaborative "information space" where we are free to roam and "interoperate" at will, we underscore the role that proprietary restrictions – operating systems, applications, and formats – have played in making online learning a remote, cramped, and emotionally "flat" experience. From there, we examine the technical hurdles that must be overcome before our online learning experiences can approximate the vitality of campus-based, socially contextualized education.

1. Introduction

We submit that the Squeak-based Croquet system – a broadband communications platform with a 3D user interface and peer-to-peer network architecture – provides educators with a new expressive "meta-medium." It is an evolutionary step forward in the Squeak community's open-source effort to address the educational and creative needs of people "whose chief ways of relating to the world are through movement, intuition, and visual impression" [1].

Squeak's development community has long regarded the computer as an expressive medium. Squeak developers often strive to ensure that computing novices, particularly children, have equal access the most basic elements of computation. Several years ago, Sherry Turkle and Seymour Papert wrote about the systemic practices within the computer science culture that discouraged diversity of approaches towards programming. Their research showed that computer programmers, like laboratory scientists, often employ a down-to-earth, ad hoc and unplanned approach to their work, only later recasting their discoveries "into canonically acceptable formalisms." Yet computer science departments around the world actively discourage – even disparage -- concrete thinking in the classroom. Turkle and Papert note that the same bias against concrete and tactile exploration is expressed by no less a figure in the world of child psychology than Jean Piaget, who "casts children's concrete thinking as a stage in a progression to a formal style" [1].

In formal classroom settings, computer science continues to be taught as a rigorous, highly structured, analytic, and above all, abstract pursuit -- no doubt, in part, as an attempt on the part of a fledgling discipline to justify its status as a "science." These programs define a professional class by winnowing out people of any age "whose chief ways of relating to the world are through movement, intuition, and visual impression." While the same process occurs across the so-called "formal" disciplines of science and mathematics, it is particularly ironic in the case of computer science, given the democratizing potential of the computer itself as tool *and* expressive medium. As Turkle and Papert explain, "the computer, with its graphics, its sounds, its text, and its animation, can provide a port of entry" for visual and experiential learners into formal schools of thought that might otherwise elude them, from physics and mathematics to musical composition [1].

The power of Squeak's object-oriented approach and support for late-binding allows students to play with the elements of a program, moving them around across the computer screen in a satisfyingly concrete and tactile manner. There is mounting evidence that students with concrete learning styles are able to perceive the underlying assumptions of an economic model, grasp the basic elements of multivariable calculus, or perceive the properties of a complex molecule through 3D simulations and models than they can by viewing equations in a textbook. Extending Squeak-based pedagogy into the third dimension will fill a void in current constructivist approaches to online learning by facilitating the creation of computer-generated 3D learning objects. Within the Croquet

virtual environment, educators and their students will have the ability to create 3D models and dynamic simulations that can be modified while they are running.

The Croquet Project's educational developers regard this flexible platform as the foundation for a next-generation online learning environment, one that is vastly more multi-dimensional than the course management system paradigm. Any approach to online education that continues to restrict itself to the delivery of content alone ignores all the depth and texture of campus life, along with the social and collaborative nature of learning. Of the three broad aims of higher education – 1) skill acquisition and competence with tools and techniques; 2) socialization and induction into the canons of particular communities, professions or disciplines; 3) development of an intentional, or self-directed, approach to life-long learning [2] [3] – current online learning environments are relatively successful in managing only the first, most transactional of goals. In this respect, they have failed to provide a "port of entry" into abstract thought for students who learn best by doing and through direct interactions with their peers.

Some learning researchers describe the recent emergence of a new type of learner, one who has grown up with the Internet and its distributed self-organizing peer-based communities [4]. The present generation of college-age students is made up of post-browser or "neo-millennial" thinkers, accustomed to personalizing their experience, demonstrating their knowledge in multiple media, and learning as much from their fellow students as from their teachers [4].

Keeping this in mind, we have asked ourselves the following basic question – e.g. if we were to build an ideal online learning environment today from the ground up -- knowing what we know now about the extraordinary speed of our campus networks, along with the processing and visualization powers of commercially available computers – what would we do differently? This is a question we want to take seriously, along with a host of others. What is it about campus-based learning that makes it so personally involving, meaningful, and rewarding, as compared with current online instructional practices? Can we devise an online learning environment that makes instruction equally personal, meaningful, and rewarding? And in terms of creative flexibility, what advantages might a collaborative virtual environment have over a bricks-and-mortar campus where new construction is always limited by physical laws and fiscal constraints?

With the phrase "campus life," we refer less to a collection of buildings and more to a "social ecology" of learning that emerges over time whenever the proper environmental conditions are put in place. It is important to draw a distinction from the start between the goals of the Croquet Higher Education Partnership and the objectives of the many website-based ventures that have billed themselves as "virtual universities" over the years. Since the late 1990s, the phrases "virtual campus" and "virtual university" have been used to describe a wide range of website-based ventures, including website "front-ends" for existing institutions (e.g. Michigan State Virtual University), online clearing houses for the joint marketing of distance courses (e.g. California Virtual University, the Virtual Open University of Finland, and the recently-defunct United Kingdom e-University), and 3D "campus tours" aimed at marketing existing institutions to prospective students (e.g. the University of California, Santa Cruz's "Virtual Campus" project in collaboration with Activeworlds, Inc.).

The majority of these "virtual universities" failed as commercial ventures largely because they presented their catalog of online courses as a viable *alternative* rather than a supplement to conventional campus instruction. Significantly, these "virtual campuses" transferred to the online realm only those real-world campus practices that required the least technical sophistication to replicate – e.g. course administration and lecture-style, one-to-many teaching techniques.

By contrast, the Croquet Higher Education Partnership members are concerned with developing a next-generation technical environment that encourages *pedagogical innovation* rather than simple replication of administrative practices and delivery of pre-packaged content. Among other purposes, the Croquet platform would provide educational researchers with an open-source "collaboratory" in which to build, share, implement and evaluate transformative teaching practices, including experiments in simulation-based learning, all within a persistent and immersive social context. We liken Croquet to a "meta-medium" capable of replicating – and in certain respects, even surpassing – the most valuable features of campus life [5].

The argument that follows is designed to address the specific interests and concerns of higher education administrators and thought leaders when it comes to the development of next-generation learning platforms. For college administrators, the traditional campus is a critical marketing tool. Recruitment materials commonly stress the uniqueness of a campus-based education as an immersive, multi-dimensional, and massively multi-user experience. Borrowing terms from the lexicon of computer science to describe the features of campus life ("interoperability," "scalability," "platform neutrality," etc.), we hope to draw attention to campus inclusiveness and

accessibility – qualities that continue to elude us in the online learning realm. Moreover, by comparing the campus to a collaborative "information space" where we are free to roam and "interoperate" at will, we underscore the role that proprietary restrictions (including conflicting operating systems, applications, and formats) have played in making online learning a remote, cramped, and emotionally "flat" experience. From there, we examine the practical steps that the Croquet Higher Education Partners are currently taking as part of a multi-institutional effort to deepen and transform the way we teach and learn online.

2. The campus as a massively multi-user world

What is it about the college campus that makes it different from other spaces? One definition of a campus is "the open space between and around the buildings," but as the OED suggests, the word has always alluded to the kinds of *human interactions* that take place there. These interactions, taken together, make up what is known as "campus life." Housing, preserving, and conserving the best that is known and thought in the world, the campus buildings and grounds lend a sense of persistence and continuity to a student's experience over time.

How much of a role does campus life play in effective education at the postsecondary level? Students at the Massachusetts Institute of Technology are willing to pay what are among the highest undergraduate tuition rates in the United States in order to enroll at the university despite the fact that MIT is working to make its course materials freely available online for anyone who wishes to access them through the MIT OpenCourseWare Initiative [6]. But then why do students still flock to the MIT campus? Clearly, the big draws are neither courses *per se* nor curricula, but rather the intellectual *contact* and the highly charged social *context* that the MIT campus life can provide.

Simply put, MIT's enrolled students gain access to one another. Ask anyone who has ever been through a rigorous program of study, and chances are they will remember learning more from their fellow students than from their professors. Campus provides the enabling conditions for a complex social ecology to emerge. Large numbers of students engage in daily role-playing (also known as "critical thinking") in which they try on a particular point of view, explaining, critiquing, justifying, deepening, and reinforcing their understanding and their group identity. The unique value of campus life, then, is a matter of *proximity* – the ability to position oneself in direct relation to relevant people and resources. Philosopher Erving Goffman called these spatially defined moments "focused gatherings" where "a set of persons [can become] engrossed in a common flow of activity and relating to one another in terms of that flow." The gathering takes its form from the situation that evokes it, "*the floor on which it is placed*," as Goffman puts it [7]. On campus, that "floor" might be anything, from a heated debate spilling out of the classroom into a commons area to a sidewalk diatribe by a student activist. Combine this with the ready availability of tools to forcefully express, embody, and exchange ideas, and the campus has all the makings of one vast constructivist online learning environment or "collaboratory."

3. Valuable attributes of campus-based learning environments

There are certain attributes of campus-based learning that students and faculty regard as valuable – so much more valuable, in fact, than pre-packaged content alone that students are willing to pay good money in order to experience these aspects of campus life first-hand. An ideal next-generation online learning environment for an increasingly distributed community of learners would be one capable of extending the following campus attributes into the digital realm.

3.1 Platform Neutrality

Campus architects and planners do not design technical barriers into the campus infrastructure for the sole purpose of preventing people from seeing the campus as others see it, or accessing information to which they are entitled. In fact, quite the opposite is true. Accessibility to public areas is a campus priority.

3.2 Persistence

The campus is a dynamic world that nevertheless persists over time. If you plan to return to a particular spot on campus, you can be confident that it will be there in much the same condition as you left it an hour, a day, or even a year ago. Since the campus is unlikely to disappear into the ether the moment you turn your back on it, you can make some long-term commitments to the people you encounter there.

3.3 Proximality

The campus calls upon members of the learning community to visualize themselves as animate beings sharing space with learning materials and information resources. It is possible to measure the distance

between oneself and resources through the property of "proximity" within a three- dimensional shared space. This property of spatial relationship, of course, is the same that transforms a physical library or bookstore from a primarily analytic and formal catalog of resources to a genuinely browsable emporium. Proponents of "constructivist" and "situated learning" pedagogies argue that closeness to objects, or "proximality" (to borrow a term once again from Turkle and Papert) sets the necessary enabling conditions for socially contextualized learning-by-doing.

3.4 Situated knowledge

An institution of higher learning signals its long-term investment in a particular line of study by awarding that discipline its own location – its own niche in the campus ecosystem. Each department and discipline is attached to a particular location so that people can locate themselves and others in direct relation to the ideas that interest them. Thus, the campus provides the enabling environmental conditions for "communities of practice" to organize themselves around *a shared location* as well as a shared history and common repertoire of knowledge.

3.5 Distributed peer-to-peer network

If our campuses insisted that teaching and learning be "served" from a central location, think of how vulnerable the institution's mission would become. If thousands of students flood this all-important central building at once, collapse would be imminent. One natural disaster, or incident of vandalism, could end classes indefinitely and destroy all administrative records. To avoid such catastrophe and accommodate large student populations, campuses distribute classrooms and departments across a wide area. A service attack on one building will not take the entire institution down. Instead, each facility has its own "firewall," or securable set of entryways, providing multiple failsafe points against potential disruptions.

3.6 Statefulness

"Statefulness" is dependent on "persistence." If our campuses were as "stateless" as the World Wide Web, there would be no such thing as institutional memory. Everyone one be afflicted with collective aphasia. Professors would be incapable of remembering what they or their students were doing the last time class met. Try assessing a student's growth over the course of a semester, when your memory is wiped clean after every class session. Luckily, the persistent campus world provides plenty of daily opportunities for people to grow accustomed to one another's faces. And that is a very useful feature of campus life, considering how much money it would cost to overcome egregious failures of continuity. Consider the fact that almost 60% of the cost of web application development is spent to overcome the inherent "statelessness" of the World Wide Web.

3.7 Continuity

The persistent environment offers students a way to understand their development as a *continuum*. Since each discipline occupies its own niche in the campus ecosystem, a student can chart her progress through the curriculum as a movement in space as well as time. While she works her way from the periphery towards the center of her chosen discipline, new campus venues, new conversational niches, and new contacts open up for her as well.

3.8 Flexibility

The living campus is a dynamic system, balancing persistence with flexibility. This has important consequences when it comes to fostering student-assisted or "peer-based" learning. Consider how easy it is for an impromptu conversation to turn into an ad hoc study group. With little advance notice or coordination required, students are able to bring their resources with them and set up shop in an unused lab or commandeer a few tables in the student lounge.

3.9 Synchronization without latency

When something happens on campus, everyone in the immediate vicinity sees the event simultaneously. Groups of people can explore and react to everything others are doing *as they are doing it.* This also means that time-limited events (including lectures, films, and concerts, etc.) may be experienced by large numbers of people simultaneously. Even browsing the Web can become a communal experience. "Over the shoulder computing" where a group of students share a single terminal to browse the web is a commonplace on campus. Compare the isolation of the off-campus computing experience with the possibilities that the campus provides for collaborative research.

3.10 Media aggregation

Books, papers videos, audios, television, photographs – individual media as conventionally

understood -- are themselves *subsumed* within the all-encompassing *"meta-medium"* of the campus. As a single, integrating environment, the campus provides both *the tools* and the shared *context* for creative processes to play themselves out and for a growing body of shared information to be accumulated and stored.

3.11 Shared content creation

There is no such thing as a "read-only" campus. The campus commons is an interactive information space, a "writeable web" where new artifacts are continually emerging. The campus, studded with tools and materials ready-to-hand -- everything from kilns and printing presses to confocal microscopes and gene sequencers – is a "collaboratory" of enormous proportions. The grounds – e.g. the space between the buildings – undergo extraordinary changes throughout the year, transformed by bleachers, sidewalk drawings, posters, leaflets, and temporary exhibits that may become permanent fixtures by popular acclaim. In this way, the common areas play off against the structural demarcations of large lecture halls, where the barrier between the lecture as content creator and the students as content consumers is rigidly reinforced.

3.12 Serendipity for ad hoc discoveries

To borrow a term from anthropologist Claude Levi-Strauss, we are all potential "bricoleurs" (or "concrete thinkers") within the university's creative commons [8]. This is to say that discoveries can be concrete, tactile, and spur-of-the-moment rather than planned. While the lecture hall serves as the conventional route into formal systems of thought, where students are asked to manipulate abstract symbols, the campus can provide a respite and an alternative for those people Turkle and Papert identify as concrete and tactile learners.

3.13 Appropriately contextualized course management

On campus, course administration occupies a discrete space in the lives of faculty and students, both literally and figuratively. Issues of enrollment, scheduling, facilities assignment, and grading, while absolutely vital to the smooth functioning of the system, do not normally intrude themselves on the classroom experience (unless something has gone seriously wrong). As far as the student is concerned, there are campus buildings that house administrative operations. The Registrar does not set up a table in the middle of the classroom. When a student enters class, she is never asked to step into an isolation booth for the duration of the class period. Neither will she be forced to sit at her desk wearing blinders, confining her view to the book opened on her desktop. If she wishes to communicate with the instructor or her fellow students, she does not have to scribble a note, pass it to the appropriate address, hope that it gets to its destination, and wait for a response that may or may not arrive days later. No, these are the parameters of the online learning experience, where all social interactions and learning materials have to be *shoehorned* into a cramped two-dimensional "window." By contrast, the real-world setting offers 1) a multi-dimensional environment where learning materials in a variety of media (text, slides, overhead transparencies, video and audio recordings) can *co-exist* within the same space as the people who use them; and 2) synchronized co-presence, making it possible for students to see the actions of others as they are performing them and to focus *as a group* on the same book, slide, or common activity.

3.14 Status and reputation provides social filtering

While permissible forms of expression are under continual negotiation, there are two mechanisms that a university or college campus uses to secure itself against vandalism and malicious intent: 1) policing and 2) peer pressure. The latter does more than anything else to curb inappropriate behaviors since an action performed in full view of others can be traced back to its source. Status and reputation are the social capital of campus life. Consider the last conference you attended and the power of the simple nametag to establish identity and curtail disruptive behaviors. Is it any surprise that 70% of the money invested in information technology has been spent to overcome the anonymity and "statelessness" of the Internet?

4. Unique attributes of successful online learning environments

Let us say we were indeed able to replicate these features in an online learning environment – which we may possible shortly, as we will soon explain. Might a computer-simulated environment of this kind even surpass "bricks-and-mortar" campus life in terms of scalability, creative flexibility, immediacy, and responsiveness? And if so, how?

4.1 Scalable personalized learning

Colleges and universities with tens of thousands of students face a "teacher bandwidth" problem without an affordable on-campus solution. While personalized instruction remains an ideal, the instructor can only be stretched so far. Network architectures, on the other hand, promise to support learning environments where personalized instruction can be offered to large numbers of students. The Internet, with its vast peer-based communities (eBay, Slashdot, and the many massively multiplayer online gaming worlds) may offer a glimpse of the future for higher education. Cost-effective and scalable, the self-organizing online learning community taps the resources of students themselves, with a variety of fringe benefits. Rather than task the limited bandwidth of a single instructor, the community draws on the distributed expertise of the group as a whole. The value of the communal knowledge base will actually grow as the number of students increases. The more "peer-to-peer" exchanges the network architecture enables, the better. Here is a learning environment for college-age students weaned on the Internet, Playstation, and XBox Live. As Dede [2] points out, these "neo-millennial" learners will demand to organize themselves from the bottom-up (co-organize), personalize their learning experiences (co-design), draw on the expertise of their peers (co-instruct), engage in contextualized learning-by-doing activities (co-construct), and use multiple media to demonstrate what they've learned.

4.2 No limits to new construction

Campus construction is a lengthy and tedious business typically involving capital campaigns, legislative fiats, and endless delays. Inflexibility limits the immediate usefulness of the physical campus for constructivist learning. Modifying a campus space is typically restricted to shuffling a few chairs around in a classroom. Think, however, of the possibilities that open up when the campus is virtualized, and people can see one another's actions. With the right software and networking technologies in place (more on this later), a computer simulated "meta-medium" would respond to human manipulation with unprecedented ease. New 3D spaces for private discussion or public exhibitions could be created with a simple click of a mouse. Students might demonstrate their knowledge of a subject by modeling a molecule in three dimensions or fine-tuning a weather system simulation. Once the authoring of 3D models and simulations becomes as quick and inexpensive to accomplish as web page publication is today, educators will be able to provide enough evidence to document the benefits of a pedagogy based on concrete visualizations of abstract concepts and "learning-by-doing."

5. Technical requirements for online learning environments

We've seen that the campus is a three-dimensional, persistent, and shared space where people may converse naturally and immediately with one another. It is also an integrative space that spawns sub-spaces with ease. It takes little effort to create a) ad hoc workspaces where people can position themselves in direct relation to relevant information and resources, or b) private zones for organizing and management personal resources. The campus is also a "meta-medium," where media are aggregated, people have direct access to them, browsing can be a communal experience, and social creativity is always possible. When people become embodied presences on campus they are readily identifiable, keeping disreputable behaviors to a minimum. Finally, technology enhances the face-to-face learning experience on campus by bringing the diversity of the Internet into the physical world's rich social context.

Now let's reconsider, this time from a wholly technical perspective, the qualities that a computer-simulated campus will need in order to encompass the many virtues of campus-based education. First of all, the arguments in favor of having an open-source alternative to course management systems and other mission-critical application software apply in this case as well. Software licensing expenditures and complete reliance on proprietary simulation technologies developed by the entertainment industry have thus far hampered attempts to harness the power of immersive computer simulation for pedagogical purposes.

A groundswell of interest in harnessing those technologies for educational purposes is building within the academy, as evidenced by the adoption of "games, simulations, and technology" as an NLIWE Key Theme. However, so long as educators look to commercial game developers for their visualization technologies and 3D content creation tools, higher education will find it impossible to develop an affordable online learning environment that matches the real-world campus in terms of social contextualization, accessibility, persistence, and continuity. Without an open-source alternative, an educational developer will be forced to continue his practice of licensing commercial gaming technologies and building his educational simulation as a dependent modification or "mod." Development is expensive and time-intensive, requiring a programmer and graphics

artist to produce new visual assets, script new behaviors, disable educationally irrelevant features, and spend long hours waiting for code to compile or graphics to render. Once development is complete, the educator's research is locked into a proprietary format. Adding insult to injury, a per-seat license will have to be paid to the gaming company for every student user of the educational "mod," and our experiences at the University of Wisconsin tells us that this fee alone can run to $30,000 USD for a class size of three hundred students.

While the entertainment industry has driven innovation thus far in the fields of simulation, visualization, and network architecture, their massively multi-user online game worlds *lack* many of the qualities that an educationally relevant environment would require, including:

5.1 Platform neutrality

If we are going to build a software and network architecture to support the qualities we value most in campus life (including accessibility), we will have to have 3D simulation software that runs identically on every computer platform so that users can share the same immersive experience regardless of whether they were using a Windows, Macintosh, or Linux machine. Once installed, this software acts as a direct interface between the software code and the computer's microprocessor, bypassing the operating system altogether. Simply put, the software transforms any computer into a "virtual machine."

5.2 Dynamic synchronization that scales economically

In order to support a multi-user online environment where people see and interact with one another and with the learning materials at hand, we will need a network architecture that permits remote participants to share the same dynamic experience at all times. The real-time behaviors that bring massively multi-user online environments alive are notoriously burdensome to compute. By contrast, a peer-to-peer network architecture could distribute the computational burden to the individual computers connected on a wide area network and obviate the need for a central server, A peer-to-peer approach towards synchronization could prove more scalable for institutions of higher learning than a traditional client-server model.

5.3 Backwards compatibility

With a click of the mouse, educators and authorized students should be able to open a 3D window and display so-called "legacy content" inside the shared workspace. By "legacy content," we mean everything formatted for a 2D web browser or web-based course management system, including course syllabi, lecture notes, PowerPoint slides, etc. What's more, any web-based resource exposed within the shared 3D environment should be *immediately open to co-browsing and co-editing*. Likewise, to ensure a smooth transition from the old paradigm to the new, users must be able to access all the applications they are accustomed to using, from their email, word processing, and spreadsheet programs to their favorite web browser, *without ever having to exit* the all-encompassing 3D educational environment.

5.4 Extensible broadband communications

The new platform should be able to leverage advances in networked communications as they arise. When the campus network infrastructure is upgraded to allow for broadband communications – from Internet telephony to live web conferencing – the software and network framework should be capable of supporting a massive number of real-time communications events and peer-to-peer interactions simultaneously. Think of the possibilities for participatory learning once educators can use a shared 3D environment to stage real-time demonstrations. Communicating directly to his class through chat or voice-over-IP, a chemistry professor could summon them to gather together in a particular part of the shared environment. He might load a 3D molecular model into the scene, manipulate the model in real-time, authorize certain students to do the same, and create new 3D objects "on the fly" that point to associated web pages.

5.5 Free educator's toolkits

In the mid-1980s many believed that multimedia publication would be the sole province of a professional class who would sell their work on CDs. Along came the World Wide Web with its hypertext markup language (HTML), and the barrier to entry was abruptly lowered. Suddenly anyone could make a reasonably effective multimedia web page and publish it with relative ease. The professional class remained, of course, and learned to leverage the demand for high-quality web development and premium creative services. To repeat this history in the realm of advanced 3D simulation, we need a combination 3D

development and delivery platform for educators. The platform should provide a physics engine, direct access to the OpenGL graphics library, and a late-binding scripting language so that developers can actually see the changes they and their collaborators are making to the 3D object while the simulation is running in real-time. No more waiting for hours for the new code to compile or the new graphics to render. Think of the current 2D "wiki" writing environments where the processes of reading and editing are combined, and you'll have an idea of the immediacy that comes when the processes of 3D development and delivery are combined as well, allowing for instant revision.

5.6 Federated repository

So long as participants can contribute to and benefit from a common pool of 3D objects and simulations, novices will be able to draw on the expertise of more seasoned 3D developers and the value of the common resources will grow exponentially as the number of members increases. To support this distributed model of 3D content development, a federated database ought to be integrated into the network architecture, ensuring that any object created within the framework is automatically attributed to its author, tagged with the proper descriptors, and stored in an extensible database for easy retrieval and re-use by any authorized member of the learning community.

5.7 Client-server trust architecture combined with peer-to-peer processing

There are, of course, certain features that will speed the adoption of a distributed resource sharing system such as the one proposed here. At the institutional level, the prospect of interpersonal, inter-institutional and cross-institutional collaboration inevitably raises trust concerns. The new platform must be able to leverage the rights management systems already in place at participating universities. Removing anonymity from transactions within the shared environment will ensure that the creative commons is respected, disreputable behaviors are not encouraged, peer recognition and review becomes a socializing force, and individual contributions to group research projects are credited to their rightful authors, leaving institutions with a useful record of peer-reviewed faculty achievement in teaching and research.

6. Conclusion

Croquet is an evolutionary step forward in the Squeak community's open-source effort to address the educational and creative needs of people "whose chief ways of relating to the world are through movement, intuition, and visual impression." As a 3D "meta-medium," the Croquet platform gives us the ability to simulate the particular qualities that make campus-based learning personally involving, meaningful, and rewarding.

7. References

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