Learning = playing: Interactive learning with game-based design principles

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Abstract

This paper explores the rapid escalation of demand for information in both complex and convergent forms of accessible technology. The authors contend that this growth creates a concomitant demand for a highly skilled information technology workforce. To ensure the preservation and continued development of this workforce, education of the information technology professional is increasingly acknowledged as one of the primary challenges confronting educators and educational institutions. Many institutions have sought solutions to this educational conundrum in populist concepts of "e-learning".

Introduction

The benefits of e-learning have been variously described and exploited (Abbey, 2002; Rosenberg, 2002; Picciano, 2001; Paulsen, 1999). Such benefits include: increased flexibility regarding both time and geographic location, reduction in administrative process and increase in efficiency and the increased levels of digital modes of communication.

The pedagogic benefits, however, appear to have been unexploited due to perceived difficulties in the development of effective and engaging educational environments. Thus Prensky (2001) and others argue that the envisaged educational revolution is yet to succeed. The need for engaging online learning methods is thus becoming critical in order to meet the future demands of both cost and learning-effective e-learning.

The implementation of successful e-learning strategies and practices tend to be impeded by this pedagogic challenge. Success has continued to elude both public and commercial educational institutions and is compounded by increasing dropout rates in online courses. In some instances the attrition rate is as high as 80% (Forrester, 2000).

However, positive trends are slowly emerging. Experimentation with alternative learning-environments combining digital games and learning (edutainment) is currently the focus of a number of researchers. Prensky (Prensky, 2001), author and CEO of "games2train.com", claims that educational games generate an environment in which all the important factors of successful learning are included: engagement, interactivity and most of all, fun.

Despite these affirmative modifications to e-learning strategies and environments, such developments are still considered both financially prohibitive and time-consuming solutions.

Thus, in the light of this disparity between the learning needs of the user, the pedagogic philosophy of educational institutions and the financial viability of such a learning environment, the authors explore the possibility of designing a game-related learning model that is conducive to both learning- and cost-effectiveness. Such a model, whilst initially premised on the need for a tool in the education of information technology professionals, clearly has potential and creative applications in other fields of education

Transforming learning with technology

Despite the escalating technological advances facilitating the further extension and interaction of educational institutions with larger and more diverse groups of populations, Rosenberg (2001, p. 20) and many others argue, and not without some degree of justification, that historical precedents for the use of technology in the learning process abound with both promise and disappointment. Technological advances and the accompanying anticipation and enthusiasm for the prospective revolutionisation deemed an inevitable corollary of such developments, have failed to generate an equally zealous approach to the transformation of learning.

As Rosenberg suggests, the most anticipated new learning technologies of the late 20th century, and the main predecessor of e-learning, CBT (Computer Based Training), failed to deliver the predicted concomitant increase in the effectiveness and efficiency of both learning process and content delivery. The major impediment to any such success was financial, as the need for maintaining dynamic content on continuously developing technologies and different platforms, rendered any investment in quality CBT-programs prohibitive and thus both too expensive and too risky for the majority of learning institutions (many of which are heavily reliant on outside funding) to pursue.

Hancock (2001) similarly concludes that:

> ...Learning technologies have gone through repeated "cycles of failure". A technology is developed and is then applied to solving educational problems. Expectations are raised that cannot be met. Many of the resulting learning programs are poorly designed and ineffective.

The rush to e-learn

In the early nineties, despite the difficulties inherent in CBT-systems, the introduction of the Internet heralded the potential for a new era in learning: "e-learning" was expected to revolutionize education. Public and private learning institutions (www.hint.no, www.webstudent.no), LMS-developers (Luvitt, Lotus Learningspace), standard initiatives (SCORM), content developers (Smartforce, Boxer) and even corporate businesses (Autodesk, IBM) rushed to embrace this new learning technology in order to meet the digital economy's growing need for effective education.

Rosenberg defines e-learning as:

> ... Networked, which makes it capable of instant updating, storage/retrieval, distribution and sharing of instruction or information. It is delivered to the end-user via a computer using standard Internet technology. It focuses on the broadest view of learning – learning solutions that go beyond the traditional paradigms of training.
>
> (Rosenberg, 2001, p. 28)

Similar blithe optimism is also rife in the business world:

> The next killer application for the Internet is going to be education. Education over the Internet is going to be so big it is going to make email look like a rounding error.
>
> John Chambers, CEO, Cisco
>
> 70% of the world's 1,000 top tier companies cite a lack of trained employees as their #1 barrier to sustaining growth.
>
> PWC
>
> IDC is currently projecting the corporate eLearning market to grow to $11.4 billion in 2003,representing an 83% CAGR since 199&.
>
> IDC

Despite such buoyant confidence, "e-learning" faces new problems (not the least of which is its nonclementure) that hinder the successful development and implementation of learning environments.

Many organizations tend to focus exclusively on the technological challenges confronting implementation such as; software, bandwidth and courseware. The strategic issues continue to remain unsolved: how do we develop a learning environment that becomes part of the daily work culture and further, how do we fully exploit and implement the power of such technological innovation?

Similarly in the rush to unequivocally embrace "e-learning" public and commercial educational institutions grappled with increasing dropout rates in online courses. In some instances the attrition rate is as high as 80% (Forrester, 2000).

Financial vs pedagogic considerations

Perhaps the most significant of hurdles confronting learning institutions in the implementation of online education is maintaining the equilibrium between the financial costs of development with the user's need for agency, interactivity and engagement in the acquisition of knowledge that is meaningful to them. Forrester suggests that the most common error regarding the development of online education is the failure to provide the user with a satisfying degree of agency in their interaction. Forrester's research suggests 56% of students who participate in some form of online courses perceive a lack interactivity.

Hanson (1997) attempted to rectify some of these difficulties with a student-centered perspective, suggesting that successful "e-learning" is dependant on the individual student's ability and skill to integrate into the learning environment on a number of important socio-cultural levels.

> Typically the greater the academic integration, the greater is the chances of success. Social integration and the ability to interact with others, including teachers, tutors and other students, likewise is a very important determination of success.
>
> Educational planners have a responsibility to provide distant learning environments that will maximize factors that contribute to success and minimize factors that contribute to attrition. Naturally the learning provider cannot control situations such as family obligations or job-related time constraints. But factors such as well-planned and clearly presented instructional materials can help distance learners to integrate their learning into their daily lives. One of the most important aspects of planning an online education program is to establish the interactive and communications components with the student.

Prensky (2001) suggests young people (arguably the largest demographic group serviced by educational institutions) respond more effectively to environments in which the focus rests on fun and visually dominated content, such as graphics. Prensky's argument melds both the engagement and agency offered to the user in fast-paced video games with "educational" content in order to create successful and effective training.

> The Nintendo and MTV generation processes information more rapidly than ever before, prefer graphics to text, and work on several fronts at once, making them champions at multitasking. As a result, today's new workforce is eager for new challenges. But so far, the traditional mainstream business-world has done very little to accommodate them, particularly apparent in the realm of training sessions. The questions arises: How do you train today's bright young businesspeople for the rules of corporate life in ways that will effectively tap their learning potential – and won't put them to sleep?

Educational institutions rarely have access to the resources, skills and knowledge required to develop and implement the games technology Prensky advocates: AI programming, physique and collision detection, path-finding, 3D-engines, 3D-graphics, sound and video programming and much more. Commercial game projects such as "Hitman 2" of IO Interactive (www.ioi.dk) or "Battlefield 1942 of Digital Illusions (www.dice.no), require human and technical resources to fund development periods of 2–4 years, 5–10 million US$ budgets and staff of 50–100 people.

Currently (and has proven historically with many technical innovations) the only "client" with sufficient resources to develop and implement Prensky's Digital Game Based Learning model are the military.

> …the military uses games to train soldiers, sailors, pilots, and tank drivers to master their expensive and sensitive equipment. It uses games to teach midlevel officers how to employ joint force military doctrine in battle and other situations. (Prensky 2001)

What about the learning?

Despite the apparently diverse range of disciplines utilizing games for training, these interactions are almost solely oriented around hard action-based procedures and technical skills. Nagel (2001) at the ImaginaryPlanet.net argues that Digital Game Based Learning cannot be adapted universally to every learning situation:

> …the ultimate risk of game-assisted learning is that the learning doesn't transfer to other domains in real life. Sure, one might be able to navigate through an imaginary elven world, but does that increase one's ability to understand real-world geography or to read a map? Sure, one could drive a virtual car through the roads of Paris, but this is not really driving. The game is about appearances and not about reality."

Thus, the use of games within a learning environment may provide a simulated context for performing an action or developing meta-strategies. However, current implementations of Digital Game Based Learning environments lack both the methodological and conceptual frameworks in which to contextualise areas such as; design, system development or research.

The search for a new model

The work of Prensky, Rosenberg, Paulson and Nagel (amongst others) might be usefully employed to assist in the development of a model for games-based learning environment that is both more adaptable and affordable. By the implementation of the simple, core motivational mechanisms enjoyed within a game environment, in lieu of rather more complex game technology, and embedding such mechanisms within a pedagogic framework a cost effective games-based learning environment might be established. GAeL (Game Accelerated eLearning) is a learning environment predicated on the conceptual and game play factors found in traditional games, yet both flexible and cost effective in its development and implementation. Thus, GAeL addresses the needs of the student/player for interactivity, agency and engagement in the learning process whilst satisfying the financial imperatives of the institution.

The Game Accelerated eLearning model is an unashamedly commercially motivated project that attempts to address the difficulties inherent in the provision, development and implementation of e-learning. Initially developed for a private learning institution, Noroff Institutett in Norway, it is expected that the success of the program will ensure its expansion into the public sector, similarly confronting the growing crisis in balancing

quality education with financially viable resources. Tapscott (1998, p. 130) exhorts "civilized governments" to take steps to address future challenges as traditional education systems fail to embrace the much vaunted technological breakthroughs:

> ... it has become a cliché to say that the educational system in the United States and other developed countries is in crisis. There are cutbacks in funding in many advanced countries. And, overall, there is a feeling that given all the improvements in technology and epistemology, we could be doing much better.

GAeL: Game Accelerated eLearning

The focus of the research project is to design a Game Accelerated e Learning model (GAeL). By employing and combining digital game principles and recent distance learning models, a hybrid prototype will be designed, implemented and evaluated in an online technology focused course at NOROFF Instituttet in Norway. The authors anticipate the research will provide valuable information regarding the potential of the GAeL model to inspire both motivation and engagement; critical factors for the successful delivery of effective e-learning. Other benefits include:

- a flexible, optional and layer-based system
- increased cost efficiency
- increased learning efficiency
- extended assessment criteria
- self-supporting academic programs.

As illustrated in Figure 1 (a layered overview of the GAeL model and its expected impact when combined with an existing online academic structure) cost efficiency and pedagogic outcome are expected to increase. As depicted, e-learning has contributed to improvements in cost-efficiency due to administration, communication and distribution savings, however, pedagogic quality fails to improve and indeed in some key areas has deteriorated particularly in the key areas of progression and completion.

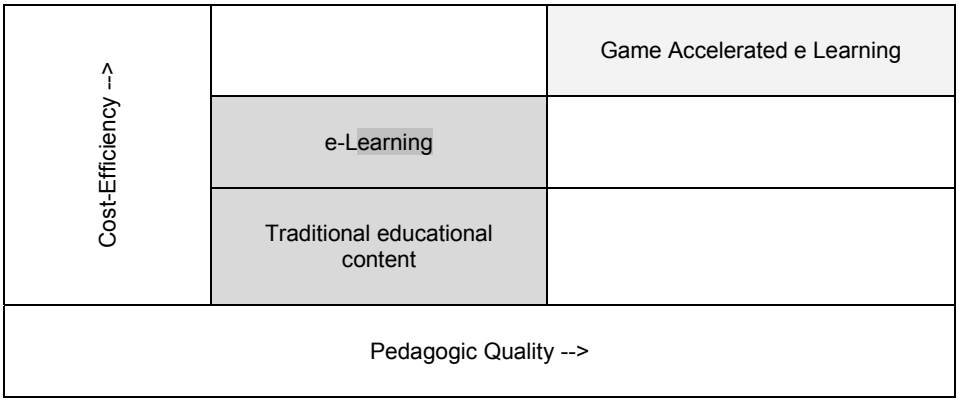

Figure 1: The GAeL model

The GAeL model will function as an important framework that enables educational vendors to use a systematic approach in the phases of designing, implementing and delivering cost-effective, flexible and engaging e-learning programs.

Definition of the prototype

The Game Accelerated eLearning (GAeL) model is an optional and layer-based pedagogic system that utilizes game principles in a modified online learning environment to improve overall cost-efficiency and pedagogic quality. The model may also prove to enable extension of assessment criterion and to be self-supporting in terms of future academic maintenance and revision.

The GAeL model functions as an optional model. Maintaining Noroff's avowed philosophic paradigm of student-centred learning, this optional feature ensures that the student chooses to participate in either the GAeL mode or a more traditionally based mode of learning at the beginning of the course. Within the GAeL learning environment, students may similarly select the activities and areas in which they will participate in order to accrue credits. This also facilitates the selection of different strategies by the individual student-user to enable attainment of the highest levels. Such decisions directly impact on the student's assessment profile.

This profile tracks the individual student's strengths within the parameters of knowledge, initiative and creativity.

As a layer-based system, implementation of the GAel model is readily and easily achieved by means of simple overlaying on top of any existing academic structure. Overlay is possible both for on-site and online environments and may be activated/deactivated without the need for structural adaptation of either the course or content.

The functionality of the GAeL model is premised on internal game economics (credits), motivating level systems and carefully designed GAeL-based activities, in which all is layered over an existing online academic structure.

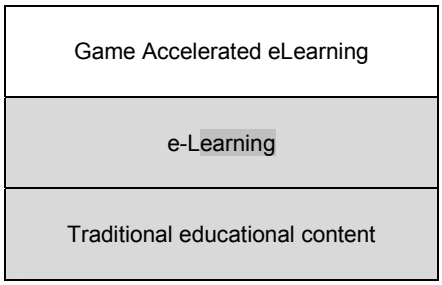

Figure 2: Complete learning model with the GAeL layer

Traditional game-based activities are integrated with innovative learning modes such as contextually specific content questionnaires, competitions and research. If the criteria set for each activity are met the GAeL mode includes a potential reward. Accumulated credits during the duration of the unit effect the final grade achieved for the unit. This system of "game economics" is the main motivating factor in the GAeL model. To further sustain both the student's motivation and the level at which the student is challenged, credit milestones or "levels" have also been introduced.

One to four levels are accessible by the student throughout the course by achieving certain amounts of credit. Each new level reveals further challenging activities, offering credits for successful completion and simultaneously evaluates the student after each activity against the assessment criteria. For example, a quiz may evaluate the student's foundational and conceptual knowledge base while the voluntary contribution of an article evaluates the student's initiative, creativity and communication skills.

The GAeL model thus provides a challenging game-based learning environment in which to resolve traditional academic tasks, yet simultaneously enables the student to expand their competence beyond the existing boundaries of the subject.

As indicated, the model comprises an independent conceptual core designed for both optimal cost-effectiveness and readily enables context-specific adaptation and implementation, as either an on-site manual system or a complete automated online system. By strategically designing GAeL activites to specific contextual requirements, in this instance a commercial academic institute, additional costs for the maintenance and update of academic content may be significantly reduced.

Implementation

The GAeL-model prototype will be implemented on a database-driven web system, operating as a portal between the test student and the learning environment. Technically, it will comprise a combination of an alternative LMS (learning management system), a game system and a resource/information portal. This technical base will process valuable data such as:

- access level and progression
- student scores and levels
- high scores
- academic resources.

The prototype will also contain discussion forums, resources and research data. Whilst ideally it may be preferable to have a completed and fully optimized web-system to manage the GAeL-activites automatically, the priority will be focused on the reception and analysis of data arising from the tests, rather than programming of the web system.

Case study

Since conversion from classroom-based education to an online educational environment at NOROFF Instituttet two years ago, staff have noted an incremental rise in the number of students suffering delays in progression or non-completion. For educational vendors such as NOROFF Instituttet, impediments to the progression of a student necessitate extended support and higher cost. For educationalists, such delays conjure a myriad of difficulties with which a student is forced to contend, not the least of which is the inadequacy of the online environment for successful and meaningful learning.

Participants in the trial testing of the prototype will complete a full GAeL course comprising mandatory activities tasks, tests, projects and exams leading to final certification. The authors consider that authenticity, reliability and validity of results can be improved by ensuring that students participate in a meaningful and rewarding learning experience rather than simply compelling the students to participate in the testing of a model, which may be perceived as unrelated to their needs.

The GAeL mode of study is intentionally non-obligatory to ensure initial acceptance and integration into traditional academic settings. Similarly, the elective nature of this mode of study constitutes an important decision for students in the initiation of self-directed learning. Both GAeL students and those who have opted for more conventional processes of learning, may participate in a similar course, however GAeL-based students have the opportunity to select GAeL-activities in which to acquire valuable credits and increased assessment values. GAeL activities are marked in the "G" column in the example of a lecture in Figure 3 below.

Lecture 6

Light&Cam

From	To	Time	Activity	G	Description
09:00	10:10	01:10	Lecture		Light, shadows, design, parameters
			Example		
10:20	11:30	01:10	Lecture		Camera, setup, perspective, rendering
			Tutorial		1-2 Tutorial(s) on lights&cam
11:30	*12:00*	*00:30*	*Lunch*		
12:00	13:10	01:10	Lab	X	1-2 Exercise(s) on lights&cam, A=3 Cr, B= 2 Cr, C=1 Cr, <C= 0 Cr
13:20	14:30	01:10		X	Contributions (Questionnaires, Resource tip etc) Max. 1 Cr for each approved
			Test	X	Optional, 10 Text and visual questionnaires. 100%=2 Cr, >80%=1 Cr
14:30	15:00	00:30	RTQuiz	X	Optional, individual interactive competition. Winner=2 Cr, Second=1 Cr

Figure 3: Example of a GAeL structured lecture

Exercises in the trial subject are customarily non-assessable, however in GAeL-mode such exercises comprise part of several "activities" specifically designed to motivate students to sustain /improve their potential results, and also assists in monitoring a student's recommended progression through the study program. Motivation and monitoring are achieved via the accreditation of variable parameters for specific GAeL objectives. If such criteria are met the student is credited with points according to the level reached. Parameters are selected upon the premise of objective needs to be obtained. As an example, Table 1 illustrates an activity in which credits are awarded according to the particular GAeL objectives met. It should be noted that higher cognitive skills (such as meta-reflective analysis of progress and quality) are the focus.

Table 1: GAel activities and objectives

Activity parameter	GAeL objective	Credits awarded
Deliver an approved solution	Sustain progression	1=delivered at quality rated 0 or better
Quality of the solution	Academic improvement/quality	0=minor faults 1=OK 2=very good
Meeting the deadline	Sustain progression	1=delivered in time

Other activities are designed to inspire and motivate the student to qualities such as initiative, creativity and leadership. Such activities are accessed at higher levels and are specifically designed to evaluate personal skills.

Table 2: Levels of GAel activities

Activities (and self-supply)	Assessment criterias	Level
Company, commercial projects	Entrepreneur	5
Assistance	Social skills/Leadership	4
Articles, research	Analysis/Creativity	3
Tips, resources, examples, exercises, tutorials	Initiative/Communication	2
Exercises, questionnaires, quiz-competitions	Effectiveness/Competition	1

A Level 1 student initially acquires credits by working through practical and theoretical self-competitive "quizzes". A further avenue for points accretion is to both contribute and collaborate in questionnaires, tips, news, resources or supplement terminology and questionnaire databases. As the student accumulates sufficient credits s/he may proceed to the next level. Progression through the levels engages the student in higher order skills such as the design, creation and implementation of exercises and tutorials, which might be collaboratively shared with fellow students. As indicated in Table 3, accrued credits ultimately impact upon the final grade of the GAeL enrolled student.

Table 3: GAel assessment

Factors	Traditional assessment	GAeL assessment
Mandatory Task	30 %	20 %
Exam	20 %	10 %
Diploma Project	50 %	40 %
GAeL Credits		30 %

Expected results

The authors' anticipate that the results of the implementation of GAeL will support the hitherto theoretical premise of the model. The initial design, with specific focus on cost-effectiveness of delivery, may be developed to allow for large-scale enhancement of NOROFF Instittutet's online courses. Expected results include:

- cost effective implementation
- flexible layering concept
- student updating
- increased assessment values
- increased academic output.

Cost effectiveness is an expected outcome of the implementation of the GAeL model and indeed, to ensure its long-term survival, a necessity. Implementation of the model involves overlay both manually and digitially to an existing educational program. The use of a database driven web-system to manage the game economics is preferable for large online student numbers, in comparison to the development of a full-scale game, as this method proves more cost-effective to develop and substantially more flexible once the system is in place.

Perhaps the most anticipated impact of the GAeL model, is that the application of game-based learning principles in an accessible web-based system will assist in sustaining the motivation of remote, off-campus students. The authors' experience of involvement in teaching online students suggests that online students, due to variable factors, have a propensity for slower progression and a higher attrition rate than their traditional on-site colleagues. Such difficulties are widely acknowledged and numerous causal factors are cited as responsible. The NOROFF experience indicates that many of the difficulties are due in part to the physical absence of the student from the perceived core of activity — the campus, where peers and staff meet in the collegial pursuit of learning. Another area of concern to the authors is the dearth of functional online educational programs, both in terms of the user's satisfaction and the pedagogic aims.

Through the implementation of game-based motivation principles such as; game-economics, levels, scores and increased incentive s for both progression and quality, the GAeL model assists in transposing face-to-face motivation to the educational system itself, thus resulting in a self-driven motivational system.

Additional benefits of such a system include the contribution to the updating and development of the academic content by the participating students. This ensures that the GAeL activities are continually attuned to the extension and update of the program's database of tutorials, exercises, questionnaires, feedback forum, resources, and the student assistance help-line.

Further, the additional assessment data the model generates is of value to potential employers as it delineates a student's application of both practical and theoretical knowledge.

To date, the GAeL prototype has proven an effective and successful addition to the learning process of the Noroff students. It is anticipated that such success could easily be transferred to other training/learning environments in business and industry.

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