Videogame Based Learning and the Problem of Gender Equity: Exemplifying an Androgynous Approach to Developing Computer Science E-Learning Games in Higher Education

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Abstract
Several authors have considered those virtual spaces in which videogames take place as being gendered and videogames themselves as gender specific (e.g. Jenkins, 1999; Subrahmanyam & Greenfield, 1994; Hartmann & Klimmt, 2006). Videogames are often considered to be an entry path into computer literacy for young people (Greenfield & Cocking, 1996; Kiesler et Al. 1985), if this is the case then to some degree first year undergraduate computer literacy is likely to be informed by videogame experiences. Videogames can be considered to be one of the most "engaging intellectual pastimes that we have invented" (Prensky, 2004) which suggests successful videogames as a useful model for developing sound E-Learning applications (Ebner & Holzinger 2007). However since E-Learning must be careful to avoid gender bias in the presentation of learning resources, any adoption of a videogame development model must undergo a process of "ungendering" wherein game models are analysed in terms of gender equity and suitably corrected. An actively androgynous "games for gamers" not specific genders (Subrahmanyam & Greenfield, 1999) approach is proposed and exemplified to consider how the game developer can avoid producing learning games that have some form of gender bias in the degree to which they are effective.

This paper examines the preparatory theoretical work in the development of a pilot study that employs an androgynous software approach to avoid those effects of gendering originating in videogames which can negatively affect games based E-Learning. The analysis is presented from a software development perspective and documents the theoretical considerations that led to the development of the "Class Solitaire" demo - a version of the popular "solitaire" videogame designed to teach java subclassing to first year undergraduates.

Background

It has often been acknowledged that first year computer science undergraduates appear to have considerable difficulty with OOP (object oriented programming) concepts (Cooper, Dann & Pausch, 2003). Computer Science students can come from a variety of academic backgrounds with regard to their school education and as a consequence are only prepared to varying degrees for the development of cognitive methods that can adequately cope with the concepts and application of object oriented programming techniques.

With the rise of increasingly sophisticated E-Learning technologies and content management systems in both schools and universities the last decade has seen many educators begin to consider the pedagogical value of non-traditional forms delivering learning resources. While many E-Learning resources still consist primarily of electronic delivery of traditional materials (e.g. Lecture notes/powerpoint presentations represented in a VLE (virtual learning environment)) there is a growing movement toward exploring the potential of videogames in educational contexts, from representation of lecture type material to complex data visualisation games are being show as effective tools. One popular belief is that the reasons videogames can work like this is not only due to their nature as being a game form where mastery of the instructions has to occur quickly and efficiently but also due to their popularity as a pastime amongst young people. Videogames have been described as one of the most "engaging intellectual pastimes that we have invented" (Prensky, 2004).

However one concern about videogames which holds significant impact for education is the degree to which they are ideologically sound in terms of to what degree they provide an equal opportunity of game experience with regard to age, gender, ethnicity, disability etc. As videogames developed as a form in the commercial sphere game developers targeted particular markets, to which they could consistently sell new games. The early days of videogaming whilst accessible to all showed greater sales in male games forms and as a result male game forms predominated (Subrahmanyam & Greenfield, 1994). As the console market has developed over the last two decades console names such as Nintendo's GameBoy and later virtual boy showed the target audience for such devices (Jenkins, 2001). It is perhaps indicative that console naming in general has not been so overtly gendered in recent years however other aspects of consoles particularly in the handheld market have indicated a desire to attract a stereotypically female audience for example the release of pink versions of the Nintendo DS and PSP

consoles and the release of cooking and weight-watching games.

If we are to use videogames as a development model for education we must consider the problem of gender equity, specifically that educational software cannot support any form of gender bias. This means E-Learning games have to be careful with regard to gender, yet the E-Learning developer must consider successful videogames as a development model since he/she needs to employ game models that have a proven track record in terms of usability and approachability lest using games introduces further barriers to learning through difficult interfaces and/or gameplay. The developer then is faced with a choice when developing games for E-Learning: Firstly selecting an appropriate game model and secondly analysing this model for any bias of presentation that may alienate certain users and deny an equality of opportunity within the game experience presented. The developer is faced with a choice of ungendering an existing game model or adopting androgynous game models as basis for development. This paper looks at the theoretical considerations leading to the second case where an androgynous, games for gamers (Subrahmanyam & Greenfield, 1999), model of game development has been adopted to teach basic OOP concepts in the development of the "Class Solitaire" demo a version of the popular solitaire game to teach java subclassing.

Development:
OOP E-Learning for Computer Science

Traditionally Computer science has adopted E-Learning related to OOP learning in two distinct forms:

Firstly the development of simple OOP languages directed towards teaching OOP concepts without the baggage of a more advanced and complex syntax. Some examples of these languages are Alice, Logo (OOP variants although there have been many versions of Logo throughout its long history), Phrogram, Agentsheets, Baltie, and etoys.

Secondly the teaching of OOP concepts by augmenting an advanced language development environment with visualization tools that conceptually simplify the development process by providing an easy-to-use teaching environment for the Java language. Some examples are JEliot, JPie, Bluej and Greenfoot,

Some notion of games, given their huge share of the software market, is of course central to Computer Science yet from an E-Learning perspective this is markedly different from other disciplines. In most disciplines E-Learning games are used to present learning resources in a more accessible manner so that learning delivery occurs primarily by playing games as oppose to creating them.

It is worth noting that both forms of Computer Science E-Learning described above employ games from the point of view of game creation. That is to say that they provide programming environments where the user can create games (as well as other software). Often games are provided as examples of what these programming environments can do so the role of games in this case is broadly speaking motivational as oppose to being pedagogical – that is to say that the student is likely to find games a fun form of software to create yet the pedagogical value is contained in the game creation process and not the gameplay itself:

"A review of the DGBL [Digital Games Based Learning] literature shows that, in general, educators have adopted three approaches for integrating games into the learning process: have students build games from scratch; have educators and/or developers build educational games from scratch to teach students; and integrate commercial off-the-shelf (COTS) games into the classroom. In the first approach, students take on the role of game designers; in building the game, they learn the content. Traditionally, this has meant that students develop problem-solving skills while they learn programming languages. Professional game development takes one to two years and involves teams of programmers and artists. Even though this student-designed approach to DGBL need not result in commercial-quality games, it is nonetheless a time-intensive process and has traditionally been limited to computer science as a domain." Van Eck (2006)

Thus it can be seen that, in Computer Science, Games Based E-Learning often consists not of games themselves but of software tools for game creation.
This paper wishes to consider the development of games for Computer Science in which learning occurs through gameplay, in particular the learning of OOP concepts. Learning through gameplay means that gameplay teaches a specific learning outcome. This paper considers the example of wanting to teach students the parent class/child class relationship in java. In order to help students understand that any child class extends the parent class by modifying some aspect of the parent class functionality, a form of gameplay was needed that conveys this principle and how it works as an "in gameplay" visualization of problem and solution. To develop an appropriate form of gameplay there were two main considerations: First, were there any successful videogame user experiences (Ebner & Holzinger, 2007) that could provide a model for illustrating the parent class/child class relationship in java? Second, would such videogame user experiences be equally accessible to all students.

At development time it is also worth remembering that Computer Science has a reputation as a predominantly male discipline and continued initiatives are necessary to both attract and retain female students as well as

deter male students from perceiving computer science from a gender biased perspective.

Videogames Based Learning

and Gender Equity

"While e-learning has been on the rise in industry and educational institutions for the past few years, it has also been attracting a lot of criticism due to a number of current limitations. Since learning is the result of rich and varied activities, many current e-learning environments propose passive educational models based on storing content that is distributed or consumed rather than learnt and where the current lore in the field of pedagogy gets scarce attention." (Moreno-Ger, 2008)

The above statement details one of the ongoing problems in E-Learning. Whilst the development of infrastructure technologies such as VLEs (Virtual Learning Environments) and other content management systems occurs at a brisk pace there is less consideration of more active models of delivering specific learning outcomes. Game Based E-Learning is one way in which this issue is being addressed. There is certainly plenty of empirical evidence supporting the use of computer games for teaching (Knezek, 1997; Kulik, 1994) and some authors advocate linking video games with education (e.g. Lepper & Malone, 1987; Rieber, 1996)". Also *"since the cognitive processes involved in learning are similar to and are based on those involved in playing (e.g. meaning, self-regulation, incidental learning, conceptualization, motivation and higher-order processing)."* (Rosas, 2003) it makes sense to consider gameplay as a way to achieve specific learning outcomes:

" What games allow you to do that lectures don't is to explore the solution space and ask, "What if I did this?" or "What happens in that event?" You can do that in an online or a computer-based environment." (Foreman et al., 2004).

It is this unique learning situation that videogames can provide that makes them an ideal form for delivering educational content. In effect they can provide a "pedagogical wrapper" (Burgos et al., 2007) where gameplay is contextualised by other learning materials. The use of videogames for learning also tackles some of the sociological problems of contemporary education that result from student diversity:

" the growing diversity of students means that level and prior experience of learning at the point of entry into higher education can no longer be assumed. Beginning students, at all levels, no longer necessarily 'know what to do' in response to conventional assessment tasks". (Haggis, 2006)

However there is certainly evidence and related literature to suggest a widespread familiarity with commercial videogames that can be exploited for educational purposes by using existing videogame user-experiences (e.g. Ebner & Holzinger, 2007. Burgos et al, 2007.):

"The commercial games have created a form of learning that young people are very familiar with. It's a very powerful form of learning, and the principles behind that learning are reflected in the best research we have in cognitive science."
(Foreman et al., 2004)

From a pedagogical standpoint one problem with commercial games is that they are often marketed in a gender specific manner that can perpetuate gender bias through their gameplay. One example of the commonly negative portrayal of women in action games has been commonly documented:

"Videogames are also said to reflect gender stereotypes that favor masculinity.
These effects have been proven, since video games tend to cast women as victims who are acted upon, rather than as initiators of action" (Cesarone, 1994).
To some extent gender equity is also a historical problem:

"The current capabilities of our video and computer game technologies reflect the priorities of an earlier generation of game makers and their conception of the boys' market." (Jenkins, 1999)

Indeed, historically even videogame hardware has been guilty of gender bias:

""I would suggest that the release of a major piece of hardware known as the game boy, suggests that the industry did identify its products along gender lines." (Jenkins, 2001)

Whilst commercial products are of course free to pursue gender specific markets educational products and resources must always be presented from a position of gender equity where all students regardless of gender are presented with the same learning opportunities. Such a consideration is particularly relevant in early stages of educational software development when work consists primarily of preparatory theoretical work in development of a pilot study.

The development of E-Learning games that uphold a principle of gender equity forces the developer to either ungender existing game models or use androgynous game models. From a development point of view the androgynous game model is the easiest choice since the developer can avoid making lone decisions on what constitutes gendered gameplay. In developing gameplay to teach students the parent class/child class relationship in java it was necessary to create a demo based on a successful videogame user experience that held no gender bias. The most

obvious pure choice was “Windows Solitaire”, indeed it’s pedagogical origins ensure it had to appeal to all users without bias:

*“Microsoft executives wanted Windows Solitaire (a rendering of the game's popular Klondike variant) "to soothe people intimidated by the operating system." Solitaire proved particularly useful in teaching neophytes how to use the mouse. When Microsoft first preloaded solitaire as part of 1990's Windows 3.0, clicking and pointing weren't yet second nature. By dragging and dropping cards, newbies developed the mousing fluency required to use every other Windows program.”(*Levin, 2008)

Results: Androgynous Approaches to Game Development: The “Class Solitaire” Demo

“Certain key design features of computer games are found to affect student learning more strongly. Among them …….. the embedding of cognitive strategies such as repetition, rehearsal, paraphrasing, outlining, cognitive mapping, and the drawing of analogies and inferences” (Azevedo & Bernard, 1995).

“Windows Solitaire” is easy to use, repetitive, cognitive yet extremely playable with a proven track record of popularity (Levin, 2008). Thus its gameplay contains many of the necessary elements required for the constitution of pedagogically sound (Govindasamy, 2001) E-Learning and allows students to “rehearse material” (Offir et al. 2007). The “Class Solitaire” demo represents a simple experiment at embedding OOP learning outcomes in gameplay: It is intended as a basis for further exploration into ungendered videogame based learning. It complies with the literature that suggests employing videogames as models for E-learning development yet actively considers the problem of gender equity that has arisen in commercial videogames and how we can avoid gender bias in E-Learning development by adopting an androgynous approach.

The problem of gender equity is usually stated as

“whether we need games designed specifically for girls versus game for gamers, that is, androgynous games” (Subrahmanyam & Greenfield, 1999)

“Windows Solitaire” (Fig. 1) is the perfect androgynous game due to possessing no gender bias in either the game space or gameplay. Thus any game that exploits “Windows Solitaire” gameplay and associated elements without the addition of any further gendered elements is necessarily androgynous.

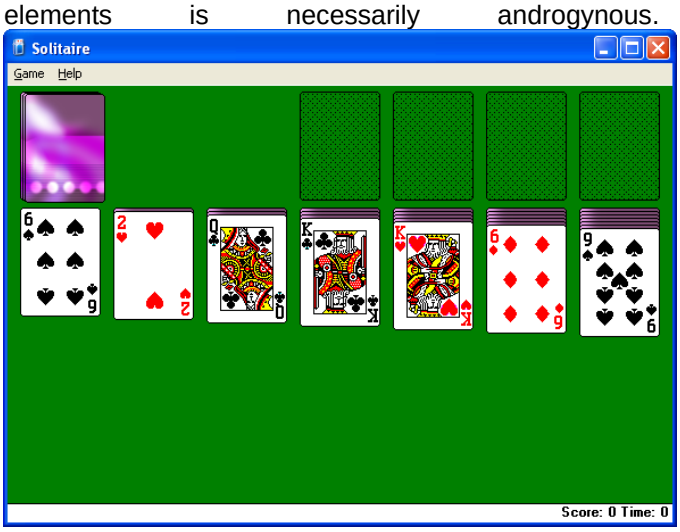

Fig.1 Windows Solitaire Game Screen

The development of Class Solitaire followed the simplest possible route to integrating a visualization of the parent/child class dependency within Solitaire gameplay. For ease of play the number of cards was reduced, the game screen rearranged and the cards themselves transformed as objects defined as classes and presenting java sourcecode with syntax highlighting on the card when displayed face up (Fig. 2).

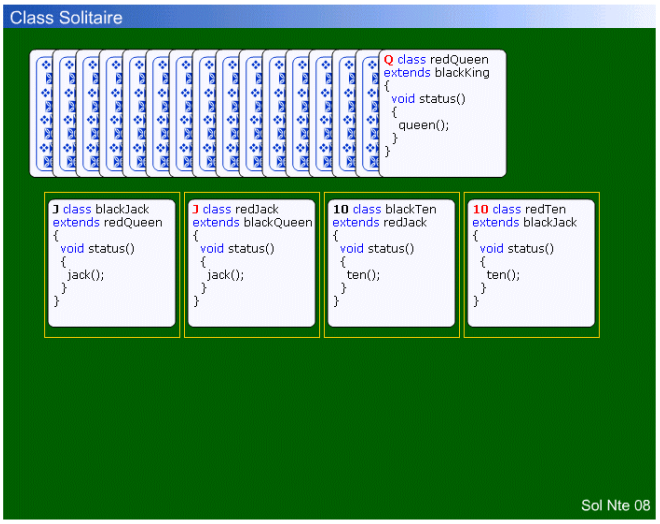

Fig.2 Class Solitaire Game Screen

The solitaire solution where red and black cards are stacked alternately is retained but emphasized in OOP terms by the java source code that lists each card as a subclass of the one above it (Fig. 3). Gameplay, where the user arranges the card to form the solution, thus involves continuous attention to the class dependencies of the cards thus exemplifying parent/child class dependency learning material and addressing the need to achieve “deep learning” by allowing students to “rehearse material”(Offir et al. 2007) through gameplay. Also implicit is the teaching of the possibility to override the status method defining

each card object's status. The use of source code on the card face affirms each card is an object and thus fits with an "objects first" (Cooper, Dann & Pausch, 2003) approach to teaching OOP.

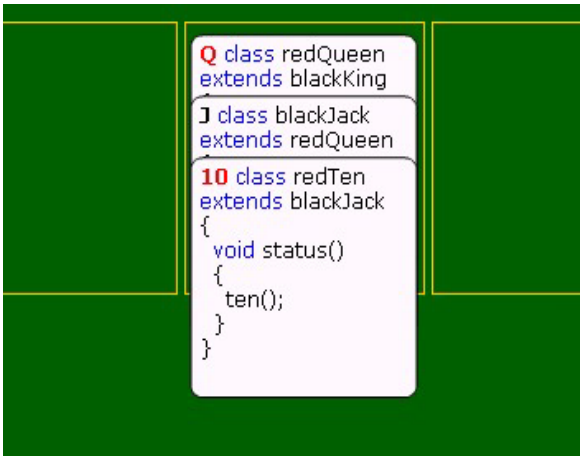

Fig.3 Class Solitaire Java Code Card Detail

This androgynous approach that emphasizes games for gamers makes casual games and puzzle games such as Solitaire ideal material for exploring the presentation of OOP concepts through gameplay that can reach the widest possible audience. E-Learning Game Development emphasizes a simple appropriation of an existing successful game form (Ebner & Holzinger, 2007) as a way of providing a starting block for a creating a demo that satisfies usability requirements. If developers adopt an androgynous approach also it is clear that it is much easier to avoid the problem of gender equity.

Conclusion

This paper has considered the preparatory theoretical work that forms part of the practical development activity of a pilot study exploring and evaluating the potential of learning through gameplay for computer science undergraduates. As such it suggests a development model arising directly from the unique software approach required for E-Learning development: Unlike commerical software development E-learning development requires prioritising pedagogy over popularity – that is to say that E-Learning software must be pedagogically sound and efficient before it can even consider being an effective learning resource. For many developers who are more familiar with the commercial model of attempting to create a user experience that will be popular and saleable the E-Learning development model is unfamiliar.

For a developer to develop effective E-Learning games he/she must follow a democratic development model and consider making products that will be accessible and enjoyable for the widest possible user base. Such products must be wholly inclusive and pay particular attention to gender equity. Games have historically often been guilty of overt gender bias where potential users could be deprived of a rewarding gaming experience depending upon their gender. It is imperative that E-Learning games do not exhibit gender bias by generating exclusive learning experiences. Androgynous development strategies offer developers a method of integrating a consideration of gender equity into the development process.

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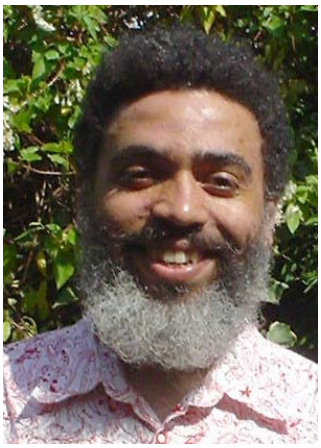
Biography



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