Being Gifted: Enhancing school performance via online educational games.

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Abstract

Whether online gaming can really enhance active student learning and performance (Gee, 2003), or Raven’s IQ test scores truly correlate school academic performance (Pind et al, 2003), remain hotly debated issues in education. We aimed to find the first empirical evidence for these two claims, as may be seen to occur within the same study. 40 pupils from a primary school in Singapore were selected to engage daily with the online e@Leader edutainment program (specifically designed to nurture learning, social and cognitive skill development), whilst also assessing individual performance with the Raven’s SPM IQ test, and school-based tests of competence in English and Mathematics. A further 40 pupils, matched for age and grade class, served as a (non-exposed) control group. IQ scores were used to assure similar numbers of ‘gifted’ (> 95%ile) pupils being represented in both groups. After five months’ daily interaction with the online learning program, all students (n=80) sat second tests of English and Mathematics, revealing significantly different results according to both IQ score categorization (gifted Vs non-gifted, p < 0.05), and online edutainment program exposure (experimental Vs control, p < 0.05). Surprisingly, a compound effect was also evident within the gifted pupils, the “e@Leader-exposed gifted” group showing significantly higher scores in post-test competences.
with both English and Mathematics \( (p < 0.02, \text{ 2-tailed}) \). Taken together, these results support claims for the use of (at least one) online educational gaming system in enhancing active student learning, as measured by school scholastic performance tests, and its putative scaffolding of higher-order reasoning skills in higher IQ students.

INTRODUCTION

Amongst the current generation of young students attending our schools, it is frequently reported that one of the most popular activities distracting them from their studies is the persistent use of computerised video games (Walsh, 2004). Accounting for as much as 20 minutes to 3 hours of choice behaviour activity per day/week (NIMF, 2002), this modern development has become of increasing concern to both parents and educators alike, many of whom are of the belief that such activities may interfere with students’ more traditional scholastic study methods and homework completion. However, little if any empirical data has as yet been put forward in confirming the fears of computer gaming activity critics (Walsh, 2004) who claim that student’s use of computerized video gaming is having a negative effect upon either scholastic achievement, or the development of core academic, cognitive or social intelligences. However, even within the modern classroom, traditional ‘chalk and talk’ methods of direct instruction, or simple frontal teaching methods are themselves becoming replaced by newer methods (including the increasing use of computer-based teaching and learning tools) for enhancing the multifariously scaffolded intelligence of pupils from kindergarten through to their high school years (Gee, 2003; Prensky, 2006). Of critical importance right now, is the determination of whether, and to what extent, the use of such alternative computer-based teaching tools (and in this case the use of a novel game-play edutainment program) may afford
the optimal nurturing and development of our pupils for the coming challenges of the 21st century, which clearly requires an increasing diversity of curricula components which can cater to the more holistic development of all students, and which may be used to complement any schools’ existing curriculum (Tan and Boon, 2007).

The question of whether, and how, such technology may be used to both increase and enhance student learning is thus a growing area of interest in educational research, and much needed empirical results are keenly awaited by both its champions and critics. In the case of the study to be reported here, the current authors set out to explore the opportunity(ies) provided by the claims for a self-paced, artificial intelligence (AI)-driven literacy, learning and intellectual enrichment activity program called e@Leader, the world's first online edutainment system to incorporate real-time autoregulatory psychometric assessment for the enhancement of student’s general intelligence. Through the use of a virtual site of this sort, students are afforded the opportunity to read, interact and learn in a fun, interesting, non-threatening environment, whilst also being exposed to a variety of social and intellectual learning challenges, new subject matter and knowledge. Indeed, as has already been proposed by Coiro (2003), frequent classroom use of the Internet, together with other web-based learning environments can promote higher levels of engagement, enhanced personal knowledge gain, and more diverse knowledge gains in terms of potential learning opportunities for pupils (although Coiro stops short of informing us how this might be achieved). With the e@Leader tool now at our disposal, this hypothesis may be tested; the perceived benefits for students using a web-based learning system to include measures of any increased general intelligence, motivation, scholastic achievement, social and intellectual knowledge development, technology skills, and pupil’s increasing ease with accepting tasks of
increasing levels of challenge and difficulty.

As Laird (2007, unpublished manuscript) has suggested, such online edutainment programs as e@Leader may “make them a rich laboratory for developing intelligent and socially autonomous agents”. However, this type of claim also remains to be tested, and there has as yet been no controlled studies (at least as far as the current authors are aware), which address specific learning aims with respect to any independent measures of scholastic achievement, intellectual, social or emotional learning content, as may be derived from interactive online game-play. Indeed, and until the current time, no complete online edutainment system has been developed which is capable of both the delivery of scaffolded tasks of increasing levels of difficulty (according to student performance success and thus autoregulation of learning challenge), together with the automated assessment of their performance with such tasks being built into its core operating system.

The current study thus aims to redress this outstanding question, and to monitor the effective use of such a program with a group of 80 primary school pupils. The research tests the explicit hypothesis that the use of an online edutainment program might enhance the intelligence of pupils, as may be reflected in their academic results, as well as in changes in other psychometric measures of their individual intelligence, in comparison with a sample-matched, non-user control group. Knowing that tests of fluid intelligence (Gf) have previously been found to correlate with scholastic aptitude (at least with regards to performance in school-based language and mathematics tests (Pind et al., 2003), and computer-based cognitive learning tasks (Jaeggi et al., 2008), indicants of student’s IQ levels need also be made to ensure that Gf might not, in and of itself, be sufficient to account for any significant variations in performance
recorded (Dickens and Flynn, 2001). We now present the first differential findings of an experiment which was explicitly designed to assess the performance of groups of primary school pupil users (versus non-users) of an online edutainment system, following a period of one year’s continuous daily exposure for a restricted period of one half hour per day. The results show unambiguous differences between the higher scholastic performance of e@Leader program users versus non-users (as measured by periodic standardized in-class primary school tests of English and Mathematics), and surprisingly so, their further (but non-confounding) differential performance, in relation to independent measures of individual student’s general fluid intelligence (Gf).

METHOD

Participants

An initial cohort of 80 English-speaking students were selected from across all levels of a single Primary School of one country, from Primary levels 1 to 6, with ages ranging from 7 to 12 years old. Students were of mixed academic ability. Students enrolling in the experimental study group (n = 40) were mostly the children of a ‘parenteer’ group, their academic ability thus wide ranging as a result of their partial-self-selection as a participant cohort. The control group comprised a comparable, matched group of 40 pupils, selected according to their academic results in terms of their school class’ baseline English and Mathematics results (as far as was possible), and studying in the same classes as their corresponding experimental group counterparts. Equal numbers of male and female students were enrolled for each age range, and treatment groups.

Design
The core study data was derived from a 2 x multivariate, longitudinal study design (see table 1 below). Critical comparison performance data was determinable from continuous performance monitoring, with pre- and post-course test data (for both experimental and control group students) obtained according to the scholastic evaluation schedule shown in Table 1, together with independent professional psychometric assessment measures.

| English and Mathematics Continual Assessment 1 | (School-based pre-e@Leader use testing) |
| English and Mathematics Continual Assessment 2 | (School-based post-e@Leader use testing) |
| General (fluid) Intelligence | (IQ [Gf] – Raven’s SPM) | (Baseline and 1 yr post test) |
| Emotional Intelligence | (EQ – BarOn Emotional Quotient) | (Baseline and 1 yr post test) |
| Creative Thinking | (Torrance – TCTT) | (Baseline and 1 yr post test) |
| Comprehension | (PII BBox Battery) | (Baseline and 1 yr post test) |
| Self Esteem | (Mod. Rosenberg test) | (Baseline and 1 yr post test) |

**Table 1. Student scholastic achievement and professional psychometric test assessment schedule.**

All of the professional psychometric testing procedures used for both pre- and post-e@Leader course testing were conducted by the same attending psychologists, each over a single 24-hr period, and completed in May, 2007 and May, 2008, respectively. Results of the pre-course testing were not made available to the test administrators or assessors prior to the completion of the post-course testing sessions, to ensure prevention of any bias treatment of participants attending subsequent testing administrations.
To evaluate scholastic achievements, standardized class-based continual assessment test results in English and Mathematics were used to indicate the academic ability of all study pupils (of both experimental and control group participants), in the context of the normal whole school examination calendar. These tests are reliable in that they provide a measure of pupil attainment in acquiring linguistic skills such as understanding and application of factual knowledge, numerical concepts, and reasoning. The tests have proven to also be of high validity, and as such are widely used with students across all the 6 levels of the chosen study school, and other comparable institutions within the same country.

Professional psychometric testing (see Table 1 above), was conducted by an independent assessment consultancy company (Global Choice Psychometrics), using standardized professional methods of administration with regards normative psychometric data collection practice, recommended procedures of individual test publishers, and the guidelines of the British Psychological Society (BPS, UK). Using the data obtained from the pre-course testing assessment of fluid intelligence ([Gf], Norm-related converted scores derived from Raven’s Standard Progressive Matrices (SPM(IQ)), an obtained score at or above the 95th percentile was employed for the purposes of further participant performance partitioning, to indicate a performance within the range of higher IQ students (“gifted intelligence”). A further target battery of customised intellectual ability test instruments were designed by the authors, in order to assess, and explicitly control for, comprehension and e@Leader Brainbox usage (by both experimental and control groups). Informed consent was invited and acquired from each and every participating student’s parents or guardians, each of whom were briefed (both verbally and in writing) as to the nature and content of the experimental design and testing procedures, and agreed to such (in writing) prior to their child’s active participation in the study.
**Procedure**

For the experimental group, all pupils were provided with a personal online e@Leader account which they could activate, launching their own edutainment program interaction sessions beginning May, 2007. A briefing session was held for invited parents or guardians of all experimental group participants, at which an explanation for the program rationale was presented, and an opportunity given for the sharing of any issues and views concerning their expectations of support and outcome.

Following this orientation session, all students enrolled in the experimental group began their access to the e@Leader on-line platform for daily sessions, for a maximum period of 30 minutes per daily session, 7 days per week. A novel and quite different edutainment game/task was made available to each student for the first time, on each of the 260 weekdays (Monday to Friday) throughout the year. Weekend access afforded students a choice interaction of game-play, which might involve their ‘playing’ any of the previous week’s games/activities according to each individual participant’s chosen preference. No restrictions with regards the time or place of service login were imposed, besides the maximum daily time limit, to cover a single daily session only, which was controlled remotely by the e@Leader service provider. Continuous site access was made available daily for a period of one year (the full length of this interactive action research study), and was completed in April, 2008.

Pre-course scholastic performance and psychometric test data was collected from both experimental and control group participants by attending psychologists, during a single testing session, conducted in April, 2007. During the interim period of September, 2007, intermediate
‘post-test’ scholastic data was again collected in order to determine the existence of any differential performance gain in terms of standard academic results. Post-course scholastic performance and psychometric test data remain to be collected (at the time of this writing), from both experimental and control group participants, by the same attending psychologists, during a single testing session, to be conducted in May, 2008. This report presents the baseline and interim results of this study with a comparison of the performances of the experimental online edutainment gaming and control groups, for scholastic achievements in English and Mathematics tests, together with an assessment of any possible effects of participant’s fluid intelligence (Gf) upon performance outcome. The full results and detailed analysis of this study’s findings will be the subject of future presentations, once the action research period and post-course intervention testing has been completed.

RESULTS

Analyses of the comparative performance of students sitting class-based assessments of competence in English and Mathematics, revealed significant mean score differences between those with exposure to the online edutainment training program, compared to the non-using control group. A summary of these results is shown in Table 2, below.

<table>
<thead>
<tr>
<th>Student Group</th>
<th>English Pre</th>
<th>English Post</th>
<th>Mathematics Pre</th>
<th>Mathematics Post</th>
<th>Pre-Post Mean Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>70.2</td>
<td>71.5</td>
<td>75.7</td>
<td>73.4</td>
<td>-1.3</td>
</tr>
<tr>
<td>Control</td>
<td>72.4</td>
<td>70.2</td>
<td>75.8</td>
<td>65.2</td>
<td>-2.2</td>
</tr>
<tr>
<td>Exptl Vs Ctrl</td>
<td>0.4</td>
<td>1.3</td>
<td>-0.1</td>
<td>8.17**</td>
<td></td>
</tr>
</tbody>
</table>

[* = p < 0.05; ** = p < 0.005]
Although starting from comparable baseline scores at the pre-course stage (mean score differences for experimental versus control groups, \( \text{MDif} = 0.4 \) and \(-0.1 \) points \((\text{df} = 78, p = 0.91 \text{ (ns)} \) and 0.98 \text{ (ns)})\), for English and Mathematics respectively), following some 5 months daily access to the e@Leader learning program, showed small but non-significant performance increases in their second English tests \((70.2 \text{ Vs } 71.5, \text{Mdif} = +1.3, p = \text{ns})\). For the second test of Mathematics, however, markedly higher scoring was observed for the edutainment gaming group \((73.4 \text{ Vs } 65.2, \text{Mdif} = 8.17, \text{df} = 39, p < .005)\). This latter observation is all the more surprising when considering that the ‘post-course’ test presented students with a much higher level of difficulty (and for which the control group showed a significant mean decrease in scoring, compared to their own baseline performance, \(75.8 \text{ Vs } 65.2, \text{Mdif} = 10.6, \text{df} = 39, p < 0.05)\).

Pre-course psychometric assessments of all \((N = 80)\) participating students included measures of each student’s fluid intelligence level \((Gf)\), as determined by administration of Raven’s Standard Progressive Matrices test \((\text{SPM})\). Results and subsequent analyses revealed that both the experimental and control groups contained participants scoring within a range consistent with ‘Gifted Intelligence’ as determined by standard psychometric test measuring schemes. Specifically, half of the experimental group \((n = 20)\) were considered to perform at the level of ‘gifted intelligence’, as did 40% \((n=16)\) of the control group, by the same criteria.

Similar analyses were subsequently conducted using the same data now partitioned according to the determinations of gifted versus non-gifted performance level results. A summary of these findings may be seen in Table 2, below. The overall pattern here may at first
appear to largely reflect that of the pooled data presented in the previous section, but a more
detailed examination reveals significant differences in that, those students determined to have
performed at the level of gifted intelligence scored consistently higher than the non-gifted group.
This was true of both the tests for English and Mathematics (and for both the pre- and post-
course sessions, (p < 0.05, all comparisons)). Furthermore, when determining the specific effects
of online gaming interaction, the sub-population of higher intelligent students showed not only
highly significant positive differential scoring in their post-course Mathematics in contrast to
non-users (p < .005, all comparisons), the same was also true of English testing (though not at an
acceptable level of significance to be a substantial effect).

Table 2. Summary of mean scholastic performance scores: for two subjects,
English and Mathematics - Gifted (n=36) and non-Gifted (n=44) groups.

<table>
<thead>
<tr>
<th>Student Group</th>
<th>(Gf)</th>
<th>Pre-Post Mean Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>English</td>
<td>Math</td>
</tr>
<tr>
<td>Experimental</td>
<td>Gifted</td>
<td>1.00</td>
</tr>
<tr>
<td>Experimental</td>
<td>Non-Gifted</td>
<td>-2.00</td>
</tr>
<tr>
<td>Control</td>
<td>Gifted</td>
<td>-1.00</td>
</tr>
<tr>
<td>Control</td>
<td>Non-Gifted</td>
<td>-3.96</td>
</tr>
<tr>
<td>Experimental Vs Control</td>
<td>Gifted</td>
<td>0.62</td>
</tr>
<tr>
<td>Experimental Vs Control</td>
<td>Non-Gifted</td>
<td>-1.40</td>
</tr>
</tbody>
</table>

[* = p < 0.05; ** = p < 0.005]  

In the light of this last finding, we next wished to re-represent and repartition the same
data once more in order to assess the possibility of this factor of student ‘giftedness’ perhaps
accounting for the main effect of the online edutainment program group’s score increases, as
presented above. Table 3 shows the mean score differences for Gifted versus non-Gifted
participant pre- and post-course test performances.
Table 3. Summary of mean scholastic performance scores: for two intelligence level groupings, - experimental vs control groups.

<table>
<thead>
<tr>
<th>Student Group</th>
<th>Student Group</th>
<th>Pre- Mean Diff</th>
<th>Pre- Mean Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>English</td>
<td>Math</td>
</tr>
<tr>
<td>Gifted Vs Non-gifted</td>
<td>Experimental</td>
<td>6.60</td>
<td>10.00**</td>
</tr>
<tr>
<td>Gifted Vs Non-gifted</td>
<td>Control</td>
<td>8.06</td>
<td>10.50**</td>
</tr>
</tbody>
</table>

[* = p < 0.05; ** = p < 0.005]

These latter results show that although the students of higher intelligence consistently outperformed their non-gifted counterparts across the different study group cohorts (and with high significance in the case of Mathematics testing, p < 0.005, all comparisons), this remained true whether or not they were exposed to the novel learning environment afforded by the e@Leader online edutainment program.

DISCUSSION

This study aimed to empirically determine whether active student learning and performance could be enhanced by the use of online edutainment gaming systems, as has been proposed by Gee (2003). A second question to be addressed within the same study, involved an attempt to examine the claims for online gaming expertise transfer as may be measurable by scholastic performance (Prensky, 2006), and concomitant enhancements (or even correlates of increments) in the development of individual student intelligence (Pind et al., 2002, Jaeggi et al., 2008).
We have now presented such effects, at least as may be indicated by increases in English and Mathematics scores in students attending a primary school, with experimental (and non-exposed control) group cohorts using the e@Leader online edutainment learning program. In the context of providing an environment specifically designed to enhance the intelligence of children learning in an educational setting, we also aimed to assess the possibility of either an increased measure of intelligence (Gf) resulting from the use of online edutainment gaming, or the putative effect of existing IQ levels affecting scholastic transfer results.

Our results are consistent with the view that the use of at least one type of online edutainment gaming platform can indeed be associated with enhanced scholastic performance, as measured by differentially enhanced scores for standardized primary school classroom-based tests of English and Mathematics. No significant effects were determined with regards data partitioning for age or gender, but putatively confounding outcome measure differences were found with regards the study cohort’s individual general fluid intelligence levels [IQ(Gf)]. Not surprisingly, students of higher Gf levels scored significantly higher in both their pre- and post-program measures of English and Math competences, but a more unexpected finding was to note that (at least for the interim data to date), the high Gf students also engaged with the online e@Leader edutainment program showed even greater increased scoring in their post-course tests (in comparison to matched high Gf students in the control group).

Although we must await the final data capture stages of the full study to be reached, it is our current belief that the environmental effects of providing specific training and curriculum content via online, computer-based edutainment gaming systems can indeed lead to increases in
scholastic performance by the transfer of core cognitive skills learnt whilst engaging with such educational tools (cf: Yung and Dickinson, 2008). Whether such a system may also be truly capable of also enhancing an individual user’s IQ, EQ, creativity level, or any other measures of socio-emotional intelligence to any significant degree, will be known soon (the post-course test data is to be collected in the months after this writing), but in the meantime we must remain content to have learned that high Gf students may indeed show even further elevated transfer performance than do other users.

REFERENCES


