Mangahigh Extended Evaluation

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November, 2012

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Executive summary

Background

Digital gaming is a popular and important part of many students' leisure pursuits and a feature of their *digital* culture. Educational technology advocates have often looked to students' leisure habits for sources of inspiration in terms of approaches to learning. The commercial significance of gaming has prompted educational researchers to consider the merits of using gaming in educational environments. There has been a recent surge in research in academic literature in gaming studies, from a diverse range of fields. Researchers, media commentators and game designers are attempting to understand the lure of computer games: how can learning resources and environments be designed in such a way that emulates the engagement and motivation levels that computer games seem to offer learners?

In addition, there are increasing numbers of empirical studies on game play that provide evidence to substantiate the use of digital games based learning (DGBL) in educational contexts. Despite this growing corpus of literature, the broader debate about gaming has typically elicited a polarised debate. Gaming has been framed in popular media as harmful and addictive, and gaming advocates have attempted to ameliorate these fears by proving the validity of gaming. As a result, the educational sector has been slow to adopt gaming as a valid tool for learning due to this conflicting information.

However, there is increasing recognition amongst academics and educators that games can provide challenging experiences that incorporate effective learning principles and sustained engagement. Teachers are now realising that they can harness the power of gaming platforms to promote student learning. Students can develop skills, knowledge and understandings in authentic contexts and simultaneously develop problem-solving and communication skills. At the same time, today's students recognise that they are not merely *playing* games but are also learning valuable skills and content while playing.

Games based learning has been identified as one technology that is expected to enter mainstream use in K–12 educational institutions in the next two to three years, according to the *NMC Horizon Report: 2012 K–12 Edition* (Johnson, Adams & Cummins, 2012). The report states, *Despite steady interest from educators, game-based learning has been tantalizingly just out of reach for the K–12 mainstream, and again appears on the midterm horizon, still two to three years away*. (Johnson, Adams & Cummins, 2012, p. 19). Educators are keen to harness the potential digital games offer in terms of learner engagement.

The *Mangahigh extended evaluation* (2012) is an attempt to provide classroom based evidence about the effectiveness of DGBL and to identify the characteristics that foster and inhibit student learning with such an approach. It is important to note that this was *not* an evaluation of the *Mangahigh* resource, but is instead an evaluation of DGBL, as a pedagogical approach.

Overview of the extended evaluation

The aim of the extended evaluation was to provide an independent review of the educational potential of digital games based learning (DGBL), in the context of *Mangahigh*, an online mathematics resource. This extended review endeavoured to build on key findings from a pilot study conducted in 2011, where nine New South Wales (NSW) Department of Education and Communities (DEC) schools participated in a trial of *Mangahigh*.

Research focus of the extended evaluation

The main objective of this extended evaluation was to evaluate the effectiveness and impact of DGBL in authentic classroom settings. This evaluation utilised *Mangahigh* as a gaming resource to consider broader issues surrounding the implementation and effectiveness of DGBL as a pedagogical approach.

The current extended review of *Mangahigh* has three broad focus areas:

- affordances of DGBL
- characteristics of teachers that impact on their use of DGBL in the classroom
- learning content with DGBL.

Methodology

This evaluation used a mixed methods research design involving both qualitative and quantitative data. Qualitative data were compiled from a combination of closed- and open-ended survey responses (from students and teachers) and teacher interview data. Teacher surveys were conducted at two points:

(i)   pre-intervention

(ii)   post-intervention.

A response rate of 96% (n=52) and 65% (n=35) was achieved for the pre- and post-intervention teacher surveys, respectively. Student surveys were conducted at the post-intervention point and a total of 235 surveys were analysed. Quantitative data were derived from survey responses and back-end analytic data from *Mangahigh*. Triangulation of data occurred through the collection of multiple sources of data (described in more detail in the Methodology section).

Scope of the extended evaluation

A total of 54 schools from New South Wales Department of Education and Communities (DEC) were initially recruited for the trial of *Mangahigh*. A total of 46 schools utilised the resource throughout the trial period, with eight schools abandoning the trial for various reasons. A total of 26 primary schools, 26 secondary schools and 2 central schools throughout the ten New South Wales (NSW) regions were initially recruited for the extended evaluation. In April 2012, Regional Directors were invited to recruit appropriate schools, given selection criteria from the Next Practice team, who are part of the NSW Curriculum and Learning Innovation Centre (NSW–CLIC). One teacher from each of the participating schools was invited to attend a one-day induction training program offered at Ryde in May 2012. *Mangahigh* personnel delivered the training with input from staff at NSW–CLIC who were also involved in the 2011 evaluation.

Participating schools were invited to use the *Mangahigh* resource with other staff members at their school for the duration of the extended review. Schools were provided with access to *Mangahigh* throughout the duration of the extended review from May to November 2012. The *Mangahigh* resource was used by a total of 1541 students, throughout the trial period, to varying degrees.

In addition to the initial teacher training day offered in May, three webinars were also offered throughout the trial period. These webinars were delivered via *Adobe Connect*. The aim of these webinars was to provide ongoing and online teacher professional learning, to enable the participating teachers to fully understand how to optimise their use of *Mangahigh*. A social networking site, *Edmodo*, was established for the participating teachers, NSW–CLIC team members and staff from Mangahigh to communicate and collaborate throughout the project.

Key findings
Listed below are the major findings for the three broad focus areas of the extended evaluation. For full details of the findings, please refer to Findings on page 39.

Affordances of digital games based learning

- *Improved student learning outcomes* – Despite there being no formal or quantitative measures of student learning between the pre- and post-intervention points, the teacher and student participants reported that *Mangahigh* had assisted in enhancing students' mathematical learning*.* Eighty-three percent of student survey respondents agreed that *Mangahigh* had improved their mathematics learning and 100% of teachers stated that *Mangahigh* use had resulted in improved student learning outcomes. However, it was inferred from that data that low- and high-achieving students benefited in different ways from DGBL. Low-achievers benefited in two identifiable ways:
    - (i)   they were able to consolidate their understanding of basic skills through repetition in a fun context
    - (ii)   (ii) they were also able to receive additional instruction, either from within *Mangahigh* or from the teacher, based on the analytic data obtained by the teacher.

    In contrast, the high-achievers were able to extend their mathematical skills and knowledge through undertaking challenges that contained more sophisticated concepts than their less able peers were able to comprehend. This evaluation did not seek comparison data: it did not aim to determine if one cohort of students benefited more than another cohort.
- *Enhanced student engagement and motivation* – Students and teachers also identified that enhanced engagement and motivation were the most tangible evidence of non-academic benefits associated with DGBL. Both the teachers and students attributed their increased mathematical learning to greater engagement and motivation. Ninety-four percent of student survey respondents agreed, to varying extents, that *Mangahigh* was more enjoyable than traditional modes of mathematics instruction.

- *Enhanced student confidence* – The teachers reported that the use of *Mangahigh* had enabled students to individually experience success on their own terms, as they were able to undertake games and prodigis (*Mangahigh* offers games and interactive and adaptive quizzes called *prodigis*) that were commensurate with their individual ability. As a result, the students' confidence improved. It is postulated that increased confidence *may* have translated into greater engagement and motivation amongst students.

- *Enhanced language and communication* – An unanticipated benefit of using DGBL was the increased mathematical language that some students demonstrated and greater collaboration amongst students. The gaming platform provided a conduit for mathematical discussion.

- *Instant feedback* – The provision of instant feedback was consistently identified in the teachers' post-intervention survey and interview responses as a critical attribute of DGBL. With *Mangahigh* the students instantaneously knew if their answer was correct and could seek to rectify any errors. The instant feedback is believed to have caused *cognitive conflict* and forced the students to instantly redress the concept or seek additional help through the in-built support mechanisms in the resource (such as *Teach me now*). Teachers reported that this made the learning process more transparent to the learners, especially when assigning *Mangahigh* challenges as homework. Students also, to a lesser extent, identified instant feedback as a key feature of DGBL.

- *Personalised learning* – The teachers overwhelmingly agreed that *Mangahigh* made curriculum differentiation more achievable and easier to execute. Using the analytic data, the teachers were able to tailor instruction to suit the individual needs of learners. It is proposed that this level of customisation contributed to enhanced student confidence and engagement that may have led to improved student learning outcomes.

- *Low and high achievers respond differently to DGBL* – The low-achieving students responded favourably to consolidating basic skills and concepts in an online platform such as *Mangahigh.* These students tended to prefer the prodigis than the games as they were able to have their learning consolidated and scaffolded in the prodigis. They were happy to revisit prodigis (or games) to consolidate their skills and understandings. In addition, the low achievers were not as motivated by the element of competition, as compared to the high achievers who thrived on the competitive elements such as the *Leaderboard.*

- *Barriers to DGBL implementation* –The participating teachers reported that reliable access to technology (both computer hardware and internet access) and time constraints limited their use of *Mangahigh.*

- *Analytic data* – The use of the analytic data was sporadic and limited according to teachers' self-reports. While 76% of post-intervention survey respondents claimed that they used the analytic data *frequently* or *sometimes*, additional survey and interview data suggested that teacher use of analytics was not as high as self-reports indicated. Of those teachers who reported that they used the analytic data, 53% reported that the analytic data provided them with an increased capacity to meet individual students' learning needs. The teachers reported that the analytic data enabled them to cater for individual leaners in two ways:

    (i)   to specifically identify the students who needed additional support

(ii)   to ascertain the precise mathematical concepts that these students were unable to master through precise diagnostic data.

Teachers could use this data to differentiate their subsequent instruction by assigning challenges according to students' ability. Teachers also reported that the analytic data allowed them to work with small groups or individual students to assist with specific concepts. While the teachers noted that this was particularly helpful for the low achievers, there was also consensus that the high achievers benefited from the analytic data as they were presented with more challenging concepts usually within *Mangahigh*. Teachers reported that they required additional teacher professional learning in regards to how to interpret and apply the analytic data.

[*Mangahigh* analytic data enables teachers to track and examine individual student performance in both games and prodigi. Data is aggregated across several challenges, allowing teachers to identify individual students' needs.]

Characteristics of teachers that impact on their use of DGBL in the classroom

- *Teacher characteristics* – There was no evidence from this evaluation that there are specific or identifiable teacher characteristics that determine the extent to which a teacher utilises DGBL in the classroom. There was a relatively even distribution of teachers in terms of their chronological age and years of teaching experience, and there was no nexus between these characteristics and their reported usage of *Mangahigh.*
- *Teacher attitudes towards gaming* – Teachers acknowledged that they needed to have positive preconceptions about gaming as a learning medium. Therefore, positive teacher attitudes towards DGBL are critical to the successful uptake of gaming.
- *Prior knowledge or skills* – The participating teachers unanimously agreed that there were no essential prerequisite knowledge or skills that teachers required to effectively implement DGBL, apart from positive dispositions related to gaming (as previously identified).

Learning Content

Most participating teachers reported that the *Mangahigh* resources were relevant, accurate, current and engaging. The following themes emerged from the data set.

- *Game design* – The teachers lamented the absence of collaborative game play. Although the students could compete with other students on the *Leaderboard* or using *Fai-To* challenges with students from other schools, the teachers claimed that students often mentioned that they would prefer to play the games against their peers, in *real-time*. This finding exemplifies how today's learners' expectations of DGBL is closely related to their out-of-school gaming experiences. Today's gamers want social game play. However, the teachers noted, in both the surveys and the interviews, that the mathematical content was embedded in the game design. It was proposed that gaming was not used in a tokenistic fashion, but was central to the game mechanic.
- *Novelty factor* – Several teachers' post-intervention survey responses suggested that there *may* have been a novelty factor associated with *Mangahigh.* It was beyond the scope of the extended evaluation to explore this possibility further. However, it is plausible, although not confirmed, that *Mangahigh* was not utilised to its full capacity with the students with whom it had a brief impact. Perhaps these students were not assigned appropriate challenges and prematurely disengaged.

- *Lack of teacher control over content* – Several teachers reported that they had limited control over the games and prodigis students encountered using *Mangahigh,* even when assigning specific challenges. Some teachers reported that students frequently encountered mathematics content, which had not been addressed by the teacher, that was beyond their level of understanding. At times, this resulted in student frustration and subsequent disengagement. Teachers lamented that they were unaware of how to restrict or limit student access to particular games or prodigis, or how to enforce students following a linear path when issued with challenges.

- *Student engagement* – There was a belief among teachers that the games, in particular, promoted student engagement, especially with those students who were typically disengaged or reluctant mathematics learners.

- *Role of overt rewards and competition* – Teachers postulated that the competitive elements contained within *Mangahigh* contributed to improved student engagement. The use of a medal system motivated *some* students. The evaluation data suggested that the high-achieving students responded more favourably to the element of competition than the low-achieving students. For the high-achieving students, competition from other peers or from students at other schools, acted as a motivational tool to succeed. However, for the low-achieving students, even when assigned appropriate challenges that were congruent with their ability, competition was not as beneficial.

- *Appropriate challenges* – The students and the teachers identified that the games and prodigis had to be appropriately challenging for individual students for learning to occur. Too easy or too difficult and students would disengage. The onus was on the teacher to use the analytic data to assign work that was congruent with a learner's ability and that would provide sufficient challenge to engage and motivate them.

- *Pace of learning* – The low-achieving students often found the pace of learning too fast in some of the prodigis and games. Despite being an adaptive tool, many teachers reported that the prodigis and games became too difficult too quickly for these students, which resulted in subsequent disengagement. Teachers postulated that many of their low-achieving students had poor procedural fluency coupled with poor literacy skills that, in turn, exacerbated the problem. Teachers explained that low-achieving students often required paper and pencil or concrete resources to aid in their comprehension, and that they were reluctant to pause games or prodigis to utilise these.

- *Student preference for games and not prodigis* – Both the teachers and students observed a student preference for games, rather than for prodigis. Seventy-seven percent of the students stated that the best feature about using *Mangahigh* was playing games. Given that 91% of student survey respondents indicated that they had previously played a game out of school, this finding is not unexpected. Today's learners' dispositions and expectations of learning with digital resources are oriented towards using technology.

- *Observed gender differences* – Male and female students displayed different levels of investment in different types of games. Some teachers who taught coeducational classes also noted differences in how the male and female students responded to the various *Mangahigh* resources. Four broad differences were reported in the cumulative data from the surveys and interviews in relation to how the male and female students responded to *Mangahigh*:

(i) the male students were described as more *enthusiastic* and *engaged* than their female counterparts at the outset of the review period, but this difference gradually dissipated over the course of the evaluation

(ii) the males showed a stronger preferences for the *action* games (see the *Mangahigh* 2011 evaluation for details of criteria for action games)

(iii) the males preferred the games, whereas the females often preferred the prodigis as they were happy to complete these independently

(iv) the males responded more favourably to the element of competition than the females.

- *Sound alignment between* Mangahigh *and syllabus* – Teachers agreed that the *Mangahigh* resources were well-aligned to the current NSW Mathematics syllabus for students in Years 5 to 9. Seventy-five percent of teachers surveyed at the post-intervention point agreed that the *Mangahigh* resources were *fairly* well-aligned to the NSW Mathematics syllabus.

- *Minimal customisation required* – The teachers reported that there was a strong alignment between the *Mangahigh* resources and the NSW Mathematics syllabus documents and, as such, there was little need for any customisation. While they acknowledged that there were a few mathematical strands that required further customisation, most of the resources were suitable in their current state in terms of the language and terminology used. The capacity to customise the text within the prodigis was proposed as a means of adapting the language and providing more contextually relevant examples.

- *Adequate syllabus coverage* – Overall, the teachers agreed that there was sufficient coverage of the NSW Mathematics syllabus in the *Mangahigh* resources. The teachers indicated that the *number* and *patterns and algebra* strands were very well covered in *Mangahigh.* Some teachers reported that they would ideally like more games.

Recommendations

Recommendations for further research

This extended evaluation has exemplified the need for additional research pertaining to educational gaming within classroom contexts. The paucity of research in this field, coupled with the key findings form the current evaluation, highlight the need for further study, particularly in classroom contexts. Further research is required to:

- explore the different ways in which high- and low-achieving students' respond to DGBL

- examine if there are inherent differences in the way that male and female students use games, and their preferences for learning with games. Increased knowledge in this area would not only inform game designers, but would be valuable for teachers looking at implementing DGBL.

- quantify the impact of the pedagogical design of games. Does the design of a game impact on what and how students' learn? Other gaming genres such as simulations, role-playing games, strategy, puzzle and adventure games may also be appealing and educationally valid.

- identify the precise pedagogical features associated with DGBL that supports learning

- provide empirical measures that DGBL is associated with for enhanced student learning outcomes
- determine if students can transfer knowledge and skills acquired in DGBL platforms to other contexts and if newly acquired knowledge and skills are retained. This requires longitudinal data.

Recommendations for teachers

The extended evaluation illuminated some critical features regarding DGBL.

- The current evaluation revealed that while there are no recognisable characteristics of teachers that promoted or hampered their use of DGBL, there was ample evidence to suggest that teachers needed positive dispositions towards gaming. Therefore, it is imperative that if teachers are going to implement DGBL approaches, that they must adopt positive attitudes towards gaming and view it as a valid pedagogical approach.
- Teachers need to view DGBL as part of a repertoire of approaches to teaching, rather than as a complete teaching solution. Teachers need to extrapolate the key features of DGBL and apply these to suit the learning goals and needs of learners.
- Teachers need to carefully consider how DGBL can support and possibly hamper students' learning, based on their learning needs and preferences for learning. This extended evaluation provided evidence to suggest that low- and high-achieving students respond differently to various aspects associated with DGBL (competition, repetition).

Recommendations for teacher professional learning

- As previously indicated, teachers involved in this evaluation indicated that teachers require positive dispositions towards gaming, if DGBL is to be effectively implemented in classrooms. Therefore, teacher professional learning needs to provide rigorous research and classroom evidence to confirm that DGBL is a valid educational approach.
- This evaluation has also demonstrated the value of ongoing and online professional learning. Ongoing, online professional development, in the form of webinars, proved to be a valuable tool for teacher learning. The digital and flexible delivery was also considered to be extremely helpful by those teachers who used it.
- Teachers' understanding of the gaming platform and the pedagogical framework in which they implement DGBL is critical to its success. Therefore, teacher professional learning needs a two-pronged approach:
    - (i) technical skills on how to utilise the gaming platform
    - (ii) pedagogical knowledge about how to best support DGBL in classroom contexts.

  This recommendation is consistent with the TPACK model that is based on the belief that effective technology integration requires developing sensitivity to the dynamic and transactional relationship between technology, pedagogy and content knowledge (Koehler, 2011). Professional learning models that focus solely on the technology are not effective models.
- The professional development model adopted in this extended evaluation could be replicated when implementing future technologies. The initial induction period provided essential technical skills and some pedagogical knowledge in regards to how to implement

the technology in a classroom setting. However, ongoing teacher professional learning is required to ensure that the technology, gaming in this instance, is leveraged in the best way possible. Just-in-time teacher training and support is also required to ensure that teachers' concerns are answered in a timely manner. Digital delivery of professional learning is also worthy of future consideration.

- In addition, the use of *Edmodo*, or other online or social networking tools has been shown to be a suitable platform for facilitating digital collaboration among teachers and professional development providers. Future teacher professional learning offerings could incorporate digital collaboration spaces to continue professional dialogue between sessions and to also provide participants to just-in-time learning.