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COLLABORATIVE HANDHELD GAMING IN EDUCATION

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ABSTRACT

This project describes the trialling of a new form of cooperative learning strategy, in the form of a game known as *EcoRangers*. *EcoRangers* is a multi-player game, designed to run on handphones, written specifically for education. *EcoRangers* is one of the first, if not the world's first, instances of this totally new genre of pedagogical tools (ie, collaborative handheld educational games).

In its current iteration, *EcoRangers* is designed to help students practise skills of relevance to the Social Studies syllabus for Grades 9 and 10 in Singapore's education system, specifically through the pedagogical strategy known as the Structured Academic Controversy, in which learners debate an open-ended problem from a variety of perspectives.

The trialling was done in three secondary schools, among fifty Grade 9 students. These students were taken through two distinct fieldwork tasks in March to July 2004, with the game being introduced as part of a post-fieldwork activity.

EINSATZ DES HANDYS FÜR UNTERRICHTLICHE ZWECKE

KURZFASSUNG

Das Projekt beschreibt den Versuch, eine neue Art von Gruppenlernen zu testen, die auf ein Spiel zurück greift, das *EcoRangers* genannt wird. Dies ist ein Spiel für mehrere Spieler, das auf Handys abläuft und ein Lernspiel ist. *EcoRangers* ist eines der ersten, wenn nicht sogar das erste Spiel in der Welt, dieser Art.

In seiner gegenwärtigen Fassung hilft *EcoRangers* den Schuelern, Fertigkeiten im Bereich der Social Studies (Gemeinschaftskunde) einzuueben (Lehrplan für Stufe 9 und 10 in Singapur), insbesondere dadurch, dass die Strategie der „strukturierten, akademischen Diskussion“ angewendet wird, bei der die Schueler ein offenes Problem aus sehr unterschiedlichen Perspektiven besprechen.

Der Versuch wurde in drei Schulen (Sek.II) durchgeführt, wobei fünfzig Schueler aus Stufe 9 waren. Diese wurden im Rahmen eines Aufenthalts im Gelaende (Maerz bis Juli 2004) mit dem Spiel konfrontiert, das als eine Tätigkeit nach dem Arbeiten im Gelände eingefuehrt wurde.

KEY DEFINITIONS AND REVIEW OF LITERATURE

One of the primary theoretical constructs underpinning the research would be Pea's idea of 'distributed intelligence' (described in Perkins (1992)). To quote Perkins, people think and remember with the help of all sorts of physical aids, and we commonly construct new physical aids to help ourselves yet more. People

think and remember socially, through interaction with other people, sharing information and perspectives and developing ideas ... People sustain thinking through socially shared symbol systems – speech, writing, the technical argot of specialties, diagrams, scientific notations, and so on. (p. 133)

Perkins develops the idea further by elaborating on three ways in which intelligence can be distributed; namely physically (describing the gamut of student output from completion of traditional problem sets, to journals and portfolios, to simple programming and desktop publishing), socially (co-operative learning), and symbolically (for example, through diagrams & charts, mental maps, and role-play).

The germ of these insights was planted in Vygotsky's cultural-historical theory of activity, first formulated in the 1920s, in which the relationships between human agents and objects in their environment are mediated by culture, tools and symbols.

These same notions of “culture, tools and symbols” are implicit in Perkins's writings. Both Vygotsky and Perkins were remarkably prescient, considering that both had developed their ideas before the widespread adoption of the worldwide web as a medium of information exchange and collaboration (let alone more contemporary technological developments such as the mobile internet).

Perkins's contemporary at Harvard – Putnam (1993) – brings to the present discussion the term ‘social capital’. This refers to social networks which go beyond traditional familial ties and connect friends and strangers for mutual benefit. Social capital is therefore the basis of collaborative behaviour.

The basic unit of social capital is information, defined by Boeck (in press) as “material which is selected by individuals to be transformed by them into knowledge to solve a problem in the specific social domains to which they belong”. In the study, the ‘problems’ in which the students found themselves are described through what Johnson and Johnson (1979) term ‘Structured Academic Controversies’.

Defined as the “deliberate stimulation of intellectual conflict by creating a highly structured situation wherein one student's ideas, information, conclusions, theories, and opinions are incompatible with those of another, and the two seek to reach an agreement by engaging in Aristotelean ‘deliberate discourse’” (Johnson, Johnson and Smith (1997)), such Academic Controversies permit investigations of the social distribution of intelligence, by building on traditional models of debate and encouraging participants to reach shared consensual values.

Such investigations exemplify Habermas's (1981) concept of ‘communicative action’ – defined as ‘the use of language with an orientation to reaching understanding. Defined thus, Myerson (2001) explains that communicative action is shared action – such ‘small-group engagement’ is the ‘process by which people come to an understanding about something’.

The study sought to apply the principles behind the design of Structured Academic Controversies to learning environments in which the protagonists were not necessarily co-located. Two such learning environments were designed – the first was field-based, and the second was a virtual world of gameplay on a handphone.

In this way, the study addressed what Detterman & Sternberg (1993) term the problem of transfer, that is to say, that producing long-term change in behaviour that persists across contexts is exceptionally difficult. Squire (2001) addressing this very issue, suggested that “designers [of interactive media] leverage the potential of other pedagogical approaches... [thus] the educational value of the game-playing experiences comes not from just the game itself, but from the creative coupling of educational media with effective pedagogy”, By designing two separate but complementary learning environments in which the identical pedagogical strategy could be practised, the study was an attempt to take up Squire’s challenge.

BACKGROUND TO THE INTERVENTION

EcoRangers was trialled by fifty Grade 9 students from Fuchun Secondary, Bowen Secondary and Christ Church Secondary Schools. The students had earlier been split into groups, with each group being taken to a different location in Singapore to conduct two distinct fieldwork tasks. First, they had to do an orienteering activity, and on a subsequent day, having been familiarised on the prior visit with the neighbourhood, they participated in a field-based debate at the same location, in which they had to explore the area to gather photographic evidence to support or refute a given point-of-view. The students recorded these pieces of evidence pictorially, using the phones, and exchanged these pictures in real time while still in the field, physically separated from each other. Students used the evidence to explore given geographical issues regarding the bounded area, in the format of a Structured Academic Controversy.

Specifically, the field-based Structured Academic Controversy task comprised the following steps:

- Each team was made up of two pairs of students. Both teams were given forty-five minutes to explore a well-delineated area, with a view to gathering pictorial evidence to support a certain point-of-view. Pairs of students from the same team were encouraged to share their findings with each other, via multimedia messaging (MMS);
- For example, teams could have been tasked to investigate the extent to which a particular neighbourhood was meeting the needs of residents of public housing;
- After the initial time-period was over, both teams were given time to engage in a dialogue along the lines of a Structured Academic Controversy. This dialogue did not take place through face-to-face interaction, but through an exchange of text- and picture-messaging, allowing the nature of the discourse to be easily archived for subsequent analysis.

Playing the *EcoRangers* game itself was conducted back in school, on an occasion subsequent to the field-based Structured Academic Controversy. Therefore, *EcoRangers* represents probably the first successful transposition of the tried and tested method of the Structured Academic Controversy to a multi-player handheld gaming environment. It achieves this by dividing the gameplay into various stages.

The stages, and how they are differentiated, are as follows (the terms ‘host’ and ‘client’ refer to one or other of the two players):

1. Exploring the environment
At this stage of the game, both players explore the virtual environment, looking for nuggets of information to either support or refute their assigned perspective on the given topic of debate. At this stage of the game, neither player can send messages to each other.
2. Presenting host’s initial perspective
During this stage of the game, the host is allowed to present his or her initial perspectives on the given topic, by composing and sending messages to the client. The client, at this stage of the game, cannot reply, but can only receive the messages.
3. Presenting client’s initial perspective
During this stage of the game, the client is now allowed to present his or her initial perspectives on the given topic, by composing and sending messages to the host. Just as the client was unable to reply during the previous stage, for this stage of the game, it is now the host who cannot reply, but can only receive the messages.
4. Debating the issue
During this stage of the game, both players are able to send messages to each other. In this way, the debate progresses and their ideas and perspectives are refined, through careful analysis from both players.
5. Presenting host’s reversed perspective
This stage of the game (and the subsequent stage as well) are critical to the learning experience for both players, for this is when they are required to reverse perspectives. During this stage, the host is required to select and adopt the best arguments from the client, and now argue them as if they were his or her very own. The client cannot reply, but can only receive the messages.
6. Presenting client’s reversed perspective
It is now the turn of the client to reverse perspectives. At this stage of the game, the host cannot reply.
7. Consensus building
At this final stage of the game, both players are able to send messages to each other, with the aim of building a consensus regarding the given topic of debate. Once the game has ended, both phones can then be given to the teacher for review of the quality of the messaging exchange that took place within the thirty minutes allotted.

ENHANCING TEACHING AND LEARNING THROUGH COLLABORATIVE GAMING

As can be seen from the above description, one of the primary objectives of developing *EcoRangers* was to give students the opportunity to practise, with minimal supervision, the strategy known as Structured Academic Controversy.

Another very important objective of *EcoRangers* was to help students realise the importance of cooperative learning as a strategy for approaching open-ended problems.

A third objective of *EcoRangers* was to present students with authentic problems which necessitated an inquiry-based approach.

Finally, *EcoRangers* was designed as a vehicle for demonstrating how the various initiatives that have been introduced by the Ministry of Education of Singapore over the past several years might possibly be manifested in a coherent way.

The strategy of the Structured Academic Controversy is of great value to the Social Studies syllabus in its promotion of an appreciation of multiple perspectives. Traditionally, Structured Academic Controversies have demanded much time and planning on behalf of the teacher, as well as in terms of the logistics of organising a debate between an entire class. For example, Watters (1995), working with college students, that the process be conducted over a series of face-to-face 75-minute periods lasting approximately a month's duration. The Public Broadcasting Service (2002) working on a shorter time-scale, published suggested lesson activities lasting a week.

By distilling the strategy to its most fundamental defining characteristics, *EcoRangers* permits learners to practise this valuable skill within thirty minutes, at times and places of their own choosing. Because *EcoRangers* is played via a wireless Bluetooth connection, players are not tethered either to each other or to a desk, and are free to move around during gameplay to suit their comfort level. Further, because each player has his or her own handset, the teacher would be able to evaluate the reasoning skills of all the students in class, with no possibility of 'sleeping' members in a team. Since gameplay takes place through the exchange of text-messages, even students who might not be comfortable with voicing their opinions aloud to the entire class would have an avenue to express their views.

With regards the objective of promoting cooperative learning, too often, students perceive the tasks and problems that they encounter as having clear-cut solutions to be approached in a binary ('win-lose') manner. By emphasising the value of sharing the data collected, as opposed to hoarding the information to themselves, students are subsequently able to appreciate that the sophistication and validity of their arguments often rest on a sharing of perspectives and information which they would not otherwise attain. In the words of one of the students who participated in the project, "I had the opportunity to work with school mates with whom I would normally have had little contact other than in class. As such, I have learned to work with others, accepting their points of view, even if they are different from mine."

Third, with regards the use of authentic problem-based learning, an example of a possible topic which students might be presented with regarding the virtual gamespace of *EcoRangers* would be the extent to which limited government resources should be spent on developing major infrastructural projects (such as an airport) as

opposed to the conservation of a wetlands habitat. Students would need to decide for themselves which pieces of information were relevant to the issue, as well as to prioritise between the search for more data and the consolidation of information already at hand. The technology enhances the teaching and learning experience because the pieces of data that the students collect in the virtual gamespace is easily customisable to the needs of learners of various profiles, as well as content interests. For example, with more independent learners, the nuggets of information could be customised such that many of them might only be of tangential relevance to the suggested list of topics. Conversely, for learners which require more guidance and structure, the nuggets might be much more explicitly related to the issues which the teacher wished the students to explore.

Finally, with respect to addressing recent initiatives, the game allows for the ready infusion of messages of National Education and concepts in Economic Literacy, by its present focus on issues pertaining to the socio-economy of the virtual gamespace; players have to exercise both critical (analysis and prioritising) and creative (perspective-reversal) thinking skills as they work their way through the game. For example, they have to prioritise which parts of the microworld to explore, given the constraints on time and the avatar's energy levels; further, they have to analyse the nuggets of information that they come across in terms of the relevance of each to the topic at hand. Players are also encouraged to take considered risks during gameplay, with respect to the balance between available resources and potential discoveries. It is our belief that by pushing the pedagogical and technological envelope in so many of the above ways, *EcoRangers* reflects the very spirit of innovation and enterprise in education that the Singapore Ministry of Education seeks to foster in students.

DOCUMENTATION OF EXPERIMENTATION AND EVALUATION

On each day that the game was trialled, two pairs of students were selected to play the game. Each student was given a Nokia 6600, and was tasked to play against the other member of the pair. As such, each pair played the game concurrently and independently from each other.

The first version of the game was played by twenty students. For that version, the mean number of messages exchanged between each pair of students was 4.7 messages per game. Based on the feedback obtained from the original twenty players, the game was improved first by increasing the density of occurrence of the nuggets within the microworld, second by making it easier for the avatars to power-up their energy levels, and third by making navigation between the different sub-regions of the virtual gamespace easier. This, current, version of the game was then played by another thirty students. This time, the mean number of messages exchanged between each pair doubled to 9.6 messages per game. This figure was equivalent to each player sending, on average, a message every two minutes.

Figure 1 is a sample transcript. The topic that the male students were discussing was "this area would benefit greatly from the construction of a large international airport".

Figure 1 about here

It can be seen that despite the fact that only a third of the thirty minutes of gameplay that the current iteration of *EcoRangers* has is actually given to each player to message the other, each member of this particular pair managed to send nearly a message per minute. Further, there was a fairly clear attempt at rebuttal (for example, “yea but people can go places faster”), at perspective-reversal about midway through gameplay, and finally at a rudimentary conclusion. While the nature of the discussion might be argued to be primitive, it must be borne in mind that these messages were typed using thumbs on a ten-key numeric keypad.

Figure 2 is a transcript of an exchange between two female students, this time on the topic “nature has not been kind to the citizens of this area”.

Figure 2 about here

Here again, the attempt at perspective reversal is clear, although no consensus was achieved. Perspective reversal is a crucial skill for these students to master because of its relevance to the Social Studies syllabus, which is designed to reward the appreciation of multiple perspectives. From the primary author’s own recent experience as a teacher in a secondary school, as well as from his interactions with practising teachers afforded him by his present position at the National Institute of Education, he knows that an appreciation of multiple perspectives, important though it is, is not easy for students at Grade 9 level to grasp. With *EcoRangers*, students now have a fun and handy way for them to practise this skill at times and places of their own choosing.

Figure 3 is a transcript between two male students, again on the topic of whether or not to construct an airport (students were not pre-assigned topics, nor were they allowed to choose them; instead topics were assigned from a list, based on the instruction to each pair to “pick a number”).

Figure 3 about here

Although one of the players in this pair was not as prolific a thumb-typist as some of his peers, this particular transcript shows clearly that he and his gaming partner did at least have an exchange of ideas, rather than simply a sharing of facts. Another salient point to raise at this juncture would be that a comparison of Figures 1 and 3 reveals the open-ended nature of *EcoRangers* – that even with the same topic, the nature of the debate and tentative consensus varies depending upon which nuggets of information were stumbled upon, and also, upon which of those particular nuggets the players chose to use.

The final transcript – Figure 4 – is an exchange between a female student and her male classmate, who is a foreign student in the school hailing from the People’s Republic of China. It is included as an illustration that *EcoRangers* is playable even amongst learners whose command of English may not necessarily be on par with their

peers. The topic was “the construction of a theme park would benefit the citizens of this area, more than the development of ecotourism”.

Figure 4 about here

Students were generous with their feedback about *EcoRangers*. Typical comments were “the game gave me an understanding of topics taught in social studies and geography. For example, I learnt more about tourism and how to attract visitors to the country.”; “the game helped me to see different points of view. It was also helpful in letting me understand social studies better.”; and “I not only honed my debating skills, but also got the opportunity to apply geographical and social studies concepts that I had learned, to make my case stronger.”

To conclude, Squire and his colleagues (2003) at the Games-to-Teach Research Team at the Massachusetts Institute of Technology have suggested several design principles of so-called ‘next-generation’ digital gaming for education. Among these are that there should be a move from parameters to ‘power-ups’, that game contexts should be designed by identifying contested spaces, that information should be used to address complex problems in simulated environments, and that choices and consequences should be provided in these simulated worlds.

It is hoped from the preceding discussion that in *EcoRangers* all four of these principles can be seen to apply. For instance, players’ avatars lose their stamina and grow hungry over time, and players must therefore make choices with regards further exploration of the microworld, or finding a suitable place to power-up with some food within their time and cost budgets. Finally, the concept of contested spaces is implicit in the game, as players explore and debate the pros and cons of land-use issues and constraints, depending on the topic chosen.

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POSTLUDE

EcoRangers earned the authors a Merit Award in the 2004 Hewlett-Packard Innovation in IT competition for schools, which was jointly organised by Hewlett-Packard and the Ministry of Education in Singapore. *EcoRangers* is trademark- and patent-pending.

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Phone ID	0037	0300
Presentation of initial position	The place is not big enuf to support big airplanes	The NEAREST airport is far
	The ground is swampy tat is why less roads were built	The people wANT TO GO FAR TO GET BETTER JOBS
	There schools around the area the airport might disturb them	Yea but people can go places faster
	Floods occur many times this is not safe	And also they are cldaring tp the place
		Factories may go on buissnes trip
Perspective-reversal	Young ppl wan to pursue better jobs overseas	
	People hav heard about the way of life overseas	The pla ce had an earthquake b4
	University is coming up 4 other ppl overseas	Wasting raw materials
Tentative consensus-building	Since the ground is swampy.. earthquakes n floods occured the place is nt suitable 4 immediate construction of an airport	Only 31percent are workers
	Tho ppl would wan to go overseas 4 better job	

Figure 1 – Sample transcript on the topic of constructing an airport

Phone ID	0037	0300
Presentation of initial position	Bicycle is the main form of transport	Flood hav ocur alot of tym
	The city is very clean	Few road bcox swamp land
	I do disagree that nature had been unkind to the citizens as the area is very clean and safe from the natural disasters	Disagr3e mayb ther is no 1 livin ther
		The place is too near to drive but too far to walk
Perspective-reversal	Nature had been unkind as there is a lot of rubbish	Forest is burnt for use of ppl
Tentative consensus-building	Nature had been kind as there is no natural disasters	
	Budden it is aso full of rubbish	Swampy land cant build road and buildin. Flood cox distaster hence nature is unkind
		Nature is unkind bcox the forest can lead to fire

Figure 2 – Sample transcript on the topic of the role that nature was seen to play in the microworld

Phone ID	0037	0300
Presentation of initial position		E mayor duty is to maintain order, nt
	Many resident stay around there and police station near by	Police gt nth to do wif airport, instead mre jobs can be fnd if an airport is built
	Pple like the place	
	Mayor is gd 4 15 years	
	Tourist go there and increase in tourist	
Perspective-reversal	Tourist go there may kill endanger speciep	If there is an airport, relationshis btw countries will b closer, we can oso help each other
	HIV case increase	
	Police protect airport	
Tentative consensus-building	Do u agree buildin airport	Yes, i agree

Figure 3 – Another sample transcript on the topic of constructing an airport

Phone ID	0010	0013
Presentation of initial position	Tis area the ppl ride on bicycle sothey its not suitable	It many schools there
	The area is prone to floodin so if a theme park is bein develop the citizens there may have a crisis for eg their house r bein flod off. So they wont have time to enjoy themselves.	There r school n clinic for locals
Perspective-reversal	The theme park can distress the citizens as they r workin in thd city and industries. It can oso make money as tourism are gd there.	The flod willaffect locals
Tentative consensus-building	To a certain extent theme park imp becos it helps tnusism	Locals learn a lot from visitor
		Some house is built for vistor

Figure 4 – Sample transcript on the topic of theme parks versus ecotourism

BIOGRAPHIES

Kenneth Y T Lim is a Teaching Fellow at the National Institute of Education, Nanyang Technological University. He has held the Chair of the Geography Teachers' Association of Singapore since 2003. He has been teaching Geography and Social Studies in a variety of educational contexts, including a military school and an independent school. He was also a pioneer member of the Thinking Programme Unit in the Singapore Ministry of Education's Curriculum Planning & Development Division. He authored The GreenAge Textbook (Federal, 1992) on environmental issues in Singapore, and more recently One World: The Essential Social Studies Resource (Marshall-Cavendish, 2002). He received his EdM from Harvard in the field of Education Technology.

Jason Y Z Wang has just received his Diploma-with-Merit in Multimedia Computing from the Ngee Ann Polytechnic in Singapore. Among the many awards he received in the course of his studies were for Best Performance in Wireless Technology, and the Student Excellence Merit Award in Technology. He is currently serving his National Service.