

Using avatars and virtual environments in learning: What do they have to offer?

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Abstract

This paper explores and discusses arguments for the use of virtual environments and interactive avatars in supporting the achievement of student learning goals within conventional educational contexts. It describes and evaluates arguments promoted by some authors (eg, van den Brekel, 2007; Deuchar & Nodder, 2003; Dickey, 2003; Facer, 2004; de Freitas, 2006; de Freitas & Oliver, 2006; Garris, Ahlers & Driskell, 2002; JISC, 2007; Martino, 2007; Prensky, 2004; Prensky, 2007) relating to advantages from gaming and avatar use, ranging from enhanced engagement in learning activities, through to more purposeful and focussed communication, and, when used in group situations, better cooperation and collaboration between students. It explores the potential of avatar environments to act as powerful communication mediums for students to display knowledge and understanding, and engage in the development of 'higher order thinking skills, such as interpreting, analysing, evaluating, synthesising and solving complex problems'.

It also introduces and discusses the avatar-based authoring program MARVIN, and identifies potential for its use as a digital storytelling tool to assist students in communicating outcomes from units of learning, and in supporting the development of a range of key learning competencies identified in the New Zealand Curriculum Framework (Ministry of Education, 2007). It profiles a successful example of the classroom-based use of MARVIN within a community project undertaken by groups of year 7 and 8 students at two Hamilton intermediate schools, and identifies how the program supported student *thinking* and *relating to others* key competencies (Ministry of Education, 2007).

Introduction

Avatars have been defined by Peterson (2005) as 'online manifestations of self in a virtual world, and are designed to enhance interaction in a virtual space' (p. 30). Deuchar & Nodder (2003) extends this by adding that avatars allow 'the user to take on a visible persona' (p. 1) within a virtual world, affording them 'the opportunity to engage in surreal and imaginary experiences that transcend the actual world in which they live' (Deuchar & Nodder, 2003: 1). While using avatars in virtual environments for social networking and entertainment purposes is now well-established, their use in educational contexts is still in its early stage of development (de Freitas, 2006), with applications being limited to early simulation games and activities such as the *Sim* series, and specialist uses mainly in science and mathematics. However, researchers such as Martino (2007), Katz and Rice (2002), van den Brekel, (2007), and Woolgar (2002), in their discussion of online object-oriented environments, claim that such environments have the potential to enhance social interaction and support connectedness, particularly among those individuals who may have difficulty facilitating communication on a face-to-face basis. They comment that the anonymity of interacting in the virtual world via a programmable avatar often enables individuals to communicate and express themselves in ways they may have been incapable of doing otherwise, thereby 'enhancing their level of social connection and feelings of confidence' (Martino, 2007, p. 9). This claim is supported by work undertaken by Katz and Rice (2002), who found evidence that cyber-relationships facilitated by the use of virtual environments generally proved to be robust and long lasting, while Woolgar (2002) claims that cyberspace can act as a support for particular social activities and relationships, rather than acting as commonly thought, as a substitute for the real experience.

Similar claims have been promoted by Antonacci *et al* (2008) in their discussion paper on the use of avatar virtual worlds in education. They state that virtual worlds hold considerable potential as powerful mediums for learning. Consistent with the studies previously referenced, they comment that benefits exist in three key areas:

1. Virtual worlds give users the ability to carry out tasks that could be difficult for them in the 'real world' due to constraints, including cost, scheduling or location;
2. Virtual worlds' persistence allows for continuing and growing social interactions, which can serve as a basis for collaborative education;
3. Virtual worlds can adapt and grow to meet user needs. (Antonacci & *et al*, 2008: 3)

Antonacci *et al* (2008) comments that engagement in virtual environments enables students to experience learning opportunities that would not normally have been easily accessible, including 'role playing, operating simulated equipment, designing and building things, or creating simulations of physical or procedural processes' (Antonacci *et al*, 2008: 4). Through these activities they claim students engage in high levels of cognitive functioning 'such as interpreting, analysing, discovering, evaluating, acting and problem solving' (*ibid*: 4), while also being supported to 'work outside traditional boundaries of reality' (p. 2). This finding is further supported by de Freitas (2006) with reference to the benefits from learner participation in the design and construction of e-learning content. She comments that engaging learners at the

development level 'put(s) the learner or user at the centre of the design process in order to meet their needs more closely' (de Freitas, 2006: 21) and that such activity can 'change the traditional role of the tutor towards one of facilitator, collaborator, producer or author' (ibid: 6).

Learner engagement

There is a significant body of research which positively links learner engagement with the achievement of learning goals and outcomes (eg, Carini, Kuh & Klein, 2004; Markwell, 2007) and more recently with the role of emerging technologies in this process (eg, Beeland, 2006; de Freitas, 2006). Increasingly, bodies of research are exploring the use of avatar-based virtual worlds for supporting student learning, with particular emphasis on the establishment of authentic, rich learning tasks, which, according to Deuchar & Nodder (2003: 257) 'provide a safe pedagogical platform to facilitate the achievement of learning goals'. Other studies (eg, Antonacci & Modaress, 2005; Foreman, 1999) are focusing on the use of virtual learning environments to foster student collaboration and teamwork, with specific emphasis on how student participation in projects involving the design and construction of these environments can enhance learner engagement and support the development of a range of skills. Foreman (1999) comments that 'avatar environments are leveraged most effectively when they support learner-centered team work', and 'through experiences that exercise team skills, students are mastering content and developing general learning skills' (p. 3). Foreman (1999) also points out that the multimedia capabilities of virtual learning environments cater for a range of learning preferences and styles, enhancing engagement and enabling learners to set their own pace and blend the range of audio, video, graphic and text-based resources to match their own informational needs. Antonacci & Modaress (2005) agrees, claiming that there is a common misconception that engagement in virtual environments is typically (by) a 'lone player, secluded in front of his or her computer' (p. 4). However, when virtual environments are used and/or constructed in groups, Antonacci & Modaress (2005) claims they provide ideal foils for collaboration, the social construction of understanding, meaning making, and process-oriented reflection. Furthermore, if authentic contexts are selected, Antonacci & Modaress (2005) comments that engagement with virtual environments can support the development of higher level thinking capabilities such as 'interpretation, analysis, evaluation and problem-solving' (ibid: 3).

Tools for supporting student thinking and communicating ideas

Since the early 1980s, visionaries such Seymour Papert have been exploring the role computer-based learning Microworlds are able to play in supporting the development of higher order thinking skills, advanced mathematical concepts, and problem-solving capabilities. Papert theorised that the value of student engagement in such tasks was not limited to the final outcome, but lay in the complex mathematical ideas and concepts being explored while developing the procedures, problem solving programming errors, and designing and interacting in the resulting microworlds (Papert, 1980).

In many ways, engaging students in designing and developing virtual worlds inhabited by programmable avatar characters for the purpose of communicating ideas and knowledge, is akin with Papert's thinking around the educational value able to be derived from microworld development. Papert defined microworlds as,

a subset of reality whose structure matches that of a given cognitive mechanism so as to provide an environment where the latter can operate effectively. The concept leads to the project of inventing Microworlds so structured as to allow a human learner to exercise particular powerful ideas or intellectual skills ... (Papert, 1980: 204)

Papert's original definition emphasised factors consistent with the features of virtual worlds as introduced previously—namely the representation or construction of a 'virtual reality', and the promotion of a range of intellectual skills and metacognitive capabilities.

These ideas are further extended by diSessa (2000), who comments that more contemporary microworlds allow students to communicate their learning and,

... engage in tasks of value to them, and in doing so, they come to understand powerful underlying principles. You might come to understand ecology, for example, by building your own little creatures that compete with, and are dependent on, each other. (diSessa, 2000: 47)

According to Mayer (2001), it is the capacity of Microworlds to support *model building* as opposed to *model using* that distinguishes them from simulations, 'where a student uses a model built by someone else, usually a teacher, in a learning activity ... (whereas) in model building, students are given access to the modelling or programming tool to build their own models' (Mayer, 2001: 554).

The following case study explores the above concepts through detailing early exploratory work undertaken by a group of year 7 and 8 students using an avatar-based program known as MARVIN for the development of a series of learning microworlds based on a 'Community Promotion' Social Studies/Language theme. It examines the value of using this program for the enhancement of the Key Competencies¹ of *thinking* and *relating to others* (cooperation/collaboration) from the New Zealand Curriculum Framework (Ministry of Education, 2007).

The MARVIN project—an exploration of student-developed avatar virtual worlds within the context of a community-promotion-based unit of learning

MARVIN is an avatar-based presentation and storytelling tool described by its developers as,

¹The NZCF Key Competencies are derived from the UNESCO Definition and Selections of Key Competencies for the 21st Century (DeSeCo) project. A discussion of these in the context of the New Zealand Curriculum Framework (2007) can be found at: http://www.nzcer.org.nz/default.php?products_id=1805

... produce(ing) multi-sensory presentations or stories that include recorded voice (in any dialect), synthetic voice, music, text, photographs and animated characters ... It can be used for any presentation, narration, story, information sharing, or training task. (NTICED, 2008)²

Originally developed to assist the state government in Australia's Northern Territory to convey critical health information to indigenous Aboriginal populations, exploratory work has been recently undertaken in schools on MARVIN's use as a storytelling tool through which students are able to relate knowledge and understanding via the development of virtual information environments. According to promotional information published about the software, MARVIN 'is a computer program that uses animated characters to share important messages about services, business and culture in indigenous languages ... it can be used within the community, by the community, and using local community dialect' (Gillard, 2008, press release). The open-ended design of MARVIN as a virtual story-authoring tool enables local media in a variety of forms to be used as content. The program uses a range of avatar characters to present content and information within a 'virtual world' that has been planned, structured, and built by the author for the purpose of communicating important ideas or concepts. In addition to a range of animated characters, MARVIN contains a variety of multimedia tools through which data in a variety of forms can be organised and then presented by the avatars. These include: text to speech functionality (including textual thinking and speech 'balloons'); a variety of character gestures, movements, and animated sequences; and a library of graphical backgrounds, images and music. There is also the capacity to generate and import sounds and images from other sources to suit the unique needs of particular projects.

Exploratory work with MARVIN by students in two Hamilton Intermediate schools in New Zealand focused on its use as a tool for communicating key messages from a unit of learning relating to 'Promoting our City'. The unit concentrated on students identifying facilities and features of their city which are strengths and make it unique, why people chose to live there, and some issues which need to be addressed to make it a more attractive place in which to live. The units were based on an inquiry learning model³ in which students were involved in generating responses to a range of research questions, and presenting outcomes from their investigations to specific audiences using MARVIN. These audiences included civic leaders from the local city council, staff from the city council's promotion and publicity division, and the general public via an open promotional forum held at the city chambers. The planning of the units also referenced the New Zealand Curriculum Framework's (NZCF) Key Competencies (Ministry of Education, 2007), with two specific competencies being identified by the teachers for development through work in this unit—namely *thinking*, and *relating to others*.

²Refer to <http://www.marvin.com.au/marvin/>

³Inquiry is a constructivist-informed approach to learning, in which students have 'ownership' of their learning. It starts with exploration and questioning and leads to investigation into a worthy question, issue, problem or idea. It involves asking questions, gathering and analysing information, generating solutions, making decisions, justifying conclusions and taking action

Research method

Research was conducted in two urban Intermediate schools (578 and 417 students and 49 and 25 staff respectively), with a total of five classes of year 7 and 8 students being selected to participate in the study. The participating classes were selected to ensure a balance of student capabilities, and included lower ability, average, and gifted and talented classes. Teachers from each of the five classes were involved in preliminary workshops which introduced them to literature related to the use of avatars in learning, and took them through the initial processes involved in designing and developing animations using MARVIN. They were also introduced to the processes involved in designing digital stories using techniques such as storyboarding, and shown a range of production and editing procedures.

The preliminary workshops were an important component of this research. For most of the teachers involved, while they were competent users of ICT in their learning programmes, it was their first exposure to avatars, and it was necessary to establish a soundly based rationale for their use, as well as identify how and where they could be integrated with their planning and contribute to the overall goals of the NZCF, in particular the Key Competencies. To achieve this, a range of research summaries, including some reviewed briefly in the introduction to this paper, were issued to the teachers in advance of the workshops, and the first hour or so in each workshop was allocated to exploring and debating the relevance of concepts and ideas contained in them. While initially there was some minor teacher resistance to this, once teachers became involved in reading the material and the professional discussions that ensued, it was gratifying to note a considerable change in their attitudes as they came to realise the breadth of possible learning and the potential for greatly enhancing the engagement of their students in the topic being studied. Some also commented that having to undertake professional reading aligned with the practical elements of the workshops was highly valuable at a personal level, as the combined approach not only helped to expand their own ICT 'technical' capabilities, but also clarified in their own minds *why* and *how* using such technologies could be beneficial to their students.

In addition to the professional reading and the practical workshop components, assistance was also provided by the researchers to help the teachers plan their units to ensure that MARVIN was integrated appropriately, and that the Key Competency focuses of *thinking* and *relating to others* were incorporated into the content and activities. This support took the form of regular after-school visits to the school during syndicate planning time, where researchers worked alongside the teachers in identifying where and how MARVIN could contribute to the communication goals of the unit, and how it could be linked to the NZCF Key Competencies. The unit involved students carrying out inquiry-based projects focusing on different aspects of community promotion and development, and then designing and producing avatar-based movie clips of up to three minutes in duration, to present the results of their investigations to their target audiences.

Data collection

An interpretive methodology was applied to this study. The goals of interpretive research can be loosely defined as the revealing of participants' views of reality (Lather, 1992), and was selected as a suitable framework for this study as it enabled the researchers 'to work within a world of multiple realities, and study the manner in which people operate, interact, and make decisions, based on the way they view and attempt to make sense of the world' (Falloon, 2005: 82).

Data were collected from teachers using a range of procedures including pre- and postintervention teacher interviews, a survey, student observation, video analysis, the recording and transcribing of staff meeting presentations where some teachers shared their experience with colleagues, and an article relating to their experience produced by the teachers, for the media. The principal, deputy principal, and ICT coordinator from one school were also interviewed. The data collected from students included videoed working sessions where dialogues with peers were recorded, postintervention interviews, and the archiving of video clips produced by students as part of the intervention. Key Competency 'themes' were extracted from the transcripts and triangulated against the other data sources to confirm their validity.

Primary research question

Data collection and analysis was guided by the following primary research question:

To what extent, and in what ways for this particular student group, does using MARVIN to communicate outcomes from a unit of learning provide an engaging medium to support the development of the Thinking and Relating to others Key Competencies from the New Zealand Curriculum Framework (2007)?

This study is relevant to the New Zealand context as the New Zealand Ministry of Education seeks to identify ways in which its significant investment in ICT in schools is able to support the objectives and focus of the new national curriculum framework launched in October 2007. It also has wider significance in terms of exploring the potential of learning technologies of this type to support the development of broader skills and dispositions, such as those identified in the OECD's Definition and Selection of Key Competencies (DeSeCo) discussion papers on educational, social, economic and environmental priorities for learners in the twenty-first century.

Findings and discussion

Qualitative data gained from both student and teacher interviews clearly indicated the high motivational value of using MARVIN to communicate outcomes from this unit of learning. From the outset, it was apparent that the students found working in the avatar-based environment provided them with a flexible and creative medium within which they could construct their knowledge representations, and that the availability of avatar characters which had been 'customised' with their own school uniform and accessories added to their sense of ownership and identity (see Figure 1). A number of students commented that the ability to develop unique designs suited to their particular

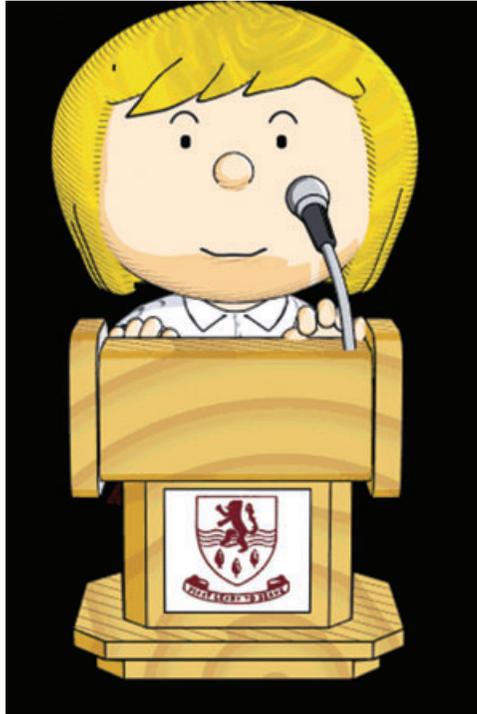


Figure 1: A MARVIN avatar dressed in the school uniform with school prop

informational needs and purposes was one of the strengths of the program, in that backgrounds and characters could be selected as appropriate to the information needing to be communicated, and the audience it was intended for,

... MARVIN is really cool because they have all the different characters to show things and you can put in your own backdrops and stuff. It's a new way of showing your work ... (my clip will make other people want to see Hamilton and all the cool things about it (ER, 2008, transcript, 0.59)

Consistent with the literature reviewed earlier, data from this study also indicates that the use of MARVIN assisted some students to communicate their understanding in a manner which they saw as less intimidating or embarrassing than 'fronting up' personally to an audience, and that this gave them confidence to get their message across accurately and completely.

As one student put it,

... you would not feel embarrassed because you are doing it (the presentation) in front of a computer, instead of doing it in front of a live audience. You can make sure you put everything into it without feeling nervous ... (ER, 2008, transcript, 1:30)

While it needs to be acknowledged that the use of programs such as MARVIN should not be seen as a substitute for the development of public presentation skills, in this instance there is little doubt that it did support the participation of a number of quieter students who may have otherwise struggled to become engaged,

... the students found the software instantly engaging. We were able to use it as a creative medium for presenting the findings of our Social Studies unit ... MARVIN completely engaged *all* students and they can get a message across effectively (Richardson & Woodcock, 2008: 32)

However, as one of the participating teachers reflected, while motivational and engagement levels were high, there was a need to initially invest a considerable amount of time in allowing the students to explore and solve problems for themselves, and to accept that mistakes and debugging was an integral part of the learning process. As with any new application, it takes time to learn how things work, and while in the opinion of the teachers this was time well invested, it could prove challenging in an already crowded curriculum,

... for teachers who want to get the reluctant writers/readers into developing a story, then MARVIN does just that. It is animated, has neat characters, you can make them talk, record etc. However, it takes a lot of time, patience and problem solving (HW, 2008, transcript, line 108)

Interestingly, the high level of engagement with MARVIN was not restricted only to the students. The principal of one of the schools commented that even the most reluctant members of her staff were keen to be involved, with two of the most reluctant 'literally "muscling themselves in" to be able to use the MARVIN with their classes even before the end of the pilot' (Principal 1, 2003, Q.3).

In addition to enhanced engagement and motivation, the study revealed that where the teachers organised students to work in groups on their research and presentations, they considered there was superior collaboration and interaction in the development of outcomes, as compared with other situations where group structures were used. One teacher commented that he had particularly noticed that students were keen to share solutions they had found to problems, and that quieter students were being 'drawn in' to participate and share their ideas more readily than in the past. He felt that when used within an inquiry framework and in conjunction with peer tutoring, MARVIN offered an ideal 'foil' to build collaborative skills and teamwork, thus supporting the objective of the *relating to others* competency,

... (using MARVIN) goes hand in hand with 'Relating to others'. It certainly encourages peer interaction. I originally paired my students up with a buddy and there was a lot of communication and ideas passed between the groups. Some of my quieter students were enthusiastic to share new ideas or new things they had found out about their character and stories (HW, 2008, transcript, line 46)

This was also reflected in interview comments made by the students, one of whom in commenting on the experience noted, 'I have learnt to communicate my message more



Figure 2: Avatars were used to communicate specific messages to target audiences

clearly and to work as a team to get the job done. I also learnt that to make my stuff successful, I should keep it simple so it is effective' (NA, 2008, Q.2).

Students in this study also appeared to be aware of the need to ensure the messages they were conveying were appropriate to their target audience, and that they developed and used the most suitable content and language to get this across. The identification of a specific issue, problem, or activity which, if addressed, would improve the image of the city, and the target group concerned with addressing this, was part of the initial planning work undertaken by the students. (see Figure 2)

This resulted in a range of presentations focusing on such things as street safety, fighting ethnic prejudice, eliminating tagging, reducing pollution, showcasing their city or school, or raising their community's profile. It was apparent during this unit that the students maintained a tight focus on these key messages, the intended audience, and the purpose for the presentation. There was also a strong sense of social responsibility displayed by many students, as illustrated by comments such as,

... if more people knew what happened, we could all do something about it (CR, Q3)

... our goal is to inform everyone ... and make people have second thoughts about polluting (JS, Q3)

... my goal is to change the attitude towards tagging. My target audience would be school kids like me (RT, Q3)

... my MARVIN clip tells about (my city ...) so more people could visit it (HB, Q3)

Such attributes are consistent with the focus of the Relating to others competency, which primarily aims to develop in students 'the ability to interact effectively with a

diverse range of people in a variety of contexts ... and work effectively together, (to) come up with new approaches, ideas, and ways of thinking' (Ministry of Education, 2007: 12).

Findings pertaining to the *thinking* competency were coded against an adaptation of the revised Bloom's Taxonomy of Thinking: Cognitive Domain (Anderson & Krathwohl, 2001). Data were gathered for this from student video files and their final MARVIN presentations which were saved onto DVD for later analysis and coding.

Elements of both *lower order thinking* (remembering, understanding and applying) and *higher order thinking* skills (analysing, evaluating and creating) were coded from the video clips collected during this study. As illustrated in the table below, the sample group of students represented by this data used the full range of thinking skills at various times during their outcome development, from lower order recall to higher order evaluation and knowledge construction and communication (Table 1).

While it is difficult to fully grasp the nature and significance of this in the absence of other contextual information and via a description on paper (as opposed to viewing the videos), excerpts from the video captures provided clear evidence supporting the value of collaborative group structures in raising the thinking performance of students, in this instance. This particularly related to the manner in which ongoing inter-student debate, negotiation, compromise, discussion and seeking of clarification of, or justification for, ideas, helped in the presentation design, refinement of content, and solving of problems. Analysis of student discourse revealed an iterative 'cycle' where ideas and comments were continually challenged, as students in pairs refined and modified both the processes and content of their work in reaching an optimal outcome. This is supported also by comments made by one of the teachers, who observed,

... the program does encourage students to think and problem solve at a high level. Early in the trial, students experienced glitches where they really had to think and then re-think how to overcome a problem. Definitely lots of problem solving was required! (HW, 2008, transcript, line 10)

The relevance of initial presentation planning and storyboarding was also raised by one teacher, who commented that although such a procedure was useful in the initial stages to ensure each group had a focus and a reasonable idea as to how key messages would be conveyed, it was necessary to be flexible when it came to presenting this using the avatars. He commented that although students knew *what* and *how* they wanted information to be presented and detailed this in their initial planning, sometimes they encountered technical limitations or other issues which restricted their ability to do this. On occasions this resulted in changes or adaptations to the initial designs,

Table 1: Examples from one student group of Thinking skills utilised during the inquiry unit

<i>Integration of Bloom's and revised categories</i>	<i>Examples from the MARVIN clip</i>	<i>Evidence in data time code/MARVIN event:</i>
Remembering. Recognising/recalling data or knowledge.	Reciting or quoting data from memory.	0:46 Remembering and quoting the names of the community house workers the group talked to.
Understanding. Comprehending the meaning, translating, interpolating, and interpreting instructions and problems. Stating a problem in own words.	Explaining in one's own words the steps for performing a complex task, translating ideas into a computer spreadsheet or an idea into their MARVIN data gathering survey.	0:18 Translating the avatar's presentation into Maori; using Relating to others Key Competency so that the presentation may address another segment of the audience.
Applying. Using a concept in a new situation or unprompted use of an abstraction.	Applying concepts discussed in class related to community building and concern for the environment, in a novel situation.	1:09 Going to the targeted park that needs intervention.
Analysing. Separating material or concepts into component parts so that its organisational structure may be understood. Distinguishing between facts and inferences.	Troubleshooting by using logical deduction, recognising logical fallacies in reasoning. Separating the concept of community building and concern for the environment into components parts, as described with time code elements.	Breaking concept into components. 0:46 Meeting community house workers and discussing their role 0:54 Learning the role of community constables 1:09 Mapping out and identifying the community locations that need their input, and identifying the nature of the desired input and developing a plan to carry it out.
Evaluating. Checking and critiquing using standards. Making judgments about the value of ideas or materials.	Selecting the most effective solution or people to address an issue. The message acts out the value of 'walking the talk' by not only talking about cleaning up pollution, but taking personal action and leading by example.	1:26 Turtle avatar grows a rapid rash: 'excuse my rash; this is what happens when I see a lot of rubbish'. Discussing and agreeing upon who should be targeted for action, and how individually and collectively they can act to help address the problem.

Table 1: *Continued*

<i>Integration of Bloom's and revised categories</i>	<i>Examples from the MARVIN clip</i>	<i>Evidence in data time code/MARVIN event:</i>
Creating. Synthesising or building a structure or pattern from diverse elements. Putting parts together to form a whole, with emphasis on creating a new meaning or structure.	Designing the MARVIN media clip conveying their public health message that pollution is not only an aesthetic issue, it is also a public health matter and that the community at large bears responsibility. The clip designer integrated information from several sources to address the point they identified in the planning phase, and then built the animated presentation to communicate outcomes from their research.	1:29 Turtle avatar: 'my rash is gone; there must be no more rubbish'. Avatar-delivered presentation demonstrates the integration of information from surveys, web and library research, interviews and a media report in arriving at a summary of recommendations for collective and personal action to address pollution concerns.

... having a storyboard and concept maps earlier on helped the students focus on how they wanted their stories to evolve, but the real thinking came on how to develop their stories using the tools provided (HW, 2008, transcript, line 10)

However, whilst maintaining some flexibility was important, the value of planning in producing a quality outcome was well-understood by the students, one of whom commented, 'I have learnt that it is very important to have a storyboard so that you will keep on the subject' (RT, 2008, Q.1).

Summary and conclusion

Whilst acknowledging the limitations of this small scale study in terms of its 'generalisability', initial data suggests that when an inquiry learning model is combined with the use of avatar-based virtual environments for the presentation of unit outcomes, a powerful, motivating, and educationally valuable learning opportunity can be created for students. The important elements of this include the identification of a 'real world' context upon which the inquiry can be based (and outcomes communicated), the adoption of student-led approaches to the identification of questions or problems to be investigated, the use of collaborative small group or pair structures in the development of outcomes, and the availability of flexible and 'customisable' software which best affords the opportunity to communicate outcomes in a way (and using content) suited to intended audiences. Within such an approach, data again suggests that clear opportunities exist for students to further their capabilities in the competencies of Thinking and Relating to others (Ministry of Education, 2007). However, the study also indicates that the extent to which this can occur is reliant upon the pedagogical approach and

stance of the teacher in terms of their views on 'ownership' of learning, and their adoption of organisational structures such as collaborative groupings.

Evolving research on the use of MARVIN in schools will concentrate on how the 'blend' of curriculum design, pedagogy, and the technology itself can be optimised to further the broader goals of the Key Competency framework (Ministry of Education, 2007), and enhance the attainment of curriculum learning goals generally.

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