Pedagogy for Education on Sustainability: Integrating Digital Technologies and Learning Experiences Outside School (LEOS)

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ABSTRACT

This paper reports on an inquiry into designing effective pedagogy to enhance students understanding on environmental education and its importance. This inquiry sought to provide insights on how to better plan for Learning Experiences Outside School (LEOS) and ways of integrating out of school activities with classroom practices using digital technologies, namely Moodle. This included identifying perceptions of students, teachers and Informal Science Institute (ISI) staff, of these experiences using semi-structured interviews, before, during and after the visit and assessing students' learning experiences. This naturalistic study was conducted in a rural private religious school in New Zealand and comprised two phases. In the first phase, 102 Year 10 (14-year-old) students and 10 teachers visited an Informal Science Institution (ISI), a pest-controlled native forest called Island Ecological Reserve on the second last day of the year. It appears that LEOS was seen as a reward, instead of an informal learning experience where students could construct knowledge through social negotiations. The second phase occurred the following year, and 65 from the same cohort of students now in Year 11 (15-year-olds), visited the same ISI, to learn about why protecting New Zealand's biodiversity is an issue, The important biological ideas about biodiversity, and differing viewpoints that people have about biodiversity. In this phase, there was emphasis placed on pre- and post-visit planning using a digitally integrating learning model. Data comprised photographs, field notes, unobtrusive observations of the classroom, student work books and teacher planning diaries. Student assessment results showed a significant increase in performance in achievement.

REGIONAL CENTRE OF EXPERTISE ON EDUCATION FOR SUSTAINABLE DEVELOPMENT

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INTRODUCTION

Science curriculum worldwide encourages schools to draw upon non-traditional resources to enhance the learning of science; in particular to engage in learning experiences outside school (LEOS) (Bamberger & Tal, 2007; Falk & Dierking, 2000, 2012). Informal science institutions (ISIs) provides contexts and resources for expanding the curriculum, reinforces key concepts, and provides links to real-world situations such as ecosystems, zoos, museums, and observatory. It is argued that such informal settings create opportunities for students to develop interest, readiness, and capacities to pursue science learning in school and beyond (Falk & Adelman, 2003; Falk & Dierking, 2012; Falk, Randol & Dierking, 2008; Roschelle, 1995).

While this may be true, an increasing number of students' worldwide continue to view learning of science to be difficult as it constitutes the learning of abstract science ideas which seldom relate to their everyday lives (Fensham, 2004; Mallya, Mensah, Contento, Koch, & Barton, 2012). Classroom practices continue to be teacher dominated where the lessons lack opportunities for dialogic discourse (SoonChunLee, 2012; Tytler, 2004). A related issue is the problem of highly didactic science teaching in many developing countries, something which has been exacerbated by an intense regime of summative examination (Coll & Taylor, 2008; Vulliamy, 1988).

This calls for a shift from the normative nature of classroom discourse to developing a learner-centered curricular where there is an integration of formal, non-formal and informal instructions (Newton, Driver & Osborne, 1999; Osborne, Simon & Collins, 2003; SoonChunLee, 2012). This move represents a deliberate attempt to shift from teacher-dominated, highly structured classroom learning to more flexible learning that takes into account students' prior conceptions and interests, and in which teachers are expected to focus on the learner and not on delivery of mass content.

An example of how some countries have tried to shift away from traditional pedagogies is in New Zealand, the context for this inquiry. New Zealand began substantial curriculum reforms in 1991, when the science education system went through a massive redevelopment programme, with curriculum statements replacing syllabuses (Ministry of Education [MoE], 1993). The New Zealand Government through the development of a national strategy for environmental education entitled *Learning to Care for Our Environment: Me Ako ki te Tiaki Taiao: A National Strategy for Environmental Education* (Ministry of Education [MoE], 2015) encourages the development of increased understanding of the environment and environmental decisions through the science curriculum which is essential for a sustainable future. While there are eight learning areas which make up the *New Zealand Curriculum*, the *Guidelines for Environmental Education in New Zealand Schools* (Ministry of Education [MoE], 2015) do not add to the curriculum requirements of the schools. Instead, these are used to assist teachers to identify opportunities, within the national curriculum statements to plan and provide education *about*, *for* and *within* the environment. To what extent is environmental education incorporated within the science curriculum continues to be determined by the trustees of each school, but most importantly, how teachers structure learning which draws on all elements of effective pedagogy and focuses on empowering students to take action for a sustainable future.

There are four key concepts in environmental education; interdependence,

sustainability, biodiversity and personal and social responsibility for action. Environment Education, *EE* is a critical theme which is evident throughout *The New Zealand Curriculum* (Ministry of Education [MoE], 2015). The school-based curriculum on *EE* supports holistic teaching programmes and learning pathways which enable the learner to engage purposefully with the environment. One of the ways some schools engage in this theme is by becoming an *Enviro-school*[1] and provides programmes which support young people in planning, designing and implementing sustainability actions that are important to them and to their communities. The *EE* national achievement standards are designed for senior school learning programmes and uses assessments which are mostly internally assessed. Most secondary schools adopt learning approaches which integrates all four concepts in *EE* by taking learning experiences outside school (LEOS) which motivates the learner, provides opportunities to engage with the environment, and potentially helps produce better learning outcomes. In this case study, *Rural High School* used a learning management system, Moodle, to integrate learning about EE using LEOS with classroom practices in order to enhance students' experiences on impact of natural events and human actions on New Zealand forest ecosystems.

ENVIRONMENT EDUCATION AND ITS IMPORTANCE

Environment can be described as our surrounding, which is made up of air, water, and land, plants and animals, people, their communities, and their social and cultural values. Guidelines on environmental education provided in the national curricula details the essential learning areas, essential skills, and attitudes and values that would enable students to develop the qualities needed to successfully create, contribute to, and participate in a sustainable future (Ministry of Education [MoE], 2015).

Education for sustainability is an integral part of the New Zealand Curriculum. It is a way of helping individuals and societies to resolve fundamental issues relating to the current and future use of the world's resources. However, simply raising awareness of these issues is insufficient to bring about change. Environmental education must strongly promote the need for personal initiatives and social participation to achieve sustainability. In New Zealand, environmental education is not one of the eight learning areas (Ministry of Education [MoE], 2015). The curriculum encourages teachers to adopt a multi-disciplinary approach to learning that develops the knowledge, awareness, attitudes, values, and skills that will enable individuals and the community to contribute towards maintaining and improving the quality of the environment.

According to the (Science in the New Zealand Curriculum [MoE], 1993), the aims of environmental education are for students to develop:

- Aim 1: Awareness and sensitivity to the environment and related issues;
- Aim 2: Knowledge and understanding of the environment and the impact of

[1] An Enviroschool is a school which provides a particular programme which helps students go on a unique sustainability journey through exploration and discovery, where they develop learning and language, care and creativity, relationships and responsibilities suited to their developmental stage. What emerges is a connection with nature and a sense of belonging to the environment and community. http://www.enviroschools.org.nz/enviroschools-programme

people on it;

- Aim3: Attitudes and values that reflect feelings of concern for the environment;
- Aim 4: Skills involved in identifying, investigating, and problem solving associated with environmental issues; and
- Aim 5: A sense of responsibility through participation and action as individuals, or members of groups, whānau, or iwi, in addressing environmental issues.

Environmental issues related to a sustainable future are often complex to teach and for students to learn in traditional classrooms. Multidisciplinary holistic teaching and learning approaches are therefore appropriate for meeting the aims of environmental education. Such approaches allows for experiential learning where students get the opportunity to experience and use all their senses (holistic). This could take place in indoor but most importantly in outdoor settings (Osborne, Simon & Collins, 2003; Şentürk & Özdemir, 2014). That is experiential learning is more than learning by doing. It involves a process of experience, active reflection, conceptual understanding and a re-orientation towards new ideas. It allows participants the opportunity to try out their new understandings, ideas and behaviours to create deeper understanding. One of the ways of achieving this is by providing learning experiences outside the school which will be discussed next.

LEARNING EXPERIENCES OUTSIDE SCHOOL (LEOS): IMPLICATIONS FOR SCHOOL SCIENCE

A number of terms are used to describe learning that takes place outside school. Terms such as "education outside the classroom", "outdoor education", "outdoor pursuits", “informal and non-formal learning”, “outdoor learning”, “free-choice learning”, and "adventure education" are used extensively in this field, sometimes interchangeably, but differences exist in the approaches and goals of each. By using a neutral term like LEOS, a variety of ISIs can be examined, along with other outdoor activities or field work such as the study of estuaries, streams and marine ecosystems (Dillon, 2012; Dillon & Scott, 2002; Osborne & Dillon, 2008; Rennie, Feher, Dierking & Falk, 2003; Tal, 2012).

LEOS is associated with high levels of motivation underpinned by attributes of choice about what one wants to find out and to do with, so with a clear sense of purpose. This type of learning opportunities helps develop new ways of thinking, interpreting, analysing information, which in turn leads to the development of scientific skills. In contrast, the classroom based curriculum may be limited by less sophisticated resources, constrained by fixed-step curricula and restrictive teaching strategies (Griffin & Aubusson, 2007; Hsi, 2007; Lelliott & Pendlebury, 2009). This incongruence between students’ formal and informal learning environment necessitates the need to explore natural learning processes that operate during LEOS and the need to relook at the ways science is taught and learnt in schools.

There are two types of LEOS used by schools reported in the literature: One where the teacher leads the visit (Lucas, 2000; Tal, 2012; Tal & Morag, 2007), and another where the visit is guided and facilitated by ISI staff, such as an education

officer or guide (Cox-Peterson, Marsh, Kisiel & Melber, 2003; Tal & Morag, 2007; Tofield, Coll, Vyle & Bolstad, 2003). In both cases, the teacher is responsible for providing learning or curriculum objectives, and this typically includes conceptual learning, enrichment, social and emotional engagement, improving attitude to science, changing pace, and reinforcement for certain content or merely to have fun (Bamberger & Tal, 2007; Falk & Dierking, 2000; Rennie & McClafferty, 1995, 1996). As noted above, one of the most common objectives for LEOS is to increase motivation, interest and attitude, which is believed to result in greater long-term cognitive impact than factual knowledge that can 'disappear' after a short time (Rennie & McClafferty, 1995, 1996). However, the literature suggests that if such objectives are to be actually achieved, then teachers need to prepare students for these learning experiences, and not just expect or hope that learning occurs naturally when students go on ISI visits (DeWitt & Storksdieck; 2008; Gilbert & Priest, 1997; Hein, 1998).

The literature goes on to say that in order to enhance the learning outcomes in science, it is important to integrate out-of-school learning with classroom practice (Orion & Hofstein, 1994). This could be achieved if teachers actively engage in pre- and post-visit planning with strong curriculum links (Anderson & Zang, 2003; Rennie & McClafferty, 1995; Tofield et al., 2003). Some authors argue that lack of integration of field-based experience with students own prior experiences during planning means students are rarely engaged in small group activities during LEOS (Tal, 2012; Morag & Tal, 2009). Skilful and thoughtful educators are sensitive to the learning needs of children, and adjust their facilitation to maximise the development of independent learning that is self-regulated, personally meaningful and motivated. These teachers look for personal 'hooks' for learning when planning for LEOS (Emmons, 1997; Waite, 2011), and ensuring constant communication with ISI staff when planning the trip jointly. An example is when teachers draw upon students experiences and knowledge of local fish, breeding conditions, and diseases when planning for LEOS in marine studies.

A number of authors have reported that the value of LEOS is allowing and encouraging collaborative learning (e.g., Dillon, 2012; Farmer, Knapp & Benton, 2007; Whittington, 2006). The literature also suggests that context is integral to what students learn, observing that knowledge is a product of the context in which it is learned (Rogoff & Lave, 1984; Solomon, 1983). If school knowledge is to be made meaningful to students, it might then benefit from links between school science and the real world which can be achieved by providing learning experiences outside school.

However, school science needs to take more into account of students' out-of-school science learning experiences and develop greater consistency to synthesise learning across formal and informal domains (Aubusson, Griffin, Kearney, 2012; Coll, Gilbert, Pilot & Streller, 2013; Rennie & McClafferty, 1995, 1996). ISIs typically do offer features to guide teachers to develop new teaching strategies, especially strategies that focus on active learning (see McGinnis, Hestness, Riedinger, Katz, Marbach-Ad & Dai, 2012; Osborne & Dillon, 2008). Active learning requires a change in both how science teaching is done in classrooms as well as the role of teachers in facilitating learning. Science learning tasks need to enable rich conversations that extend beyond formal school settings. This would involve design and mediation of school-based projects utilising new media literacies (NML), collaboration and creativity which resonate with student

experiences as digital natives and LEOS provides us with an opportunity to do this. Next, we discuss student learning in digital space

STUDENTS LEARNING IN DIGITAL SPACE

Students' informal participation in digital space is altering their social identities, style of learning and patterns of communication (Coll, et al, 2013; Green & Hannon, 2007; Facer, Furlong, Furlong & Sutherland, 2003; McFarlane & Sakellariou, 2002). The large scale availability of the Internet as a learning environment for non-formal and informal learning has changed rapidly and dramatically. The use of digital media for interaction has become, in a short time, a normal daily activity and many students cannot imagine the world without digital media. The literature recommends the use and promotion of the Internet to produce and publish work, critique and analyse important topics where students exchange ideas and learn as a community (Hickey & Whitehouse, 2010; Jane, Fleer & Gipps, 2010; Rodrigues, 2010; Sawyer, 2006). These social spaces enable collaboration and conversation among students, where they share ideas with and question each other, the teacher and other experts. However, central to this type of learning is autonomy and independent learning which would require high levels of support if students are to flourish in intellectually challenging science learning environments (Aubusson & Griffin, 2008; Warschauer, 2007). Further emphasis is placed on the key role of teachers in these collaborative project-based science tasks, in modelling and mentoring to support self-directed processes, especially with students who require learning support. Students need teachers' support to help understand the broader context of their school science experiences and also for developing skills for appraising evidence, recognising social and other influences and implications for decision making (Osborne & Hennessy, 2003; Warschauer, 2007).

While consideration for learning at ISIs such as museum and zoos, digital space, and through science research and display events such as science fairs can help generate high levels of engagement, enjoyment with patterns of deep involvement and commitment, these features are equally capable of failing young students (Aubusson et al., 2012). However, when they succeed, a set of characteristics of participation that become evident includes: Autonomy, interactions with other peers, artefacts, parental and teacher support, and a creative display of communication in their social spaces, which has increasingly become more digitalised.

The literature on ICT use in education suggests that its use also helps motivate students to learn (Rodrigues, 2010). This motivational impact on students' learning helps afford ownership and control with respect to the pace of learning and choice of content (Ryoo, & Linn, 2012; Van Rens, Pilot & Van de Schee, 2010). ICT-integrated learning in science also is reported to help enhance new literacy skills, creativity, social skills and digital competencies (Lewin, 2004; Walsh, 2007). The uses of ICT also have reportedly had an impact in the area of science interactions and collaboration between students and between students and teachers (Jonassen, 1994; Linn, 2003). ICT has become an important interactive tool in most New Zealand classrooms. The integration of classroom learning and other activities such as LEOS can draw upon ICT - in particular learning management systems. LMS are software applications that have a number of operational features which

are useful for administrative tasks as well as having affordances for use in classroom practice. LMS are also referred to as '*learning platforms'* and combine a range of course or subject management and pedagogical tools to provide a means of designing, building and delivering on-line learning environments. Moodle, an acronym for *Modular Object-Oriented Dynamic Learning Environment*, is an open-source software package, widely used in secondary and tertiary institutions in New Zealand, including the school used in the case study described below.

The nature of a LMS is consistent with a social constructivist theory of learning, which presupposes that learning is best achieved in social environments, and the notion that any form of communication (virtual or real) can be used to enhance the social presence of others, and thereby facilitate learning (Downes, 2005). A LMS is then a 'pedagogical space', where the teacher and the learner may be geographically separated, but are connected via knowledge construction processes, and who communicate via discussion *forum*, submit assignments via email or digital drop box (Downes, 2005; Siemens, 2004). This new type of social space and its social networking features can facilitate numerous types of interactions, whereby students can develop a new sense of 'self' and 'community' -something that can be mediated, negotiated and if necessary continuously renegotiated. Many research studies report that when using interactive materials, students not only learn more - and more quickly and more enjoyably - they learn the much needed life skill of learning how to learn; that is, they begin to take ownership and responsibility for their own learning (Ryoo, & Linn, 2012; Siemens, 2005; Van Rens, Pilot & Van de Schee, 2010).

THEORETICAL FRAMEWORK

Recent research on EE points to a need to diversify teaching and learning approaches that draw on all elements of effective pedagogy and focuses on empowering students to take action for a sustainable future (Dillon, 2003; Berryman & Sauvé, 2016). The use of LEOS according to St John and Perry (1993) serves to bridge the 'critical disjunction' which exists between science and popular culture. Tofield et al. (2003) stress that there is often lack of teacher preparation, and Tal and Steiner (2006) assert that teachers mainly play a passive role during LEOS, such as managing student behaviour rather than actively mediating, encouraging and questioning students' findings. School visits are mainly controlled by the teacher to meet certain learning outcomes; however, some degree of choice is appreciated by both teachers and students (Bamberger & Tal, 2007; Falk & Dierking, 2012; Rennie & McClafferty, 1995, 1996).

Additionally, students are inherently excited about LEOS because it involves changes to their daily routine, but ironically their very excitement may inhibit learning (Bamberger & Tal, 2007, 2012; Jarvis & Pell, 2005). Therefore students' experiences at ISIs need to be focused by the use of well-organized teaching plans. Unfortunately, with the exception of a few studies reported in the literature, it seems that most teachers fail to provide adequate preparation for their students, and seldom plan much in the way of effective learning activities (Griffin, 1994; Griffin & Symington, 1997; Jarvis & Pell, 2005; Tofield et al., 2003). The literature further reports that children do not necessarily link their classroom-based experiences with the curriculum that teachers taught, the pre-visit classroom activities, nor the educational objectives with their ISI visit. These experiences are seen as unrelated activities/events. There are

also reports in the literature that little monitoring of learning occurs during visits - leaving students unclear about how the LEOS relates to instruction in the classroom (see, e.g., Anderson, Piscitelli, Weier, Everett & Taylor, 2002; Kisiel, 2003a). Therefore, teachers need to engage in planning for LEOS, which considers students' prior knowledge, foci, interactions, and reactions during LEOS and, most importantly, the context in order to more effectively design robust learning activities.

While the type of learning experiences which occurs in out-of-school settings is complex and involves cognitive, affective and social aspects of learning and multiple and interrelated outcomes, it seems clear that students learn by collaboration where knowledge construction is mediated by artefacts and dialogues (Ash & Wells, 2006). Learning is seen as a system of participatory competencies and activities, which means that individuals actively engage in group discussions to find answers to complex questions (Leinhardt & Knutson, 2004). This process is important for investigating the way school trips allow for students to discuss complex questions and the role adults play in mediating and encouraging these dialogues. Mediation, which is provided by objects, symbols and humans, is a central idea proposed by Vygotsky (1986) which is helpful to understand learning in out-of-school.

If Vygotsky's (1986) theory sees children develop in social or group settings, then the appropriate use of communication technology, such as computer-generated programs to mediate these dialogues, could enhance field trip experiences. Technology provides essential tools with which to accomplish the goals of a social constructivist-based classroom. There is, however, only a small body of emerging research on the contribution of digital technologies in out of school settings (Rennie, 2007). Digital space allows students significant autonomy and this encourages active participation (Lewin, 2004) and students are also reported to become self-directed, negotiating their own goals, expressing meaningful ideas and displaying a strong sense of collective ownership (Willett, 2007). Peer mentoring and modelling by more knowledgeable friends, siblings and other adults are distinctive features of these informal e-learning experiences (Gerber, Cavallo & Marek, 2001). Common interests can emerge in these digital networks and knowledge can be built collaboratively (Siemens, 2005).

The current literature describes ICT in terms of *Web 2.0 Technologies*, collectively known as *New Media Literacies* (NML), (Gee, 2003; Jewitt, 2008; Leuhmann & Frink, 2012; Livingston, 2003; Rodrigues, 2010) generally support the notion of constructivist style of learning (Downes, 2005), allowing for easy viewing and creation of content along with capability for sharing, editing, commenting, connecting or tagging, all means which allow others to interact with the content created. Learning management systems such as Moodle is a *Web 2.0 Technologies*, which provides a means for dialogue, discussion, and interactive debate that leads to the social construction of meaning (www.moodle.org) Students can 'talk' with other students, teachers, and professionals in communities far from their classroom. LMS is used here as a learning platform which offers affordances for students to provide evidence-based arguments and explanations, to analyze and synthesize data and to defend conclusions. These activities are done by collaborating via *forum*, a feature of Moodle, and /or sharing documents using the new media literacies (NML). Learning can be facilitated in such a way that the perception of social presence is increased by the use of a LMS; this in turn greatly increases the ability to substitute ICT for face-to-face interactions while achieving the same learning outcomes (Richardson & Swan, 2003). Since collaborative or group learning characterizes informal learning, it is

proposed here that the use of NML via LMS could be an effective way of enhancing learning outcomes in EE which features well in this inquiry.

RESEARCH AIM

The research in this work sought to examine the potential of LEOS to improve education for sustainability. The motivation for the research was the literature reports that students fail to see science as related to their own lives (Griffin, 1994, 2004; Griffin & Symington, 1997; Rennie, 2007); they like being outside school (Bamberger & Tal, 2007; Jarvis & Pell, 2005, Tal, 2012) and, that there are a multitude of ISIs that focus on potentially interesting and relevant topics (like Bird Sanctuaries and Eco-Parks) (Allen, 2002; Brown, Collins & Duguid, 1989; Falk & Dierking, 2000; Griffin, 2007; Leinhardt & Knutson, 2004; Rennie & Johnston, 2007; Tofield, Coll, Vyle, & Bolstad, 2003; Tal, 2012) . Motivation to learn along with student interaction using digital technologies might be stimulated by interesting outdoor learning experiences. It is also noted that many ISIs invest a substantial amount of time and resources to help students and the public to learn science. The overall aim of this work was to ascertain how the learning of education for sustainability might be enhanced by the use of LEOS integrated with digital technologies, particularly *forum*. This inquiry was explored using two research questions:

RESEARCH QUESTIONS

Viewing learning settings using a semiotic lens helps us to consider the questions, "How are the messages representative of recurring patterns in a our culture's production of human meaning?" and "What messages must we, in light of current environmental challenges, rethink and perhaps disrupt?" The ways that students are impacted by these culturally constructed structures depend on social and personal developmental influences that are both internal and external (ACNielsen, 2004; Eco, 1976; Taylor, 2003; Yarbrough, 2001). Learners are consumers of sign and symbol systems. They are also symbol users. One of the larger goals of education is to enhance the capacity of learners as sign interpreters. Another goal is to help them learn to be creators and users of sign systems. Understanding the complex ways that we use these sign and symbol systems provides powerful insight into how we communicate with learners in environmental education settings. The intention of this work is to provide resources to help educators consider new ways of conveying positive environmental messages, and thereby, new ways of *inhabiting* learning environments to embrace new and more positive environmental behaviors and actions.

> *Research Question One*: Are New Zealand teachers' classroom practices in teaching EE using LEOS effective in producing the desired learning outcomes for developing scientific understanding as evaluated against the New Zealand Curriculum achievement objectives?,
>
> *Research Question Two*: Does pre- and post-visit planning of LEOS using the *forum* feature of Moodle improve the learning outcomes in EE as evaluated against the New Zealand Curriculum achievement objectives?

METHODOLOGY

The methodology employed in this inquiry was a qualitative case study approach, where multiple interviews and observations were conducted over a considerable length of time (ca. 12 months). The inquiry sought to provide insights on how to better plan for teaching EE using LEOS integrated with digital technologies, particularly *forum*, creating an integrated learning model. Such intensive, ongoing use of qualitative methods was of particular importance in order to gain a better understanding of the classroom practices involved in LEOS and to better prepare for pre- and post-visit activities to help enhance learning of EE. The qualitative methods used in this case study approach are good for investigating issues in depth (Anderson & Arsenault, 1998; Anderson & Ellenbogen, 2012). Table 1 below shows the 6-step process used in this inquiry.

Table 1: Six steps: Integration of LEOS with Digital Technologies

1. Pre-visit: Semi-structured focus group interview: *Can you tell me the purpose of this visit?*
2. Observation of classroom practice before the visit: *What type of preparation is done in classrooms for the visit?*
3. Observation of the type of interactions between teacher, student and ISI staff at the ISI: *Was there any opportunity for free choice learning?*
4. Post-visit: Semi-structured focus group interviews: *What have you learned from the trip?*
5. Observation of classroom practice after the visit: *Did the classroom lesson draw upon the information gathered at the ISI?*
6. Use of digital technologies, Moodle, to integrate learning: *Were forum site used to allow for collaborative learning to occur?*

Phase One: Traditional Practice in Teaching EE using LEOS

Phase one of the inquiry sought to gain a general understanding of how *Rural High School* (a pseudonym) prepared students for LEOS. This included observations of classroom activities, content and thematic analysis of relevant documentation such as curriculum material and student assessment results, teacher planning diaries, interviews with all stakeholder groups, taking field notes during out-of-school visits and inspection of student workbooks. This phase involved 102 Year 10 (14-year-old) students and 10 teachers who studied a topic on *Pest Ecology* where they worked in groups and collected data from the tracking tunnels (pre-designed boards with peanut butter and black ink) which were set up around their school. The pests which were expected to visit these sites were feral cats, rats, stoats and ferrets. The data was to be collected from each class and pooled, and subsequently used by students to write their interim reports. It was intended then that visiting the ISI, *Island Ecological Reserve* (a pseudonym) would provide students with an insight to what was being done on a larger scale to control pest populations. All interaction between the ISI and the school were conducted via the Teacher-in-Charge (TiC), without involving Year 10 subject teachers.

The tracking tunnels were left out for two weeks, collected and the footprints studied to identify the pest population around the school. The teachers were rather unhappy when this revealed only cat foot prints, which they felt could not be used as evidence towards completion of this project. The reason given was that the project

was on investigating the rat population in the *Rural High School* community and so the TiC decided to use data collected from the previous year for this project. The students were asked about their expectations of an actual ISI visit, and their views were probed on how the ISI visit fitted into classroom activities. Their perceptions of ISI visit were similarly elicited by a post-visit interview. The teachers' objectives for the visit were similarly elicited and perceptions of the visit again developed from post-visit interviews. These data were triangulated with pre- and post-visit activities, examination of students' work that was related to their ISI visit, and unobtrusive classroom observations, using semi-structured focus group interviews and students assessment results.

Phase Two: Integrating Informal and Free Choice Learning in EE via Digital Technologies

The Year 11 Science programmes are at Level 6 of the New Zealand curriculum, and this intervention study is based on the strand called *Making Sense of the Living World*. The achievement standard AS90926, *Issues of Protecting Biodiversity in New Zealand* (MoE, 2007) required students to collect and process information and write a report which discusses why protecting New Zealand's biodiversity is an issue, the important biological ideas about biodiversity and the differing viewpoints that people have about protecting biodiversity. *Rural High School* is an *Enviroschool* [1] and is affiliated with Enviro-Organizations who help provide specialist assistance not only with information on this topic, but also work with teachers and students at *Rural High School* to regenerate the *Rakau Paina Stand* (New Zealand Pine Forest) of the school which was once badly damaged by pests and pathogens. This provided an excellent opportunity for non-formal learning, which was also conducted outside school.

In this phase of the study, each student group was made up of eight participants, characterised by diversity in gender, academic ability and experience in NML. Five groups of eight students in Year 11 (15-year-olds) were told about the purpose of these interviews; most of them were the same students who were interviewed for the first phase of the study. The teachers were advised of the procedures to be adopted during this phase of study, which included free choice learning, data collection pre-visit, during-visit and post-visit which involved the use of digital technologies, namely *forum*, to help integrate learning and improve the learning outcomes for this standard. The teachers were required to be part of the learning community and be actively involved in moderating the postings on *forum* made by students. This engagement was intended to help ensure students were guided in their knowledge construction processes when interacting via Moodle.

RESEARCH FINDINGS

Phase One - Classroom Practice: Pest Ecology-Investigating the Rat Population in [Rural High School] Community and Pest Impacts on Island Ecological Reserve

Pre-visit: During class time, students had visited the Website of the ISI and read about its history, funding and its importance. Teachers reported that they had covered concepts such as food chains, food webs, ecological niche, biodiversity, biosecurity, nutrient cycles, energy flow, predator-prey relationship, and human influence on ecosystems. The teacher's went on to say that they wanted students to experience a live setting to appreciate the fragile nature of ecosystems, and they felt that the

learning gained at the ISI would reinforce what was covered in the classroom. "The visit should be done while the topic is currently taught and not on the second last day of school". They saw their own roles as merely maintaining discipline, and "not anything to do per se" during the visit. They all expected the "experts" to share their knowledge with the students.

During the visit: All students evidenced wonderment about seeing a 200 year old *Tuatara*, a native lizard, and the *Kakapo*, a rare, endangered bird, and climbing up the tower to appreciate the scenic view. The other most popular activity with the students was seeing the variety of traps used in pest control, even though they had seen pictures of the same traps on the ISI Website. None of the students reported knowing what was going to happen at the ISI before the trip, besides the fact that they were visiting it to "study wildlife" (Student Interviews, 04 December, 2013).

Post Visit: Feedback from focus group interviews with students after the visit suggested two learning outcomes were achieved; namely, low level factual recall of information, and the increased motivation to learn about the fragility of New Zealand ecosystems. The students reported that while they enjoyed the visit to the ISI, they wanted the learning to be more interactive. They were keen to share their findings with their peers to identify the level of understanding they had developed about pest control. These students stated that one way to find out if they have learnt something is when they can "share that understanding with their friends" (Student Interviews, 05 December, 2013).

Interviews with students suggested very limited knowledge of the different features of Moodle. The only function noted of this learning platform was a repository of resources. However, students in their interviews said "that one way to find out if I have learnt something is when I can share that understanding with my friends" (Student Interviews, 27 March, 2014). This statement tends to suggest that there was a possibility of creating a community of learners where students shared their thoughts and ideas using a learning platform. In the intervention phase of the study, *forum* was used to create a collaborative learning environment.

The findings from this part of the study led to the following six recommendations:

- To maximize learning outcomes, LEOS should be facilitated by pre-planning and post-visit activities, all of which should be strongly linked to curriculum objectives;
- Students should be made aware of the learning activities for their visit to the ISI;
- Students should be involved in planning for LEOS, where their ideas are considered, and the trip must include some free choice learning;
- Trips to ISIs should be planned to run concurrently to the topic being taught in the classroom;
- To maximise student interaction during LEOS, the ISI staff should be informed of the objectives of the visit in order to prepare targeted activities, which enabled group discussions; and
- Features of Moodle, such as *forum* should be used to enhance informal learning, enabling collaboration between students and between students and teachers before and after LEOS.

These 6 ideas were in fact implemented during intervention study giving rise to the research findings which are discussed next.

Phase Two: Integrating Informal and Free Choice Learning in EE via Digital Technologies

The standard explored was AS90926: *A Biological Issue*, *Protecting Biodiversity*, which belonged to *Making Sense of The Living World* strand (MoE, 2007). This strand focused on living things, and how they interact with each other and the environment. Here, "students are expected to develop an understanding of the diversity of life, life processes and ecology, and of the impact of humans on other forms of life. As a result, it is intended that they will be able to make decisions about significant biological issues, such as the sustainability of New Zealand's unique flora and fauna and its distinctive fragile ecosystems" (MoE, 2007, p. 45).

Pre-Visit Activities: Students had used *forum* to prepare for this trip. It was also intended to find out if students envisaged using Moodle as a collaborative tool, excerpts of which follow:

> *Interviewer*: Can you tell me what activities you have done prior to the visit?
> *Martin*: We have learnt how to use Moodle *forum* and we have been grouped up to discuss the topic with each other.
> *Laura*: We had been shown how to use *forum*. We did some work on *forum* and discussed why fungi in Moana Island were both good and bad and should we conserve it. It was fun. While I thought we should kill it because it causes diseases, my friend suggested to keep it because it is endemic to our country. I like debates.
> *Interviewer*: Can Moodle be used to collaborate between students?
> *Joseph*: You can talk to each other, participate in multiple *forum* discussions and post articles for other students to read.

During the Visit: Being an *Enviroschool*, the teachers were able to seek assistance from the Regional Council Team (RCT) who looked after *Enviroschool* and were experts in biosecurity and pest control measures. The TiC, Mrs. Lomas included the School Career Advisor to accompany them to the ISI which they had visited last year, *Island Ecological Reserve* to look for opportunities for student to do volunteer work during school holidays. She also invited Mr. Linc, ISI staff from *Island Ecological Reserve*, to be with the students at the *Rakau Paina Stand*, which was a Pine forest adjacent to the school, in the morning before they visited his ISI in the afternoon. This arrangement was envisaged to maintain consistency in the theme which students had to learn about. Ms. Audrey, the team leader of the RCT set up six stations in the *Rakau Paina Stand*, which contained information on biosecurity related to diseases affecting plants, biodiversity which included the impact of possum on native plants, and biodiversity with reference to control of weeds.

An example discussed was "what would you do if a disease was found to have affected the pine trees in the North Island?" (Field Notes, ISI visit, 04 September 2014). Students were asked to work in groups and present their findings to the station leader. More discussions followed between ISI staff and students after students presented their work (Field Notes, ISI visit, 04 September 2014). All teachers helped facilitate discussions between students and between students and ISI staff to ensure that they were learning what was required of them at each station. "I now understand when dad and I go duck shooting; dad always tells me to clean all our gears. We could have brought some weed seeds with us. The *Purple nutsedge* is highly invasive and it competes with agricultural crops and can completely smother other native plants".

Post-Visit Activities: Feedback from ISI staff showed that he experienced excitement amoung students to learn the topic and that the lessons were very interactive.

> *Interviewer*: What do you think the students learned?
> *Mr. Linc*: I guess that there are a lot more involved in looking after biodiversity than what they were aware of, especially in terms of the different organisations.
> *Interviewer*: How do you think they have learnt that?
> *Mr. Linc*: Oh because the students had the opportunity to interact with different professionals, and this would help them to learn better and see the different roles they play in protecting the species.
> *Interviewer*: How do you know they have learnt that?
> *Mr. Linc*: The students asked questions whenever information was shared. This shows engagement and that they understand better. Also, these students had visited us last year, so that helped them relate to things better.

Feedback from Ms. Audrey from RCT showed a similar finding. The students had developed better understanding on issues related to biosecurity and biodiversity.

> *Interviewer*: How do you think the trip went?
> *Ms. Audrey*: Extremely well. When I started with the first group, I had to probe their thinking, but after they visited other stations and came back to me, they had gained enough prior knowledge and could process and utilise these in the "what if scenarios" which I had for them. They could articulate what they had learnt from other stations and really think of solutions.
> *Interviewer*: What do you think the students learned?
> *Ms. Audrey*: There are pests throughout the country. I wanted them to learn about the importance of biosecurity. Also, I wanted them to become more responsible. I asked them as to who should notice if pines look sick and who should alert the right authorities. Is it important to have the pine forest in order to maintain biodiversity? Awareness on biosecurity: what that actually means in terms of potential threat, e.g. *Kauri dieback*. They could articulate some animal pest information. Recognising that we have animal pests and we should be doing something about it and also recognise that we are not doing enough.

The teachers were equally pleased with what they had achieved and concurred that pre-planning was vital to ensure targeted and engaging activities for the students.

> *Interviewer*: How do you think these visits went?
> *Mrs Lomas*: The presenters in the morning session were excellent and more engaging than the afternoon one.
> *Mr Gibbs*: I agree. The Regional Council Team was informative. The examples used were more specific and students related well to those information. Also, the brochures supplied contained information students would use for their assessment.
> *Interviewer*: How do you know that students enjoyed these presentation?
> *Mrs. Lomas*: The Regional Council Team did exactly what I had asked them to cover during their presentation. The topics discussed were very useful and presented using language which students can understand. Students asked questions on *Kauri dieback* which is a disease affecting the *Kauri* plants. That shows that they were interested because they have written the first draft of their project.

Focus group interviews with students also suggested that they enjoyed the trip, but most importantly, they felt included in all the activities, met enthusiastic staff who explained the concepts well and also that they knew what the visit was about. They found the use of *forum* to collaborate helped them construct questions which they could ask the ISI staff, they helped each other by finding Websites which provided more information and also, they could collaborate asynchronously with friends and particularly those who could not accompany them on the visit.

Interviewer: How did you find the visit?
Kyla: The trip was very good because I started to understand more about native species.
Interviewer: What do you think you learned?
Drew: I learned about native plants and how they benefit us.
Interviewer: How did you learn that?
Beatrice: Well, we were given a guided tour of *Island Ecological Reserve* where we were told about the importance of certain plants and the way it affects the species abundance in the forest. He also talked about endangered animals.
Jedd: The guide was good because he told us a lot of information about the bush and birds and what they had to do to help keep this area safe etc. Jeff was a very good speaker and he sounded like he knew what he was doing. Our group got a wide range of information from him and we had stops every 10-15 minutes to talk about that area we were in.
Interviewer: How do you know you learned that?
Bianca: I can discuss the topic better because I now know more than I did before.

RESULTS AND DISCUSSION

The overall aim of this inquiry was to gain a better understanding of how the use LEOS might improve learning outcomes in environmental education. *Research Question One* sought to establish if current classroom practices in teaching EE using LEOS were effective in producing the desired learning outcomes for developing scientific understanding, evaluated against New Zealand Curriculum achievement objectives. Even though The School Handbook for *Rural High School* stipulated creating a learning environment, including styles and practices which intended to maximize learning via a dynamic innovative learning environment, analysis of the findings for Year 10 students (14-year-olds) at *Rural High School* in 2013; indicated classroom practices mostly adopted traditional teaching and learning methods. The lessons were teacher dominated, with only limited use of *Web 2.0 Technologies*, mainly for accessing resources such as examination papers. Additionally, while the Faculty of Science agreed that LEOS had enormous potential for informal learning, where students had the opportunity to experience the fragility of an ecosystem by observing the effects of pest eradication at the *Island Ecological Reserve*, there was no assessment evidence to suggest what learning outcomes if any, were achieved by the visit. It was equally concerning to note that only students in years 9 (13-year-olds) and 10 (14-year-olds) participated in LEOS, and no subject teachers were involved in planning these visits which were usually made to the same locations at the end of every school year.

Figure 1: Students engaged in both non-formal and informal learning to enhance their understanding on biological issues concerning New Zealand's fragile ecosystems

Figure 2: Students collaborating via comments on the forum after visiting both ISIs, namely Rakau Paina Stand and Island Ecological Reserve

Re: Responsible Organizations
by Drew - Thursday, 4 September 2014, 12:57 PM
I have found that the ministry of agriculture and forestry is overall in charge of biosecurity. Others include The Ministry for the Environment (offsite link to www.mfe.govt.nz)
Ministry of Tourism (offsite link to www.tourism.govt.nz)
by Beatrice - Friday, 5 September 2014, 3:05 PM
Thanks Drew, this is helpful. The presentations at the *Rakau Paina* Stand and *Island Ecological Reserve* helped me to understand more about biosecurity which I read from these websites, and what we can do to help biodiversity in NZ.
by Lily - Friday, 5 September 2014, 6:14 PM
Yes it was quite interesting to learn about all these possible problems. There are a lot of the actual problems out there to overcome in order to protect biodiversity.
by Drew - Friday, 5 September 2014, 7:09 PM
I found going to the *Island Ecological Reserve* and *Rakau Paina* Stand helped me understand the difference between both ecosystems. The presentations in the *Rakau Paina* Stand helped me learn about the *Kauri dieback* and *Island Ecological Reserve* showed how the vegetation is much improved having a pest proof fence.

The Scheme of Work which contained the Unit Plan for this part of the study outlined the achievement objectives, learning plan, thinking skills, values, social skills and assessment evidence. However, examination of the teacher's daily planning diary, classroom practices as well as students work books showed lack of planning for both pre- and post-visit activities. Likewise, activities at the ISI showed no curriculum links, and that no student ideas were explored when planning the visit. There was then no provision for free choice learning. Due to lack of communication between the teachers and ISI staff, the activity at the ISI did not engage the students, who constantly talked about their camp trip which they had returned from a day before. It was also observed that students were not required to complete a post-excursion report which further contributed to the lack of student engagement. The planning and execution of the topic *Pest Ecology: Investigating the Rat Population in the Rural High School Community, and Pest Impacts on Island Ecological Reserve* was seen to be *ad hoc*.

Several reasons were reported for the lack of LEOS integrated learning. These were lack of flexibility in the teaching calendar, and that students should not miss out on other curriculum areas. Other reasons were having very large class sizes, which required more teacher supervision, more meals, and transportation which would be expensive. It appears that a culture of not providing any LEOS at senior levels became the Science Faculty norm and teachers did not intend to bring any changes because they were already struggling with numerous responsibilities together with long working hours. The practices adopted by these teachers showed significant lack of affordances for LEOS which was mostly seen as a reward. Therefore, better pre- and post-visit planning activities and integrating learning using a LMS, Moodle, became vital in achieving better learning outcomes during LEOS.

Research Question Two of the inquiry sought to establish if emphasis on pre- and post-visit planning of LEOS using the *forum* feature of Moodle helps improve the learning outcomes in EE as evaluated against the New Zealand Curriculum achievement objectives. This was explored using the achievement standard in science, AS90926, *Issues of Protecting Biodiversity*. Teachers expressed great enthusiasm about digitally integrating LEOS with the classroom practice because they believed that this approach contributed to a substantial improvement in student performance in their summative assessment as seen in Table 1 given below. There was strong evidence of pre-visit planning which were linked to post-visit outcomes. Constant liaison with the ISI staff helped ensure more targeted and hands-on activities for students, which were enjoyed by all. Also provision for at least some free choice learning allowed more collaboration between students and between students and the ISI staff. It was interesting to note that students wanted to share their findings because it helped them understand the topic better. This was an example of students taking ownership of learning, one of the reported outcomes of informal learning. The use of LMS was one of the ways of achieving this. In the past years, students usually gained information from text books, work books and Web pages accessible through the school portal. The staff did not use Moodle as a pedagogical tool, even though it had been available at the school for six years. Hence, the development of digitally-supported LEOS was deemed an important teaching tool. The teachers agreed that *Web 2.0 Technologies*, such as Moodle had considerable potential to support the teaching approaches. Lack of staff professional development in e-learning as a pedagogical tool was seen as the primary reason for its lack of usage in classrooms. After conducting two workshops with all teachers of the Faculty of Science, they saw

themselves playing a crucial role in student e-learning communities. For example, students' postings on *forum* had to be actively moderated in order to maximise learning through digital means. This was something of a 'foreign concept' to the teachers involved initially but with constant checking of teacher planners, having several meetings at a time convenient to them and with several classroom visits, the digitally integrated learning model appeared worthwhile.

Creating a blended learning environment from the first day, helped establish a culture that was lacking in the first phase of this inquiry. Students were taught in the library, which had a classroom and a computer suite. While the classroom was used to help students learn the biological concepts, interactive discussions were encouraged using *forum*. Identifying affordances of Moodle with both teachers and students helped integrate all three types of learning, formal, non-formal and informal. Induction to the *forum* feature of Moodle, with students and teachers, and ensuring teachers moderated the posts, helped maintain communication, promoted reflective thinking, and increased the quality of student work. It also became evident from interviews that exposure to learning as an e-community changed the way most students perceived the use of Moodle. There were, however, a few students who continued to rely on their teacher as they felt reassured they were doing the right thing. It appears that reliance on teachers was a way to escape fear of not doing well in examinations.

Sharing information became an important part of informal learning and the postings on *forum* suggested that the students developed a better understanding when learning as a digital community. It was also interesting to note that some students, who were usually quiet in the classroom, responded actively via *forum*. Communicating using the LMS thus helped provide autonomy for students who were usually quiet in the classroom, as peers encouraged and supported one another. Additionally, students provided Webpage addresses to show the sources of materials which were used to make postings. There was also evidence of the development of shared responsibility for learning amongst the students, and group leaders made sure all members contributed to the *forum* discussions. Next, we discuss some conclusions from this study.

Table 2: Summary of assessment results for AS90926: Report on a Biological Issue between 2013 and 2014

Year	Not Achieved	Achieved	Achieved at Merit	Achieved at Excellence
2014	7	39	32	22
2013	0	50	29	21

CONCLUDING REMARKS

Research reported in the literature suggests that learning at ISIs is influenced by a number of factors, namely teacher preparation, choice of ISI and the nature of ISI staff, as well as inclusion of free choice learning. Research notes that visits to ISIs such as zoos and museums if not planned properly by teachers, that is, employing proper teaching pedagogies and setting specific learning outcomes, results in missed opportunities for learning (Kisiel, 2003; De Witt, 2007; Tofield et al., 2003; Tunnicliffe, Lucas & Osborne, 1997). Findings from the first phase of this inquiry

which relate to research question one, indicated that lack of planning by teachers resulted in little evidence of learning outcomes during LEOS. There are numerous studies in the literature which report that while LEOS helps give meaning to abstract science ideas learnt in the classroom (Aubusson et al., 2012; Gardner, 1991; Orion & Hofstein, 1994), there is a need for proper planning if we are to maximise learning opportunities. That is, preparing a learning environment where informal learning can be self-paced and self-directed (Griffin & Symington, 1997). As noted by Falk and Dierking (2000), LEOS planned properly with some degree of choice helps improve learning outcomes. This is consistent with findings from Rennie and McClafferty (1995, 1996) on inclusion of some freedom of choice in learning. Informal learning at an ISI should then include free choice learning, which acts as a mediation tool and helps scaffold students learning (Jarvis & Pell, 2005). This helps students to collaborate in groups, and ask personalised questions which are not formally assessed. According to Bamberger and Tal (2007) and, Jarvis and Pell (2005), this enables growth of individual identities (see also Griffin, 2007). However, Tofield et al. (2003), argue that the constituents of the environment are free choice in nature, activities that remain highly teacher-centred, reduce student choices about their learning, thus affecting the learning outcomes. This part of the inquiry revealed complete lack of any inclusion of free choice learning, which resulted in students' disengagement from the task. Equally as no assessments were carried out, there was no way to measure if any learning had taken place. In summary, findings from this part of the inquiry support literature recommendations that pre- and post-visit preparation by teachers helps improve the learning outcomes during LEOS.

The findings from research question two of the inquiry are consistent with those of other studies involving ICT, in particular *Web 2.0 Technologies* to afford new forms of participation. Moodle, a LMS, used as a cognitive tool also has a positive effect on the affective domain. However, Cuban (2001), Linn (2003), Sandholz and Reilly (2004) and Zandvliet (2006) report that simply increasing the use of computers or such technologies at a school does not necessarily result in changes in instructional methods and/or improved learning. This notion is further supported by Cope, Kalantzis and Lankshear (2005), DeGennaro and Brown, (2009), who stress the importance of teachers role in using digital tools to meet different learner needs, in order to achieve the expected learning outcomes. In the present inquiry, there were a few students who struggled to take up learning asynchronously via *forum.* When students struggle to take up a new mode of learning, they continue to depend on their teacher for learning support, as was the case in the early phase of this inquiry. Gerber et al. (2001) and Green and Hannon (2007), argue that students should be encouraged to develop a sense of self-directedness, mentoring and modeling roles in digital spaces. Typically, according to these authors, students need to be grouped with those who can provide peer support and encouragement. Such students will also need more exposure to different sources of information, such as from ISI visits and multimedia spaces, in order to develop confidence to collaborate and share information from multiple sources via *forum*. There was merit in integrating all three types of learning via digital technologies, in particular, using the *forum* feature of Moodle. *Forum* postings allowed students to view their individual work, hence increasing digital participation.

There are research studies on affordances of blogging (in this case using *forum*) which state that its effective use promotes reflective thinking, nurtures collaboration and helps build relationships (Leuhmann & Frink, 2012; MacBride & Leuhmann,

2008). Digital spaces help students take ownership and control of their learning as asserted by Chandra and Fisher (2009), Ryoo and Linn (2012) and Van Rens, Pilot and Van de Schee (2010). The present work likewise found that even though students were not aware of the affordances of Moodle, their uptake was rapid, probably due to the fact that they were digital-natives. The findings suggested that students readily took opportunities to collaborate using digital spaces, which helped establish a learner-centered learning environment, and they were motivated to learn. While this is possible, it requires teachers to provide students with these learning opportunities.

Griffin and Symington (1997), observe that when teachers provide opportunities for students to take ownership of what and how they are learning, it helps improve students' attitude towards learning science. This was evidenced in this phase of the inquiry where students informed their School Career Advisor of their interest in taking up volunteer jobs during school holidays at this ISI. It should also be noted that being an *Enviroschool*, students of *Rural High School* are highly conscious of environmental changes and their consequences on biodiversity, which could have contributed to the idea of helping as a volunteer worker at *Island Ecological Reserve*. Next, we discuss some implications from these findings.

IMPLICATIONS

Tofield et al. (2003) suggested that a key finding of science education research is that pre- and post-visit preparation is essential when engaging in LEOS in order to improve the learning outcomes. It is equally important that during pre-visit preparation, teachers include strong curriculum links with classroom practices in their planning. The findings of this inquiry indicate that for the teachers at this school at least, such a dramatic change in role can be accomplished.

Tobin (1993) explained that constructivism, as a reflective tool, empowers teachers and enables them to fashion learning activities to the circumstances in which they find themselves. Therefore, it is important to consider including free choice learning during pre-visit preparation. Students develop an increased level of enthusiasm when they have opportunities to learn in groups and take ownership of their learning in an informal learning environment (Rennie & McClafferty, 1996). Where possible, science achievement standards on EE should be integrated with LEOS using a LMS as suggested in the New Zealand Curriculum (Ministry of Education [MoE], 2015). These non-formal learning experiences should be conducted concurrent to the topic being taught and not done at the end of the year. Such a suggestion has been the cornerstone of a constructivist-based view of teaching-but how feasible such a recommendation would be at other secondary schools, is debatable. Consequently, in order to teach from a constructivist-based viewpoint requires a shift in the role of secondary school teachers. That is teachers creating and facilitating a blended learning environment where students transform from being passive recipients of information to actively engaging in their learning process. Brown, Collins and Duguid (1989) pointed out that social interactions promote learning and social construction of knowledge. However, to achieve this during LEOS, teachers needed to liaise with ISI staff during pre-visit preparation to ensure the preparation of targeted and interactive activities, which are subsequently presented by enthusiastic staff. Such a shift is unlikely unless secondary school teachers feel a need to change and are involved in planning visits out-of-school.

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