Making the Most of Out-of-School Visits: How does the Teacher Prepare? Part I: Development of the Learner Integrated Field Trip Inventory (LIFTI)

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Abstract

This paper reports on the first Phase of a two-part study, involving the development and implementation of an intervention to improve the learning of science, involving learning experiences outside school (LEOS). Part I reports on the development of the *Learner Integrated Field Trip Inventory* (LIFTI), while Part II describes the implementation and evaluation of the LIFTI, in which there is evidence that it can lead to improvements in the learning of school science. The LIFTI was developed based on modern views of learning, using social constructivism as a referent, and on previous research such as the Field Trip Inventory reported by Patrick, Matthews and Tunnicliffe (2013). The LIFTI comprises three components: Social, Procedural, and Cognitive. Each of these components was used to design activities prior to, during, and after an out-of-school visit. The development and use of the LIFTI is exemplified here using an off-site visit to a Show Home, used to develop student understanding of heating and insulation, a learning area from an achievement standard of the New Zealand science curriculum.

Introduction

The first author has been as a science teacher for 20 years, and during this time, she has had a strong interest in taking learning outside the school. She found from her own experiences and that of her peers, that students are energized by the excitement and anticipation of leaving the school environment. Students have the opportunity to see new things and learn about them in a more unstructured way. They have the opportunity to determine what they learn and how they learn it since, student learning at informal science institutions (ISI) such as museums and zoos, can be interest-driven, rather than teacher and curriculum driven. Also, transportation to and from the ISI site is often a pleasant open-social time. Learning experiences outside school (LEOS) encourage students to experience a more holistic, integrated picture of the information that, in the classroom, may have only been presented in a textual and abstract way. However one thing teachers can struggle with is how to best prepare for out-of-school visits which could improve student learning in science.

There are numerous zoos, museums and exciting learning centres not far from many schools in New Zealand, the context of this study. Also, the New Zealand Curriculum Framework encourages teachers to include LEOS in their lesson plans. For several years, the researchers have pondered whether there is a field trip checklist which could be used for preparing out-of-school visits, and whether this would have an impact on teacher's abilities to design more appropriate out-of-school visits. These questions then led to the central research question: could better planning of out-of-school visits help improve student achievement?

According to Kisiel (2007) and Kisiel and Anderson (2010), it is important to understand teachers' perspectives of field trip design. Field trips take students into public spaces. Therefore, even if students are disciplined and interested, the multi-media environment and the public bustle and noise will most likely be distracting. Teachers prefer to use worksheets during field trips, where students work in groups, and this approach helps manage student behaviour. In open spaces and without close supervision such as in zoos, museums or an observatory, many students may simply not have the discipline or interest to pay attention to what they're seeing. Also, moving through rooms and/or open spaces, students can get separated from the group. Suddenly everyone's attention is turned to finding the missing student(s) instead of being absorbed in the learning opportunity at hand. However, placing a strong emphasis on completing work sheets only limits student choices of deeper learning, and also ignores student's interests, and connection to prior knowledge. Hence, this approach becomes a missed opportunity which could have otherwise been helpful in engaging student learning. Kisiel (2007) and Kisiel and Anderson (2010) contend that the reasons for this disconnect between the teacher and the field trip design is due to teachers' conceptions regarding field trips.

Conceptual framework

A fairly substantial body of research on field trips has accumulated over the past 30 years, much of which has attempted to identify whether or to what degree these contribute to school-based instruction and learning. Learning on and from out-of-school visits, hence, is no longer seen as simply an extension of classroom teaching, but if integrated with teaching programs may *complement* learning activities in the classroom (Falk & Dierking, 2012; Rennie, 2007). The literature suggests that classroom teachers value the opportunities afforded by field trips for positive affective and social experiences (Storksdieck, Werner, & Kaul, 2006). More recently even 'cognitive' learning outcomes are being broadened beyond facts and concepts to include process skills, and awareness of lifelong learning (see, e.g., Storksdieck, Robbins, & Kreisman, 2007). Nevertheless, just as research is beginning to document the broad educational value, out-of-school visits are again coming under attack, and are faced with the need to prove their worth. For example, they are increasingly threatened by limited school funding, compliance with occupational health and safety standards, lack of time and crowded curricula, the pressures of standardized tests and student assessments, and a need for teachers and principals to document whether, and in what way, individual out-of-school visits satisfy curricula demands (Anderson, Kisiel, & Storksdieck, 2006).

Fortunately for many concerned with the outcomes of field trips, research indicates that both cognitive and affective learning can occur as a result of class visits to out-of-school settings. However, such learning is influenced by a number of factors, including the structure of the visit itself which includes; setting novelty (Orion & Hofstein, 1994), prior knowledge of the students (Falk & Storksdieck, 2005), the social context of the visit (Falk & Dierking, 2000), teacher agendas and actions during field trips (Patrick et al., 2013), and the presence or absence, and quality of preparation and follow-up experiences (Davidson, Passmore, & Anderson, 2010).

Moreover, despite their potential, field trips are still often underused as learning experiences, and despite ISIs like zoos and museums being reported as useful learning environments, the literature indicates that not all encounters have led to effective learning outcomes. Work by Guisasola, Solbes, Barragues, Morentin and Moreno (2009) suggests that teacher planning prior to out-of-school visits does make a difference in students' post-visit understandings and increases their learning during the trip.

According to the literature, the key to deriving the most from out-of-school visits is when learning is facilitated by pre-planning and post-visit activities - all linked directly to curriculum objectives (Patrick et al., 2013; Tal, 2012). This, it seems, helps to give meaning to abstract science ideas studied in the classroom (Bolstad, 2001; DeWitt & Osborne, 2007). This is consistent with research reported by other authors, who emphasise the importance of careful planning in order to maximise learning, especially beyond surface learning of facts (see, e.g., Nabors, Edwards, & Murray, 2009). Davidson, Passmore and Anderson (2010) claim that more classroom input, equals optimal learning experiences outside school gains.

Learning outside school requires associated pedagogies to take cognisance of theories of learning. As is well noted in the literature, modern theories of learning have resulted in a shift in thinking from viewing learning as occurring by transmission, to learning conceptualised as the construction of knowledge in a particular social context (Falk & Dierking, 2000; Goodrum 2007). Constructivism is a theory of learning concerned with the internal processes associated with learning (Spivey, 1995; von Glasersfeld, 1995). One of the variants of constructivism is social constructivism. The importance of social interactions during learning was first noted by Vygotsky (1986), who shared many of Piaget's assumptions about how children learn, but placed stronger emphasis on the social context of learning. In the context of out-of-school visits, both constructivist learning theory and Falk and Dierking's (2000) interactive experience shifts the focus of inquiry away from the perceptions and intentions of the exhibit designs at the ISI, to take into account the perceptions and understanding of the learner/visitor. We argue here that there is a need to understand teachers' perspectives of field trip design.

Outdoor activities can help students give meaning to abstract science ideas, and students seem to enjoy out-of-school visits, but most teachers see these as rewards only (Aubusson, Griffin, & Kearney, 2012; Orion & Hofstein, 1994). According to Kisiel (2007), the reasons for the disconnect between the teacher and the out-of-school setting are due to teachers' conceptions regarding field trip design. People who visit places of informal learning arrive with different agendas, backgrounds, and reasons for the visit. Even students' agendas differ from their teachers' ideas about the field trip experience (Storksdieck, 2001). Teachers usually overlook these competing agendas, but they are an important part of planning a successful field trip (Anderson, Piscitelli, & Everett, 2008). In order to prevent students' misinterpreting the reasons for the out-of-school visit, teachers can provide graphic organisers and allow students the responsibility for their own learning by linking the trip to their personal experiences (McLoughlin, 2004). Post-visit activities are incorporated into the field trip design less often than pre-visit and during-visit activities (Kisiel & Anderson, 2010). Such activities are critical to anchoring student learning to the field trip. The lack of suggestions for post-visit activities confirms that this is the weakest link in theory and practice. Teachers know the importance of pre- and post-visit planning, but may know less about how to do it. While there are suggestions in teachers' work books for outdoor learning, there is often a lack of lesson guideline or checklist which could be used for preparations. Therefore, understanding the visit experience from both teachers' and students' perspectives can provide a useful starting point for preparing field trip design, and enhance learning outcomes.

In this paper, we reviewed field trip design literature, but particularly drew upon the Field Trip Inventory (FTI) over others (DeWitt & Osborne, 2007; Patrick et al., 2013) because the FTI uses three educational components (cognitive, procedural and social) and a number of descriptors that better fits in with the present study, and which should be considered by teachers when developing a successful informal learning experience. The LIFTI model (see Figure 1) was a design created by the first author for exploring learning experiences outside school, a construction from her doctorate thesis. This study is important because while integrated planning to increase the effectiveness of out-of-school visit is an established practice (DeWitt & Storksdieck, 2008), there is paucity of research investigating first year secondary school students' ideas when preparing for out-of-school visits. Also, recent literature suggests a need for research into how can we provide more individualized experiences that better meet students' needs (DeWitt & Storksdieck, 2008). Hence, this study drew upon the FTI model to develop the Learner Integrated Field Trip Inventory (Figure 1).

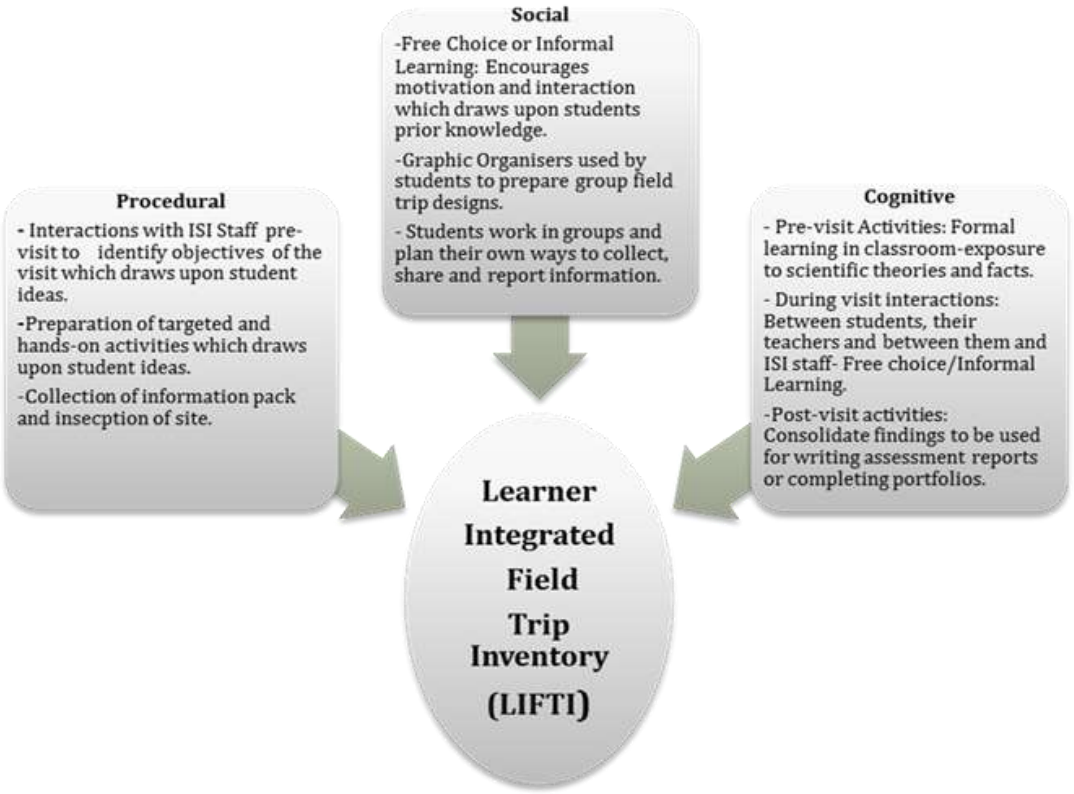

Figure 1. Proposed learner integrated field trip inventory (LIFTI) model

Aim

This study reports on the development of the LIFTI when taking students on out-of-school visits. It also explores the role of teachers when using LIFTI.

Methods

Research design

The methodology employed in this inquiry to develop and evaluate teachers' perspectives of the LIFTI was a qualitative case study approach where multiple interviews and observations were conducted over a considerable length of time (ca. 24 months) (Lincoln & Guba, 1985). This inquiry sought to provide insights on how to better plan for LEOS by first developing and

then implementing the LIFTI which could potentially improve the cognitive learning outcomes in science (reported in Part II). Data for the study was gathered from pre-visit, during-visit and post-visit observations and discussions with both teachers and students.

Sample and context

The study focused on pre- and post-visit planning which included free choice learning, roles of ISI staff and teacher planning which displayed strong curriculum links. This involved a visit to an ISI called *Show Home* and the objective of the study was to explore and report on processes such as convection, conduction and radiation and designing a home which was energy efficient.

This study involved 100 Year 11 (15-year-olds) students. In New Zealand, Year 11 students are enrolled in their first year of the National Certificate of Educational Achievement (NCEA) program. The visit was part of the Physics program where students were required to write a report on heat insulation, AS 90943 Design game: Keeping your home warm (see Figure 3 below). Data collection involved classroom observations pre-visit, field notes and having semi-structured focus group interviews with students, teachers and ISI staff, and triangulated by observations of classroom practices post-visit, and further examinations of students' workbooks and assessment reports.

Student assessment results from 2013, and classroom observations suggested that there was a lack of pre- and post-visit planning for out-of-school visits which included learner ideas. The teachers were equally keen to learn how to prepare for out-of-schools visits as they saw this as an opportunity for professional development in an area which the school lacked. This study considered the first year level at secondary school because science is compulsory at this level.

A checklist was originally designed to assist teachers to prepare for out-of-school visit using Field Trip Inventory (FTI) (Patrick et al., 2013). However, with the experience of qualified high school science teachers at *Rural High School*, together with the research expertise of the authors, the checklist underwent a research based iterative redesign in order to better deliver the content, align the three components of FTI (Procedural, Social and Cognitive) with best practice which includes key roles of the learner and teacher during pre-, during and post-visit planning.

Instrument: Learner Integrated Field Trip Inventory (LIFTI)

Cognitive component of the LIFTI

Pre-, During- and Post-visit Activities: In 2013, reflections from teachers suggested that pre-visit preparations did not have depth in terms of pedagogy and content knowledge. For example, two thirds of the teachers wrote that students visited the same ISI, *The Cottage*, every year, and since the assessment was the same, they were capable of doing it all by themselves without involving 'experts from outside'. However, after being introduced to the LIFTI model and using the LIFTI checklist (Figure 2), these teachers developed out-of-school visit plans, which included ISI staff and also diversification of classroom instruction, including some free choice learning. Additionally, students became an essential part of field trip design, and some students were recorded saying *"we have suggested a problem solving activity to our teacher, and he has asked the ISI staff to help us with it*." Teacher planners recorded a variety of problem solving activities proposed by students which was aligned with the objective of the visit.

During the visit, students used worksheets, which they had put together, while teachers moved around to help facilitate discussions with student groups and between students and ISI staff. Teachers reported that post-visit activities allowed students to discuss their findings before they completed the assessment task. For example teachers commented: "*students are designing their own houses, and these findings will be used to write their final assessments*" and "*in class, we will ask each group to share their findings so that the students could learn collaboratively before they sit for their final assessment"* (Teacher Interview, 27 March, 2014).

Procedural component of the LIFTI: ISI staff and information pack

Before visiting the ISI, *Show Home*, teachers liaised with the ISI staff to inform them of the objectives of the visit. Teachers shared the various problem solving activities students intended to do at the ISI, and objectives of the visit which was aligned with the assessment task. These were professional architects and designers of modern buildings, and so contacting them pre-visit helped prepare targeted and interactive activities for the visit. Information packs allowed students to be aware of the different parts of the building, routes to follow, and amount of time they had in each area of the ISI. The teachers decided to divide the group into two, where each group took a turn to explore inside and outside designs of the *Show Home*. Students also were provided email addresses of the ISI staff to contact them for any further inquiries post-visit.

Social component of the LIFTI: Student group learning

Learning is a social process and allowing students to choose their own groups enabled them to enjoy each other's company, and get an opportunity to study outside school. Including student ideas during pre-visit planning allowed students ownership of learning as they drew upon their own experiences to find answers to complex problems, which was clearly reflected in their assessment results (discussed in Part II, a separate paper).

Figure 2 shows a checklist which has been derived from the LIFTI model and used for learning and teaching to ensure effective planning is done before, during and after a visit to an ISI. It also encourages teachers to reflect and evaluate their practices, which is important when planning for subsequent visits in the future.

Students were asked to collect information from the school library on different building materials and possible sources where heat is lost in a home. They were also asked to design a home which would minimise heat loss. They were given an internal assessment sheet to use for planning before the visit to the ISI – see Appendix 1

LIFTI: A Checklist for Planning Out-of-School Visit		
Cognitive:		
Pre-visit Activities Classroom activities completed prior to the visit should be directly related to the visits learning goals. Moreover, the pre-visit activities that were completed in the classroom should convey a strong correlation between the during-visit and the post-visit tasks. These are aimed to provide exposure to a range of scientific theories, models and discussions about the concepts being studied (Goodrum, 2007).	*During-visit Activities* The activities completed during the visit should be directly related to the pre-visit activities. Students explore questions which they had put together from their group discussions pre-visit, and use it to make inquiries with the ISI staff. Some degree of freedom of choice is reported to have better learning outcomes (Falk & Dierking, 2000). Students have the advantage of exploring topics of their own choice, which are not assessed.	*Post-visit Activities* Classroom activities are used to consolidate learning, which occurred during out-of-school visit (Tal, 2012). The post-visit activities provide students with an understanding of how the out-of-school visit relates to their classroom learning and subsequently findings should be used to complete assessment task, either a portfolio or a written test.
Planning Cognition:		
Reflection:		
Procedural:		
ISI Staff Besides teacher preparation, other factors which help facilitate out-of-school visits are, ISI staff experience, attitude to help students as well as targeted interactive activities conducted at the ISI which are related to the objectives of the visit (Tal & Morag, 2007).	*Advance Organizers* Packet of information which provides students, and teachers with a map of the ISI, description, and a directory of the exhibits. It includes routes students could take around the ISI.	*Work Sheet* Worksheets could be used to provide guidance during the visit, but should be constructed by drawing upon students ideas about the topic. The quiet students should be assigned roles according to their choice to feel more involved in field trip design.
Planning Procedure:		
Reflection:		
Social:		
Student Groups Students expect to have fun which often at the same time acts as a stimulus for more detailed learning (Rennie, 2007). Students were grouped with their friends taking into consideration how well they would interact and their ability to work well together. If students do not like their groups, they would less likely interact and experience significant discussions. Students learn by sharing information.	*Control of Visit* Informal learning, which includes free choice, allows students to take control of their learning. They choose a plan of how they wish to work, with whom and the inquiries they wish to make using advance organisers.	*Control of Learning* Students enjoy learning and engaging in socially mediated learning environments where they have both *choice* and *control* of what they are doing (Bamberger & Tal, 2007). While students visit ISIs to collect information in order to complete their internal assessment projects, they should be provided with a directory of what they could see and/or do. Students should be allowed to choose what they want to study and explore their individual interests.
Planning Social Collaborations:		
Reflection:		

Figure 2. A checklist which was developed by the authors for teachers to use when planning for out-of-school visit

Results and discussion

Pre-Visit

The 10 teachers were divided into eight different groups with approximately eight students in each group, guided by ISI staff at the Show Home. The students were to collect information to write up an assessment report for an internal achievement standard. The New Zealand Curriculum Framework is made up of four learning strands and two integrating strands (MoE, 1993, p. 16). The science curriculum is presented in a way where learning spans eight levels, and is described in sets of achievement objectives; these in turn are organized within learning strands (Ministry of Education, 1993). The aims of science education in New Zealand are expressed as a series of achievement standards that "provide the themes that link the achievement objectives of one level to the next" (MoE, 1997, p. 17). The national achievement standard studied for this inquiry was (AS90943): Investigate Implications of Heat for Everyday Life and the internal assessment used was, The Design Game: Keeping Your Home Warm. The out-of-school visit provided opportunities for students to observe various building designs, building materials, and to better understand the R-values (the thermal co-efficient of building materials), and their use when designing different parts of the house, especially the floor plan. Teachers were asked to supervise students, but more importantly, probe their ideas during discussions which were recorded as field notes. The researcher met with the teachers and discussed the use of the LIFTI checklist prior to visiting the ISI.

During-visit

Teachers together with ISI staff guided student groups for a total of four hours where they collaborated in groups, and made inquiries with each other and the ISI staff. Focus group interviews of students were recorded to identify perceptions of experiences of the visit. Inclusion of some free-choice learning allowed students to make inquiries which were not assessed, but which made lessons more interactive, student-centered, and interesting. Students also used worksheets which they had put together with their teachers to collect information in order to complete their assessment reports.

Post-visit

During the semi-structured interviews, teachers were asked to consider their experiences on student group learning at the ISI. Classroom observations were also conducted to see if teachers followed their field trip designs, particularly for post-visit activities. Focus group interviews were conducted with students to identify their experiences of the visit, while semi-structured interviews with ISI staff helped identify their perceptions of the visit. Using the information gathered at the ISI as well as from classroom discussions, students wrote individual reports under examination conditions for two hours. Interviews with teachers and students are shown below.

Field trip design	Students' and teachers' representative quotes from interviews	
Pre-visit activities:	*Interviewer*:	Why do you want to go on field trips?
	Student:	One and a half hours of out-of-school time.
Classroom activities completed prior to the visit		It's fun. We don't go on trips. It is good because we can be with our friends. We are told to behave or we may not go.
	Interviewer:	What preparations had been done in class for this visit?
	Teacher:	Well, we had completed this topic in the middle of the year and so I am sure the students remember some of the work.
	Interviewer:	How effective do you think the visit will be?
	Teacher:	Not very effective, because the students will not get any time with us after the trip, and also they had just returned from a camping trip. We do not want to disturb learning in other curriculum areas, and so we plan visits at the end of the schooling year.
During the visit:	*Interviewer*:	What types of discussions took place between you and your friends?
Field trip activities completed during the visit which should challenge students to think creatively	*Student*:	At the ISI, we followed the teachers around as they explained the various designs of *The Cottage*.
	Interviewer:	Did you ask your teacher any questions?
	Student:	The teachers asked all questions.
Post-visit observations:	*Interviewer*:	What types of post-visit activities if any will be conducted?
Classroom activities completed after the visit should draw upon preparation done pre- and during visit activities	*Teacher*:	The following day, students sat individually at their tables and completed their assessment reports under examination conditions.
	Interviewer:	So did you discuss with students some of the findings from their visit?
	Teachers:	Three teachers reported that there was no need for any discussion in the classroom after the visit because they had been explaining 'things' at the ISI. Also, the assessment was better done just after the visit because the students will 'remember what I told them'.

As reported in the literature and noted at this school, there was a need to change ways in which out-of-school visits are planned, and this led to the following recommendations which were used to inform the interventions:

(1) To maximize learning outcomes, out-of-school visit should be facilitated by pre-planning and post-visit activities using the LIFTI checklist, strongly linked to curriculum objectives;
(2) Students should be made aware of the learning activities for their visit;
(3) Students should be involved in planning out-of-school visits, where their ideas are considered, and visit should include some free choice learning;
(4) Visits to ISI should be planned to run concurrently to the topic being taught in the classroom;

(5) To maximise student interaction during out-of-school visits, ISI staff should be informed of the objectives of the visit in order to prepare targeted activities, which enable group discussions.

These five recommendations were subsequently implemented giving rise to the findings, discussed next.

Pre- and post-visit planning at Rural High School using LIFTI

The visit to the *Show Home* involved pre- and post-visit planning, and some degree of free-choice learning. The students were required to complete an internal assessment at Level 1 Science, called AS90943: *The Design Game: Keeping Your Home Warm.* Semi-structured focus group interviews with students suggested that they appreciated going on visits outside the school which helped them see *"real things"* and *"enhance conceptual understanding of science taught in class"*. Student perceptions about out-of-school visits varied from the previous year where they thought that an out-of-school visit was only reward based. They were very pleased to be able to visit the *Show Home*, even though most of the students interviewed reported that they had been to one before, but this time it was *"with my mates"* and to *"do some studies"*. They reported enjoying talking to ISI staff, who was professional designers and architects. The students explored different types of building materials, and also had a choice of designing a home of their own choosing. This was much enjoyed by students with one student stating, *"I know the kind of home I will build when I settle down".* Another student displayed a likeness for building and design and reported that he was thinking of taking it up as a future career: *"I do graphic and design at school, and this is something I will enjoy doing"* (Field Notes, 27 March 2014). Students became actively engaged with the tasks they had to do at the ISI. Again, to check data triangulation, student's worksheets during the visit contained detailed information of observations made as a group, and the questions they asked the ISI staff. The ISI staff felt pre-planning by the teacher helped better facilitate the visit. Observation of the classroom showed teachers did include some free choice learning in their planning (Classroom Observation, 27 March, 2014). Teacher diaries also provided evidence of correspondence with ISI staff on multiple occasions to make sure that the objectives of the visit were understood in order to prepare activities which were targeted, group-based and equally engaging. Teacher planning diaries showed a variety of instructions for both pre-and post-visit (Classroom Observation, 27 March, 2014). Below is some of the feedback recorded from randomly selected students during focus group interviews, and semi-structured interviews with teachers and ISI staff.

Field trip Design using LIFTI	Quotes from interviews	
Pre-visit observations:	*Interviewer*:	What was the purpose of this visit was?
	Student 1:	To find out about the types of insulation used in building a house.
	Student 2:	To see how to better insulate a house.
	Interviewer:	Why do you want to know this?
	Student 1:	Oh well, we were taught that heat travels via conduction and convection and so we just wanna see how it really happens.
	Student 2:	I find it very hard to understand what R-value means. I still struggle to understand this concept. I want to ask the architect what it means.
During the visit	*Interviewer*:	Do you see any benefit of field trips?
	Teacher:	The students can ask the designer relevant questions. Also talk to each other because they have been paired up for the first part of this internal assessment and to share notes taken at the ISI.
	Interviewer:	Do you think it is important to include some free choice learning?
	Teacher:	Yes off course, because students can ask questions which may be related to career choice and it will equally motivate them to do better at school.
	Interviewer:	What do you think the students learned?
	ISI Staff:	There is a lot to designing a house. There is a lot more to it such as the sun, views, the type of materials used all become part of the design especially when you look at insulation. Particularly the different materials used to design the floor, double glazed glass windows and heating systems. If you want glass, you can't have it all on the South side. The students learnt why designing are important for building homes in New Zealand, especially when it comes to building heating efficient homes. I was pleased to see one girl ask about R-values of the different building materials.
Post-visit observations:	*Interviewer:*	*How did you find this visit?*
	Student:	I was happy to talk to an architect and find out things I did not know
	Interviewer:	Do you see any benefits of field trips?
	Teacher:	Students get a better understanding on the relevance of 'R values', something they struggled with. They can see why the house was built in that way, mainly orientation, view and heating. They also have the opportunity to learn from the designer and share their ideas and findings with members of their team.

Discussion

The analysis suggests that teachers (and students) experienced considerable benefits from using the LIFTI checklist when planning out-of-school visit. The checklist design required inclusion of ISI staff prior to the visit, problem-solving activities, monitoring student group dynamics, and allowing students to contribute towards developing their individual group worksheets. Reflecting on the observation from the visit to *The Cottage*, not only provided the teachers an opportunity to identify the limitations in their out-of-school visit plan, but was also beneficial in increasing their awareness of the need for student involvement during pre-visit activities, contacting ISI staff to share the objectives of the visit, as well as the need to conduct a thorough post-visit discussion with students which draws upon the findings from the visit, and how these were aligned with the assessment. Teachers identified cognitive objectives as an important characteristic of a field trip design and recognised the significance of field trip preparation, hence the need to use the LIFTI model. Another theme emerging from the data is the difference in student interest in the topic. Since this was the first time Year 11 students were given the opportunity to visit an ISI, we suggest that other interventions are needed in different topics in science, and each site will influence the field trip design and student engagement.

There are a number of factors that influenced student learning in this work. These range from the ability to have freedom of choice in learning, the nature of the ISI, and the experience and behaviour of ISI staff. Kisiel (2003), DeWitt and Osborne (2007) suggest that a lack of preparation and planning on the part of a teacher as well as choosing poor activity types, can lead to limited use of out-of-school-visits. Also, when teachers are more concerned about student behavior, and want them to only learn tasks which they have planned, keep to rigid timelines, and insist students simply complete worksheets (Griffin, 2004; Kisiel, 2003), this results in limited learning outcomes. This means that during the visit, students may not be involved in finding answers to their own problems. Therefore, we suggest that teachers should be aware of the importance of identifying learner ideas when planning for an out-of-school visit.

Some freedom of choice in learning is reported to make out-of-school visits beneficial. To what extent choice and control determines the meaningfulness of field trips is difficult to determine, but having limited choice with some structure and guidance tends to have a positive effect upon students' learning of science. There is a need for balance in student interactions, with each other, and with the exhibits (Rennie & McClafferty, 1995; Tal & Morag, 2007). However, while one might assume an ISI is a likely setting for free choice learning, Tofield, Coll, Vyle and Bolstad (2003), say that even though the constituents of the environment are free choice in nature, the activities may still be highly teacher centred, and transmissive in nature which reduces students' potential of improving their learning outcomes from the visit. Hence when students are asked to contribute to developing worksheets, it gives them the opportunity to find information related to the assessment, in addition to information related to self-interest.

Familari, Da Silva, Rayner, Young, Cross, and Blanksby (2013) suggest that it is important to provide opportunity to students to participate in practical classes because it is a successful strategy to develop inquiry skills in science. Furthermore, Gordon, Sharma, Georgiou, and Hill (2015) say that students enjoy inquiry-based learning, and so visiting an ISI is one of the ways of providing this opportunity. Teachers value field trips as opportunities for cognitive, social and affective learning (Patrick, et al., 2011; Storksdieck et al., 2006). Qualitative findings

using the LIFTI suggests improvement in both teacher and student engagement in teaching and learning respectively. The teacher planner showed that the students had been exposed to a greater range of instruction for the topic than in the past, where student ideas guided teacher planning for out-of-school visits. This improvement in pre- and post-visit planning helped provide a social setting where students socially constructed knowledge. The findings support Vygotsky's (1986) view of social constructivism, where he emphasised the need for culture and social context for cognitive development.

An additional theme was the need for teachers to involve ISI staff who created a scaffold between the visitors and the exhibits by engaging in conversation with audiences about the complex topics presented in exhibits. They serve as the human interface, and provide a direct link between the visitors and exhibit (Gupta & Adams, 2012). Inclusion of ISI staff pre-visit helped provide targeted activities when students visit the site. The ISI staff were enthusiastic and encouraging, similar to what Jarvis and Pell (2005) and Tunnicliffe, Lucas and Osborne (1997) observed, arguing that an active interest in the activity by ISI staff has a positive impact on students' memory and attitude towards learning science. The ISI staff in the current work were professionals rather than trained teachers, as reported in some other cases (Bamberger & Tal, 2007; De Witt & Storksdieck, 2008), which may have influenced the ISI staff motivation and practice during the visits.

In summary, reflecting on their own classroom teaching practice, and being introduced to the LIFTI model, the teachers seemed able to generate knowledge about promoting reflective practice when planning for an out-of-school visit; hence, providing an opportunity to reflect on their students' cognitive and affective learning experiences, using the LIFTI checklist.

Conclusion

The checklist derived from the LIFTI model provides teachers with a lesson plan for an out-of-school visit. It seems that students enjoy learning during out-of-school visits, and demonstrate the much needed skill of collaborative learning, where they develop deeper understanding. The opportunity for free-choice learning encourages students to take ownership of their learning which influences their participation in learning.

Teachers may not be equipped with the knowledge of how to prepare for lessons when taking students on out-of-school visits, and may unknowingly adopt practices which do not impact on students' learning. Alternatively, there are teachers who may not even consider taking learning outside the classroom, as they may not be aware of its impact on the cognitive and affective domains. The cognitive, procedural, and social components must be integrated to build a comprehensive field trip design. If one of the field trip characteristics is removed, the framework collapses, and cognitive engagement may not occur. If teachers do not take into account the cognitive, procedural, and social characteristics of a good field trip design, then learning experiences may not take place. For example, students need to have problem-solving interactions before, during, and after the field trip in order to maximize their cognitive experiences. This would require the teachers to work with the ISI staff to plan the visit, and to include opportunities for students to interact with the ISI staff. Moreover, allowing students' input to the development of the field trip experience is an important element of cognitive development. Teachers need to consider how students are grouped, and allow students some say in who they wish to work with, what they want to see and learn.

An important outcome of this research is the extent to which a complex science topic, thermal insulation and conductivity, seems to have been understood by the students. Out-of-school visits were originally seen by both students and teachers as a reward, only to be conducted at the end of the school year. Taken together, the various components of this study and other studies on field trip design suggest the promotion of the checklist derived from the LIFTI model which is learner inclusive.

But arguably what is most important is whether the use of the LIFTI makes any difference to student learning. This issue is explored in the second phase of this research (Coll, Coll, Treagust, 2018).

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Appendix 1

Procedure and Instrument

Below is the internal assessment which was used by students during 2013 and 2014. However, in 2014, the students used the LIFTI model during their out-of-school visit, and used the findings to write their final assessment.

AS90943: Design Game-Internal Assessment

Achievement Standard Science 1.4: **AS90943 V1**

Investigate implications of heat for everyday life

Resource Title: The Design Game: Keeping Your Home Warm
Credits: 4

Achievement	Achievement with Merit	Achievement with Excellence
Investigate implications of heat for everyday life.	Investigate, in depth, implications of heat for everyday life.	Investigate, comprehensively, implications of heat for everyday life.

Student instructions

Introduction:
This assessment activity requires you to investigate the implications of heat in an everyday situation. It is based on designing the layout of a house and how best to keep it warm. You will write a report on your investigations and draw valid conclusions which are explained in terms of the science ideas of the topic.
Read all of the instructions before you begin.

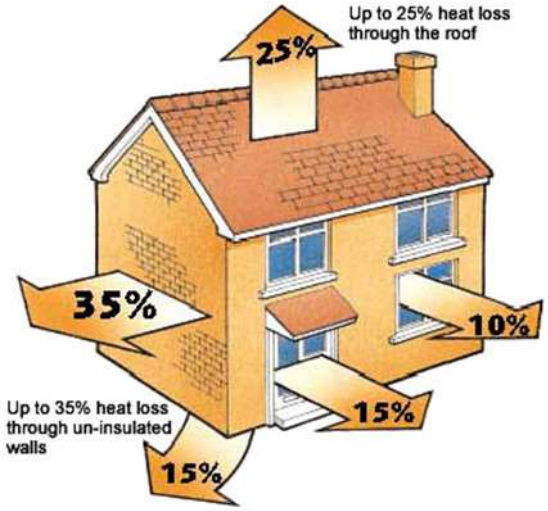
Conditions:
This assessment activity is to be carried out in two parts – Part One: design and insulation and Part Two: implications for heat loss/retention. The task will be carried out in pairs for the design and insulation (Part One) and individually for the interpretation and implications for heat loss/retention (Part Two).
You will be given 12 hours to complete this investigation:

- Pre-planning, Planning, designing the house and processing/interpreting of secondary data: 8 periods. (Done in pairs)
- Writing the final report about the heat implications of your design: 4 periods. (Individual)

All plans, notes and work needs to handed back in to your teacher at the end of each period for re-issue to you.

You can do background research and/or gather additional information during your field trip.

Setting the scene:
In a house heat escapes through the walls, roof, floor, windows and doors. By insulating a house and keeping the heat in for longer, we can halve the energy needed to heat it and halve the fuel bill. Below is a diagram of how much heat escapes from a house.



If we get the design and building materials of the house right, we can also use the Sun's energy to heat it.

A house needs to be designed so it needs minimal energy to heat it. It has lots of insulation in the roof and walls as well as double glazing.

Write a report that discusses the implications of heat loss and insulation of your home in everyday life by:

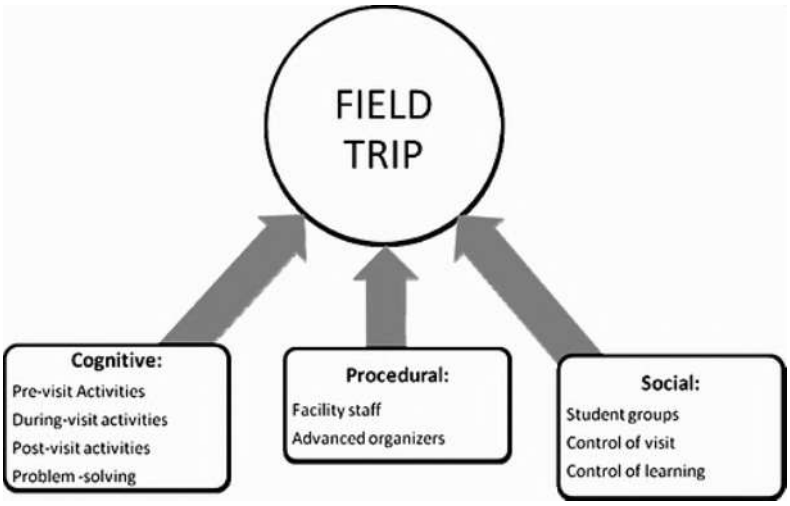
- describing the 3 main methods of how heat is lost from your home and why it should be prevented;
- giving a scientific description of why you designed the floor-plan of you your house the way you did;
- giving a scientific description of how the physical properties of the chosen building materials aid their ability to insulate (prevent heat loss);
- discussing how the insulation ability of each material you have chosen to use in your home maximises heat retention;
- how should the material be installed (thickness, placement etc.) and the impact that water or moisture might have on the materials ability to insulate.
- linking the data you have gathered (R values etc.) about the various building materials to scientific theory, for example, providing scientific reasons why one material was a more efficient insulator than the another;

The quality of your discussion, scientific reasoning and how well you link this to the layout/design of your home will determine the overall grade. Use scientific statements, comparative data or statistics about building/insulating materials as appropriate in your report.

Appendix 2

Field Trip Inventory

Based on the characteristics of successful informal education experiences (Davidson et al., 2010; Falk & Dierking, 2000; Perry, 1992), the field trip inventory (FTI), a checklist of guiding characteristics that assist preservice and in-service teachers with field trip planning, was developed. The FTI uses three educational terms (cognitive, procedural, and social) and a number of descriptors that should be considered by teachers when developing a successful informal education experience. The characteristics of a successful field trip design are:



FTI model: Important aspects of field trip designs

Cognitive

a.

Pre-visit activities: Classroom activities are completed prior to the visit and clearly and directly relate to the visit's learning goals. Moreover, the pre-visit activities that are completed in the classroom convey a strong correlation between the during-visit and post-visit activities.

b.

During-visit activities: Field trip activities are completed during the visit and clearly and directly relate to the pre-visit activities. Students easily identify during-visit activities as an extension of the pre-visit classroom preparation. The during-visit activities are designed to develop the questions posed in the pre-visit activities and facilitate discussion during the post-visit activities.

c.

Post-visit activities: Classroom activities are completed after the visit and organize, build on, and connect the pre-visit and during-visit activities. Moreover, the post-visit activities provide the students with an understanding of how the field trip relates to their learning in the informal environment. The post-visit activities are an important aspect of tying together all components of the field trip.

d.

Problem-solving: Students are engaged in pre-visit, during-visit, and post-visit activities that allow them to think creatively, analytically, and critically. This does not include a fill-in-the-blank worksheet. Students are challenged to interpret new information.

Procedural

a.

Facility staff: Students have a desire to interact with staff because they are viewed as the ‘experts’. Students are primed for contact with the staff and want to learn about their occupations. Preparations may include scheduled or unscheduled meetings with the staff. It is important for the teacher to contact and visit the facility prior to the visit and meet the staff.

b.

Advanced organizers: The advanced organizer is a packet of information that provides students and chaperones with a map of the facility, a description of the facility, and a directory of the exhibits. It includes the route(s) the student groups will take around the facility.

Social

a.

Student groups: Students expect to have fun. Students are grouped with their friends, taking into consideration how well they will interact and their ability to work well together. If students do not like their groups, they will be less likely to interact and experience significant discussions. Chaperones are included in the planning and understand the reason for

the visit.

b. Control of visit: Students and their learning are the reasons for the visit. Therefore, it is important to allow them some control of the visit. Allow students to choose their itinerary, what they will see, and/or the people in their group. This information should be included in the advanced organizer. What do they expect to see? What do they want to see?

c.

Control of learning: Allow students a voice concerning what they learn during the visit. Students are provided with a directory or inventory of what they could see and/or do. Students are allowed to choose that they will study. What are their interests? What do they expect to learn? What is their favourite aspect of the visit?