

RESEARCH REPORT

The Effectiveness of Using Young Professionals to Influence STEM Career Choices of Secondary School Students

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Abstract: *There is a concern in many countries that secondary school student interest in careers in the STEM areas is declining. In response, a program has been developed in New Zealand for young professional technologists, engineers and scientists (known as ambassadors) to visit schools and carry out a variety of interventions to educate and encourage students to choose STEM careers. The interventions include careers talks and classroom activities, organized by regional facilitators who are employed by the Institution of Professional Engineers New Zealand (IPENZ) to co-ordinate the programme across New Zealand.*

The goal of this research was to ascertain whether ambassador interventions are influential on students' attitudes to careers and curriculum choices in school. The objectives were 1) To investigate the impact of the interventions on students' views and perceptions of STEM careers; and 2) To discover any specific factors that must also exist in a given context for an intervention to be effective.

The main finding was that the ambassador interventions were influential on student career decision processes, though not all students were influenced. The facilitators work effectively in recruiting, training, organizing and supporting the ambassadors, and the ambassadors belief in the value of what they are doing helps ensure effective interventions.

The research outcomes are presented as a range of recommendations.

Keywords: Formative assessment, dialogic classroom, feedback, responsive teaching

There is general concern in many countries that declining numbers of young people are choosing a tertiary education in science, technology, engineering and maths, and this will result in downward trends in economic indicators. Aligned with advances in technology that are increasing ubiquitous and disruptive, the need for a highly trained STEM workforce and a STEM literate population are perceived as essential (Commonwealth of Australia, 2015; International Technology Education Association, 2009).

In many countries, organizations have been established to coordinate the significant range of activities related to the promotion of STEM (Australia's Chief Scientist; US Government Committee on Science, Technology Engineering and Math Education; UK Science, Technology, Engineering and Mathematics Network (STEMNET)) in order to develop synergies between the activities and so attempt to maximize impact.

In New Zealand, and in other countries, this concern has resulted in a range of STEM initiatives to: address low numbers of students entering engineering (Johnson and Jones, 2006; Joyce, 2014), clarify and enhance the STEM pipeline from secondary to tertiary education (Strawn & Livelybrooks, 2012), provide

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teacher professional development focussed on STEM (National Education Association), develop STEM curriculum materials (see for example stem.org.uk), as well as other initiatives designed to facilitate innovation and creativity in education, business and industry and to streamline the commercialization of research.

The purpose of this study is to evaluate the effectiveness of a program in which early career professionals in the STEM areas (ambassadors) visit schools to share with students the nature of their work and to engage the students in activities related to their career, in an attempt to encourage positive attitudes in school students toward careers in the STEM areas.

Literature Review

In New Zealand, Jones (2012) has pointed out that it is important for governments to find ways to encourage able students into STEM subject areas, as well as create an environment where scientists and engineers are valued within society. Declining popularity of engineering degrees among undergraduates in Australia and New Zealand is a trend duplicated in the United States and in most Western European countries. This shortage concern is increasingly widespread, particularly in industrialised countries (Sjøberg, 2010). In Europe, Bowen Lloyd & Thomas (2003) found most Year 12 students had little perception of engineering as a career option and had received little or no advice about the engineering profession. Furthermore, as a result of poor careers advice, students who had expressed an interest in engineering were often not studying relevant subjects to make them eligible for entry into an engineering degree.

It was reported in New Zealand media (New Zealand Herald, 2013) that “the shortage of engineers is the consequence of a long-term under-investment in engineering graduates. The percentage of total graduates who choose engineering is lower in New Zealand - 6 per cent - than any other country in the OECD, which averages 13 per cent.” Although the importance of STEM for the foundation of society as well as for everyday life has continued to grow, the gap between the understanding of STEM from creators of technology (engineers) and technology consumers and users has widened. This gap is also reflected in young people’s understanding of what scientists and engineers actually do. In addition, there is a strong international trend to negative attitudes towards STEM education in secondary students from Western developed countries (Sjøberg & Schreiner, 2010).

The five year UK based Aspires project (Archer, DeWitt, Osborne, Dillon, Willis & Wong, 2013) revealed understandings about the development of young people’s (10-14 year olds) aspirations to science related careers. They found that of this group only 15% aspire to become a scientist, in a context where there is no evidence of a poverty of aspirations, and widely held positive views about studying and learning science. Family and friends were found to play a key role influencing students’ aspirations, and most are not aware of where science can lead after school.

Careers in STEM tend to become less appealing as students progress through their schooling (Baram-Tsabari et al., 2009) and many programs have been developed in an attempt to encourage positive attitudes toward STEM careers (Baker, 2013; Fadigan & Hammrich, 2004). In an Inquiry-based Science and Technology Enrichment Program analysed by Kim (2015), 83% of the middle school-aged girls involved said that their interest in science changed from negative to positive, indicating that even short (1 week) targeted interventions can have an effect. A longer term project in which high school students finish their last 2 years of high school in conjunction with their first 2 years in college indicated that participants had STEM dispositions more similar to STEM education professionals (Christensen, Knezek & Tyler-Wood, 2014).

When mentors employed in the STEM areas interact with students, there are indications that students are positively influenced toward STEM careers. At the King David School in Australia a mentor program has positively influenced student attitudes toward STEM (Cerovac, 2013). A one day event for middle school students at the Princeton Centre for Complex Materials resulted in more positive attitudes toward science and scientists (Greco and Steinberg, 2011). So there are indications that targeted interventions have an effect on student attitudes.

The Futureintech program in New Zealand has a clear objective to bridge this gap and help students

develop positive attitudes toward STEM. A significant part of the Futureintech program is the interventions in schools carried out by ‘ambassadors’ who are practising scientists, technologists and engineers. Previous research into the effectiveness of the ambassadors’ interventions (The University of Auckland, 2007; Robertson & Bolstad, 2010) provided a range of conclusions. These included that teacher demand for interventions is approaching the programme’s capacity in the large urban areas of Auckland and Christchurch; STEM careers interventions are likely to have greatest impact on students’ education/career decisions when delivered before age 14; students are deciding whether or not to continue with STEM subjects before Year 10; student attitudes to ongoing science learning are likely to consolidate in Years 7-8; students’ decisions about whether or not to continue with STEM subjects are significantly influenced by their family, and Year 12-13 students who are studying STEM subjects need specific information to make further study choices.

The research described in this paper was conducted in order to interrogate the views of the students, to a greater degree than this earlier research, on the impacts of the interventions on their interest in STEM careers, and to discover any specific factors that must exist in a given context for a Futureintech intervention to be effective.

Research Paradigm

This research uses an interpretivist paradigm (Denzin & Lincoln, 2000) which is supportive of constructivist philosophical approaches. Such approaches share the notion that reality is a social construction, created by members of a community, and that lived experiences need to be understood from the perspective of the participant observer.

This evaluation research, carried out in an education context, is infused with a multitude of human values and beliefs, and appropriately so within a constructivist framework. The researchers strove for the representation of all stakeholder views in a fair and balanced way. As constructivist researchers, there is a recognition that “truth is greatly constrained by the time, context and particular experiences of the stake holding community that generated it” (Guba & Lincoln, 2004, p. 231).

Consequently, because of the situated nature of the study, no attempt is made at generalization by the researchers. This does not mean that the findings and recommendations are not useful to other practitioners in other contexts, but it is up to the reader of this research to determine its applicability to their context.

Methodology

There are many approaches to evaluation research (Mathison, 2004; Fleet (2001) but two broad categories are those commonly recognized as formative and summative. A formative evaluation is a method for judging the worth of a programme while the programme activities are in progress. According to Boulmetis and Dutwin, (2005), formative evaluation is an on-going process that allows for feedback to be implemented during a programme cycle. Summative evaluation is a method of judging the worth of a programme at the end of the programme activities. This research utilizes a mix of summative and formative evaluation research strategies, contextualized in this research in Figure 1.

Research Questions

The main research question was:

Are ambassador interventions more or less influential on students’ attitudes and choices related to STEM careers?

And the subsidiary question was:

Are there any specific factors that must also exist in a given school/class for an intervention to be effective?

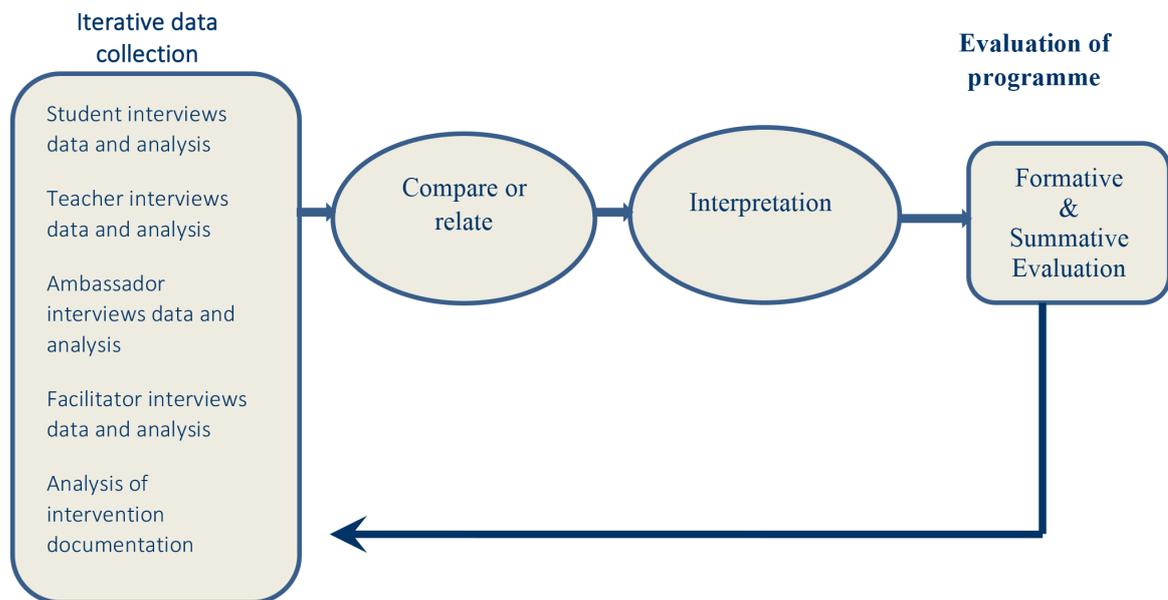


Figure 1. Methodology adapted from mixed-methods convergent parallel design

Participants

There were five groups of participants in the research:

- Facilitators : IPENZ staff, who organised and facilitated the ambassador intervention programme.
- Ambassadors : experts from industry, who give their time to provide presentations and workshop activities.
- Teachers : classroom teachers, who provided the facilities and timetable release for students to attend the interventions.
- Students : school children, who participated in the interventions offered.
- Researchers : the evaluation experts, who attended the scheduled interventions and evaluated the programme.

Table 1 summarises the characteristics of the schools and the number and year of the students that were involved in the school visits observed by the researchers.

Table 1.

Characteristics of schools and participants.

Location	Type*	Decile#	School Population	Year	Students In activity	Activity
urban	sec	1	1313	9	40	Career talk & technology challenge
urban	sec	1	1313	10	20	Career talk & technology challenge
urban	sec	1	1200	12	30	Career talk & technology challenge
urban	inter	6	628	7	30	Career talk & process flowcharting
rural	Sec	2	424	12	23	Talk on algebra use in engineering
urban	prim	1	627	7	39	Experiments related to acids & bases
urban	prim	1	630	8	70	Experiments related to acids & bases
urban	sec	1	1581	13	17	Talk on Antarctica.
urban	sec	8	2167	13	18	Career talk
rural	sec	2	760	8	20	Programmable Xmas Tree activity
urban	sec	6	1219	13	17	Career talk by 2 engineers
urban	sec	10	2553	10	30	Career talk by 2 engineers
rural	inter	9	699	13	24	Career talk

*Schools are classified as primary (year 1-8), intermediate (year 7-8) and secondary (year 9-13).

All schools are rated in a socio-economic band where 1 is the lowest and 10 is the highest.

Data collection

An interpretative approach to the perceived reality, which is co constructed within a community, influenced the research questions; the choice of research methodology; and the methods of data collection, generation and analysis. The evaluation methodology utilised in this report was designed to inform both formatively and summatively through data collection, analysis and reflection.

The thirteen interventions which are the subject of this study were attended by over 350 students across intermediate, secondary and primary schools located in North, Central and Southern regions of New Zealand. Ethics permission was sought and gained from all participants, including the parents/guardians of underage students. Interviews were conducted with focus groups (4-6) of students at all thirteen interventions. In-depth interviews were conducted with five facilitators, twenty one ambassadors and thirteen teachers. All interviews were audio recorded and transcribed into MS Word documents.

The project comprised multiple forms of data collection, including:

- Pre-intervention, semi-structured focus group interviews with students;
- Post-intervention, semi-structured focus group interviews with students;
- Post-intervention, interviews with ambassadors;
- Pre-intervention, interviews with teachers;
- Post-intervention, interviews with teachers;
- Pre-intervention, semi-structured interview with facilitators;
- Post-intervention, semi structured interview with facilitators;
- Intervention observational field notes;
- School brochure/prospectus;

- Principal semi-structured interview;
- Copy of ambassador PowerPoint.

Researcher observation of the intervention programme was an important source of qualitative data for evaluation. The main purpose of the observation was to obtain a thorough description of the intervention programme including the activities, and the involvement of the participants. It involved careful identification and description of relevant human interactions and processes.

Semi-structured interviews involved the preparation of an interview guide that listed a pre-determined set of questions or issues that were to be explored during the interviews. This guide served as a checklist during the interview and ensured that basically the same information was obtained from a number of people. Flexibility was possible as the order and the actual wording of the questions was not determined in advance, and within the list of topic or subject areas the interviewer was free to pursue certain questions in greater depth. The advantage of the interview guide approach is that it makes interviewing of a number of different persons more systematic and comprehensive by delimiting the issues to be taken up in the interview. Logical gaps in the data collected can be anticipated and closed, while the interviews remain fairly conversational and situational.

Focus group interviews were conducted with small groups (4-6) of students, who were asked to reflect on the questions asked by the interviewers, provide their own comments, listen to what the rest of the group had to say and react to their observations. They were interviewed before and after the ambassador's visit where the timetable permitted such access. It was attempted to ensure that at least some of the same students were included in both the before and after groups. The focus groups were either purposively selected on the basis of the teacher's recommendation, or conveniently selected in terms of who was available within the school timetable restrictions. The main purpose was to elicit ideas, insights and experiences in relation to the interventions they experienced. The researchers acted as facilitators by introducing the subject, guiding the discussion, cross-checking each other's comments and encouraging all members to express their opinions.

The researchers supplemented the observation notes and interviews with documentary material, namely the school brochure which provided a record of the demographics of the school, and a copy of the ambassador PowerPoint which served as a record of the nature of the intervention.

Findings

In order to provide a clear understanding of the nature of the intervention activity, it will be presented in a chronology of preparation for the intervention and then the intervention itself, and then these elements will be integrated in the discussion and conclusion in order to answer the research questions.

Preparing for the Intervention

There is a general approach taken to establishing a school visit by an ambassador. The facilitator gets agreement from the ambassador a month or so before the visit. Then two weeks and again two days prior, information related to the details of the school location and access are sent and copied to the teacher.

Some facilitators work very closely with specific schools to the extent that the school teacher selects the ambassadors they want.

Each year, I work with the head of science and we kind of try and get to as many of the senior science classes as we can, so I probably have six to eight ambassadors that do multiple talks to different classes. I plan it out with the HOD and he chooses the ambassadors that he wants, I give him a list of some of the potential people and then he picks from those and then I set it up.

The general attitude of facilitators is that they are happy to support the curriculum, but the main purpose is to promote career awareness. One ambassador had received a list of topics from the teacher that the students had studied so far this year, and he used that as a reference in his presentation:

Cause yeah, I thought okay, they've learnt about this, maybe we should show them how it works in the real world.

The students then seemed to more easily relate to the presentation because of the link it provided with their previous studies.

However, few of the teachers interviewed had done any significant preparation for the intervention visit other than organizing the time and location, even though they recognized that the integration of the content of the ambassador visit into their lesson planning would have advantages. Some indicated that in the following year they would plan the time of the ambassador visit to align with the student subject selection process, in an attempt to increase their enrolments in upper school science subjects.

Student anticipation of what the session was going to focus on depended on the extent to which the teacher had prepared the class for the visit, so consequently varied from 'no idea' to a quite specific anticipation such as 'We're building an electronic Christmas tree'. The majority of students who had some idea of what the visit was going to be about had pre-conceptions related to content (engineering, physics, food, bio-robotics) rather than careers.

About half of the students interviewed before the visit had not done any preparation for the ambassador visit. The majority of those who had done some preparatory work had been asked to think of some questions that they might like to ask the ambassador. Others seemed to have done some preparatory work, either with a focus on careers, or on content:

We did something yesterday - we just looked at some jobs in biology, like if you're doing biology.

We also read, like a booklet, and it tells you about what jobs can you do.

There was no obvious indication that this type of superficial preparation had any effect on student engagement during the intervention, nor on a more positive interest in STEM careers. However, in those classes in which the teacher had more thoroughly integrated the intervention (for example including a follow up questionnaire, and integrating it with course content) it was obvious to the observers that the students were more engaged during the intervention, and the teachers reported that the students were more impacted by the STEM career message.

As would be expected in the case where most of the ambassador visits were to science classes, the majority of the students favoured science related subjects, as shown in Table 2.

Table 2.

Students' favourite subjects

Subject	%
Sciences	26
English	12
Maths	19
Art / drama	12
Technology	12
PE	11
Other (sport, economics, history)	8

Despite the feeling of the teachers and facilitators that an ambassador visit, which was aligned with the curriculum currently being studied, would have more impact on students than a single unrelated visit, there was no consistent effort to ensure that there were links between the curriculum and the topic of the ambassador visit.

The Intervention

There were some teachers who seemed to be using the experience as a 'filler' or an excuse for a change of routine. These teachers tended not to get involved in the presentation and either sat at the back of the room or used the time to catch up on other things.

... 'cause we're towards the end of the year, we've kind of finished all our external prep and we've just got an internal [activity] left to do with my year thirteens for sort of a bit of a break at the end of the week; on a Friday it's sometimes difficult to get them doing anything, so I think they're happy to sit there and have a listen, yeah.

The researchers observed that the students seemed to be more focussed and engaged in those interventions with which the teacher was involved.

Cool, awesome, interesting, good, and enjoyable were the most common adjectives used by students to describe the ambassador visit. There were no negative responses from the students related to the visits, which could be because the students with negative feelings remained quiet, but it seemed to the researchers that the students were quite disclosing in their feedback. One student did comment, with some surprise, that, unlike some other presentations, this one was not boring, and was actually good compared with the others.

Some of the students went a little deeper in the post-visit discussion, and indicated that it was engagement with the activities that was the most positive feature for them.

I liked the fact that she got us really involved; like, sometimes when you find stuff like that you don't get very involved but like all the class and stuff that we have had have been like really involving us.

Other students responded more to the career related goals of the visit, and thought it was those aspects which made the presentation positive for them.

It kind of gave some insight into how many different - like, how different skills go into his job kind of like the different types of stuff that go into what he does like in management and engineering and that kind of stuff.

Some students found the specific job that was discussed interesting, or information about the specific job was aligned with their interests.

It was a very interesting job, the way how they managed to get something as simple as sand and turning it into something that could change the world.

A number of students mentioned that a memorable aspect of the presentation was how the job information was related to the broader context, and often it was an environmental/ sustainability context that appealed to them.

I think it was really cool and I liked seeing what they did in their jobs and how it affects the environment and how they did it.

It's cool to see like, what elements are in like, around the world in the environment and how you could use those to benefit our lives.

There were two broad categories that summarized what the students felt were the best parts of the presentations: one related to the physical or practical aspects (*the machine, the dry ice, the structure, the bubble stuff, etc.*); the second, and less significant category was about the job – *learning about it, how many jobs there are, all the different things she got to do*. A not uncommon response was: *I just liked all of it*.

When asked what could have been better about the program, a range of responses were recorded, but this was mostly in a positive and constructive context, and about 30 percent of student interviewees indicated that there was nothing that could have been done better. While many of the ambassador visits were accompanied by some kind of activity, some were just a discussion based around a PowerPoint presentation,

and some students felt that there should be some activity associated with this kind of visit, and reported that this would make it more engaging.

A quite common theme from students in different schools after the presentations was that engineering seemed like fun: engineering sounds fun. This perception, however, did not always translate into career affinity: *It's really fun but I don't think I'll be able to do, like, be able to do it myself.*

Of those students who indicated that the presentation had influenced them to consider a STEM career, their reasons were as various as the number of students.

Oh yeah, 'cause I wanted to do law and that but that doesn't really involve maths but I like maths, and engineers involve that, engineering and that involves maths so I might look towards that.

I'm still not exactly sure what I want to do but it does give me some idea where I want to kind of be.

A number of ambassadors incorporated some form of related activity within their presentation, and they had various goals in mind with that approach. One just wanted the students to have a positive STEM related experience that they found interesting, and could take away a feeling of some success that they had achieved a technological outcome. Others recognized that students get more engaged with their presentation if there is an active element to it, thinking that this engagement would translate into a higher degree of impact about STEM careers.

Of the students interviewed, 65 percent stated that they were interested in a career in a STEM area. Their intentions varied from the general (something to do with science) to a quite specific career area (geologist, chemical processing engineer). Twenty percent of the students had career aspirations in areas other than STEM, and these spanned a broad spectrum from rugby player, actor, teacher, and 'something in commerce'. There were a number of students who had ideas which were clearly unresolved:

I want to be an actor or someone who studies cancer and stuff like that to find cures for cancer.

And I'm probably looking at commerce now, but that's changed throughout the year - I was looking at civil engineering at the start of the year.

It's sort of a process of elimination for me - I didn't really want to do med, I'm not particularly interested in law so ... yeah. It's engineering.

Because I was planning on trying to be an author or an English teacher but the thing was, I like science, okay, so I'm like maybe yes, maybe no, I'm not sure yet.

For many of these students it seemed that they needed assistance and more information in order to help them clarify their career aspirations. Of the students interviewed, 15 percent were not sure what career they wanted to pursue.

For almost all students, their reference point for their career aspirations was what they enjoyed, and that became the basis of their (sometimes rather vague) career direction. For example:

I really enjoy maths and science.

I find maths a little bit boring.

I've kind of always been interested in programming.

I've just always really liked science.

I just like it and I want to do psychology, [it's] just interesting.

Apart from 18 percent of students who didn't know where to go for more career information, students indicated there was a wide range of sources of information (Figure 3) for career advice.

Table 3.

Sources of information for career advice

Information Source	%
Don't know	18
Careers Expos/days	15
School Careers Centre	9
Teachers	10
Professionals	10
Internet	17
Universities	5
Other (parents, brochure etc.)	16

Feelings about the optimum age of the students who benefit most from an intervention varied, but age was also recognized as critical:

Before their subject choice, they need to meet some people, so that's why I've targeted either year nine, ten, sometimes eleven - before you split the sciences 'cause that's when you either shut down or remain open your science potential.

Other facilitators felt that a range of age groups benefit for different reasons:

I reckon the year seven, eights is crucial so that's my next push, so I've got into most of the science classes at the junior level.

This same facilitator was also working with year 12 physics classes at a girls' high school, and reported that the girls were very responsive:

The girls were like, oh! We never knew, you know, everyone said I should do Health Science; well, actually I didn't know about the engineering.

Despite the difficulty of evaluating the impact of ambassadors' visits on career choice, facilitators were adamant that their main goal is to influence career choice. The facilitators considered that there are many variables that come together to make an intervention impactful on students' attitudes to STEM careers, such as:

- Teacher interest – if an intervention is imposed on teachers it does not provide a context for maximum benefit.
- Integration with school curriculum – when school structures support the ambassador visit, the effects seem to be enhanced. At one school the teacher had integrated the ambassador's presentation into the curriculum and had developed a questionnaire for students to complete in conjunction with the presentation. The ambassador recognized that this enhanced his presentation. At another school:

The Principal set up this last year where it's project time for year nines on Thursday morning and project time for year tens on a Friday and the engineers will go in and look after them - they'll mentor their kids with a specific teacher, that's the same teacher each time. The Principal argues that these kids are very excited about working in computer science, software engineering or electronics as a result.

- Position within a broader context – if a school has a careers day or has a number of activities focussed on careers during a week; facilitators felt that this contextualization has more of an impact on students than a one-off presentation.
- Exposure to a number of ambassadors over time – some facilitators thought that a number of ambassadors' visits over a period of time from a range of professional contexts provided students with a broader picture of STEM careers and so more adequately provided a range of contexts with which they

could identify.

- A series of activities – one facilitator attempted to organize the ambassador's visit as just one part of a series of structured activities:

One period was spent browsing our websites and another period was listening to a couple of people from the industry, and another one is perhaps reading the brochures and answering questions and doing little group activities.

- A long term project – in one city a company provided funding for electronics kits for students, which they work on over a period of time. The facilitator organizes for ambassadors to visit the students about once per fortnight, and sees this project as getting maximum benefit because of the emotional involvement by the students in being able to keep their programmable kits.

Commonly cited evidence for effectiveness was related to the developing numbers of '360 ambassadors'. These are current ambassadors who are working and engaged in the Futureintech programme, and can recall being directly influenced in their choice of career by an ambassador visit when they were in school. One facilitator recalled that there were about 35 of these 360 ambassadors.

I've got an ambassador who's just started working. She finished uni last year, she was at ... where I ran some talks so the parents would go into a classroom and listen to some talks, and she was there with her mum listening to a foodie and said 'That's what I want to do' and bam! She did it.

All of the ambassadors felt that they would have had an influence on at least some of the students, but not all, as it was often clear that in all groups there were at least some students who had a clear idea of their future career path. This was confirmed by the students, 25 percent of whom said the visit had no influence, 50 percent said it was influential, and for 15 percent, it confirmed what they were already thinking. A significant proportion of both the NO and YES categories already had firm career ideas in mind prior to the program.

Of the students who provided feedback through the interviews, 60 percent indicated in the pre-intervention interview that they were considering a STEM related career, and 73 percent indicated this in the post-intervention interview. These were not always the same students in the pre and post interviews, so it is not a matched sample. However, even when interpreted cautiously, this is one indicator of the effectiveness of the intervention in this regard.

About 20 percent of students did not know where they would go to get more career information. The most common response from those who did have some idea was a teacher, generally, or a specific teacher such as physics. Other responses encompassed the predictable range of library, the careers room or teacher, or computers. In one school, there was a general consensus that the careers advisor is very condescending; she's not that useful to be honest.

The ambassador visit met or exceeded the expectations of most of the teachers, the criteria being the level of engagement of the students. Engagement was most pronounced in those interventions that included hands-on activities.

Discussion

The researchers observed the variety and flexibility of the interventions conducted throughout New Zealand during the six month period of the research, both in terms of activity and also in age appropriateness. The form of the interventions varied from formal career talks and technology challenges, through to full day and extended project-based learning activities. Each intervention was professionally facilitated, all participants endeavoured to create an influential learning experience for the students involved. The interventions occurred in a variety of schools including single and coeducational, intermediate and secondary as well as a range of different socioeconomic ratings. The content areas of intervention included: civil engineering, mechanical and structural engineering, chemical engineering, water treatment engineering, electrical engineering, plant and

food research scientists, and transportation engineering.

The facilitators were enthusiastic, conscientious, knowledgeable individuals who are an essential major component in any successes achieved by the intervention programme. They attract new ambassadors; they liaise with the industry partners to ensure they have a good understanding of the important role they play in the success of the endeavours. They provide ambassadors and teachers with support pre- and post-intervention, which helps to avoid any potential problems or issues that could easily arise.

The majority of teachers observed during the evaluation period were willing and open to receiving the interventions. They endeavoured to meet the practical and logistical requirements that each different intervention required. The senior management of the schools played a minor role in the interventions, but the feedback from teachers indicated a positive supportive disposition towards the program.

The industry experts observed during the evaluation period were young enthusiastic ambassadors who have been generous with their time and support for the Futureintech programme. Each has commented positively about the intended outcomes and the personal benefits they received from giving of their time and energy.

The students have, in the main, been willing participants in the interventions: many have shown insight and appreciation for what has been done. The intervention programme was shown to be an effective model from the perspectives of all the participants involved.

Recommendations

While it is clear that the program does influence student career choices in STEM areas, not all the interventions were as successful as they could have been and some themes have emerged to inform the recommendations.

1. Students recalled prior ambassador visits positively, and were almost exclusively positive about the observed visits. Engagement was a key factor in their positivity, either through activities which were part of the presentation, or just through involvement in the presentation itself. In students' suggestions about what could have been done better, engagement emerged again as a key criteria. As a result it was recommended that where possible the interventions contain both career talks and related practical activities with which students can engage, providing that the link between the two is made explicit (Millar, 2002).
2. Presentations that contextualized the ambassador's career into a broader career context rather than focussing narrowly on their specific job, appealed to students and would also, potentially, appeal to a broader range of students. As a result it was recommended that the ambassadors discuss the range and opportunities of STEM related activities in their enterprise as well as the specifics of their individual job.
3. Not all students recognized that the purpose of the visit was related to helping them make informed career choices, especially those visits that were mainly activity based where the ambassador spoke only for a short time about themselves and their career. This is despite both facilitators and ambassadors being quite adamant that career awareness was the priority for all the visits and activities, and some facilitators, but not all, ensured this in the introduction of the ambassador to the class. Despite the ambassadors all recognizing that STEM career awareness was the goal of their visit, this did not always come across to students. As a result it was recommended that greater attention be given to pre and post intervention career related activities.
4. About half the students had done some preparatory work for the visit, and this was most commonly to think of some questions. This was reinforced by the facilitators who only organized communication

between the ambassador and the teacher if they were preparing for a curriculum related visit. The ambassadors did not feel that prior communication was necessary, although they recognized that when curriculum links were made, their message was more effective. As a result, and considering that advance organizers facilitate learning and retention (Luiten, Ames & Ackerson, 1980), it was recommended to facilitate meaningful communication between the ambassador and the teacher prior to the school visit to devise methods to prepare the students.

5. Of the students, 65 percent were interested in a STEM career, 20 percent were interested in careers other than STEM, and 15 percent were not sure what career they wanted. The visits seemed to generally confirm those who were already interested in a STEM career, and rarely changed the ideas of those who were thinking of a career outside the STEM areas. The 15 percent undecided are the real target for the interventions. As a result it was recommended that where possible in schools, ambassador visits be organised for those students who declare they are undecided about their career aspirations.
6. The pre-visit interview revealed that almost one fifth of students didn't know where to go for more career information, and this ratio didn't change after the visit. Some facilitators handed out information after the visit, but this did not happen in all cases and seemed a little rushed when it did occur, with students wanting to get out to lunch or the next class. As a result it was recommended that a clear strategy be developed and implemented to ensure additional STEM career information including the website are always identified for the students at interventions, and further connections are developed with career advisors in schools.
7. Facilitators and teachers felt that both the younger (years 7-8) and older (years 10-11) groups were both important targets for ambassador visits. This reinforced previous research by Robertson & Bolstad (2010). As a result it was recommended that a greater focus be placed on these age groups – Years 7-8 because the children were more open to STEM career opportunities, and Years 10-11 because this is often where the students are making subject choices.
8. All the ambassadors observed had followed university pathways into their STEM career. With the increasing diversity of pathways available to students into the STEM professions (Fealing, Lai & Myers, 2015), it would seem that ambassadors with alternative pathways would provide some students with a broader range of relevant information. The use of these ambassadors may necessitate a review of the target student audience to include early school leavers rather than only those progressing to the final year of school. As a result it was recommended that an additional focus be placed on alternative pathways into STEM based careers, and ambassadors be sought who have followed these pathways.

This research was mainly focussed on one aspect of an intervention programme, and was conducted on a small representative sample of the interventions that take place, therefore, it is not possible to make generalisations. However, the researchers are confident that educators in a range of contexts may be able to apply some of the findings to their situation.

Overall, all participants involved in the ambassador intervention programme were very positive about the experience. Teachers, facilitators and the early career ambassadors, working together, enabled students to be positively influenced.

Conclusions

The research questions were:

Are ambassador interventions more or less influential on students' attitudes and choices related to STEM careers?

The indications from the data are that ambassador interventions are generally influential on student STEM-related career choices, but not all students. Some students have fixed preconceptions about their career aspirations which are not amenable to change.

Are there any specific factors that must also exist in a given school/class for an intervention to be effective?

There seem to be a range of factors, outlined in the recommendations, which combine to make interventions effective. The most significant factor is individual student receptivity regarding career choice. If they have made up their minds about their career, then the interventions may have little impact. However, if seen as part of an overall career choice strategy including printed and online materials, it offers some clear benefits. For those who are considering a STEM career it helps to reinforce and validate their decision making. For those who have never considered a STEM career it is a good introduction and may encourage students to investigate further.

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APPENDIX A

PRE-SESSION STUDENT FOCUS GROUP INDICATIVE QUESTIONS

Have you been to a session like this before?

If so what did you get out of it?

What do you think the session you are doing today is about?

Have you done any preparation work to get ready for this session?

What careers are you interested in? Why?

Have you considered a career in STEM (Science, Technology, Engineering or Mathematics)? Why?

Why not?

If you wanted to know about STEM careers where would you go for information?

Are there any resources in the school that could help you?

What are your favourite subjects at school?

Is your family interested in STEM? (family activities, visits, careers)

Do you think you are capable of having a career in a STEM area?

POST-SESSION STUDENT FOCUS GROUP INDICATIVE QUESTIONS

What did you think about today's session?

What were the best bits?

What bits could have been better?

Did it help you to consider a STEM career?

Did it change your mind about STEM careers?

What might influence your career choice?

Are you interested in more information about STEM careers?