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THE YOUNG STEM LEADER PROGRAMME

Programme Evaluation

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STIRLING



"It's quite inspiring that we can influence younger people and even ourselves, we felt quite inspired to go on this journey and bring about awareness of STEM"

Secondary Young STEM Leader

"I've absolutely loved it, really enjoyed it personally, really enjoyed working with the children and the parents and it's got to be one of the most successful partnerships and programmes, I think it's just excellent how it's planned, the logs are great and the feedback has been brilliant."

Community Tutor Assessor

First of all, I would maybe be a scientist, but now I've thought that I'm definitely going to be a scientist

Primary Young STEM Leader

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Introduction

The importance of science, technology, engineering and mathematics (STEM) in addressing the challenges that Scotland faces in the ever-changing global context has become increasingly clear in recent years. Scotland's STEM Education and Training Strategy (2017) states that;

“the vision is of a Scotland where everyone is encouraged and supported to develop their STEM skills throughout their lives, enabling them to be inquiring, productive and innovative”

(Scottish Government, 2017, pg.9)

The Young STEM Leader Programme (YSLP) is a novel, high-profile award which offers young people, as Young STEM Leaders (YSLs) the opportunity to gain leadership skills and develop STEM identity through the creation and delivery of STEM activities, events and interactions within their schools, communities or youth groups. A research team from the University of Stirling has completed an evaluation of this innovative Scottish programme.

The YSLP operates in two versions, non-formal and formal, with each version containing three award levels. The non-formal awards operate within the Broad General Education (BGE) remit of Scotland's Curriculum for Excellence (CfE). This offers programmes working at CfE Second, Third and Fourth Levels in which participants are supported to achieve four 'digital badges', Discover, Create, Inspire and Lead. Successful completion of all four elements enables young people to achieve the full Young STEM Leader award at their appropriate level. The formal awards enable young people to work towards an SCQF accredited award at levels 4, 5 and 6. Each level within the formal version of the programme carries credit points for the young people and the award is available on 'Insight' (a professional tool used across Scottish Secondary schools to identify areas of success) for centres to gain the associated tariff points, YSLP at Level 6 is also included on the UCAS tariff.

All six levels of YSLP are available across schools and community settings in Scotland. Page x will outline the numbers of settings involved and the geographic spread.

This report, written by the research team from the University of Stirling, is an evaluation of the programme over the first two years of its implementation. Data was generated using quantitative and qualitative methods. The evaluation methodology was developed by the researchers working closely with colleagues at SSERC. The overarching question(s) for this evaluation was:

How successful was the implementation, delivery and impact of the Young STEM Leader Programme?

YSLP Aims and Objectives

The first three aims of the YSLP come directly from the STEM Education and Training Strategy for Scotland (2017):

- Aim 1** mobilising the enthusiasm of young people themselves will help grow the number of role model and mentoring opportunities for other young people;
- Aim 2** being a Young STEM Leader could, in turn, help motivate that young person to follow STEM study or careers and to become a STEM Ambassador in the future. It will also help them develop 'soft' skills that are in demand from employers;
- Aim 3** In doing so, we will make sure that Young STEM Leaders help to address stereotypes that act as barriers to participation in STEM. This will include making sure that there is a good gender balance amongst the Young STEM Leaders.

(STEM Education and Training Strategy for Scotland, 2017, Section 8: Inspiration, pg. 28)

The YSLP supports children and young people from upper primary age to the senior phase in secondary in the development of STEM literacy and STEM enthusiasm. YSLP is available within school and youth and community groups. The programme aims to create culture change through developing peer role models (YSLs) who actively challenge stereotypes and improve awareness and attitudes towards STEM. It is intended that this will lead to development of leadership qualities and mentoring skills, and an increase in STEM capital, with improved retention in STEM subjects in both leaders and participants. The remaining aims of the programme connect to this vision:

[The following excerpt is taken from: Young STEM Leader Programme Handbook]

The YSLP enables young people to develop their personal skills and qualities in a STEM context. Through delivering STEM activities, events and interactions in their schools, communities and beyond, a young person can consolidate their existing knowledge and understanding of STEM concepts being delivered, as well as:

- Aim 4** developing skills for the 21st century;
- Aim 5** building confidence through a leadership role;
- Aim 6** developing employability and career-management skills;
- Aim 7** increasing STEM literacy, awareness and appreciation;
- Aim 8** preparing young people for the ever-changing world.

The University of Stirling research team, working in close collaboration with SSERC, agreed a number of research questions for the pilot evaluation that comprehensively address the aims and objectives of the YSLP.

Pilot Research questions

Does the YSLP:

- Improve awareness of STEM careers? (Aim 2, 6)
- Improve attitudes towards STEM? (Aim 1,7)
- Support conceptual understanding in STEM? (Aim 7)
- Improve STEM uptake and retention? (Aim 2, 7)

Does the YSLP:

- Challenge stereotypes? (Aim 3)
- Develop transversal competencies of leadership and mentoring? (Aim 2, 4, 5, 6, 8)
- Have an impact on staff expectations? (Aim 1, 3)

This evaluation was undertaken in two phases. Firstly, an evaluation of the pilot phase interrogated the impact of the programme in terms of the Young STEM Leaders (YSLs) and the Tutor Assessors (TAs) delivering in primary and secondary schools, and in community learning settings. Following this, an evaluation of the first fully operational year of the YSLP expanded on and deepened our understanding of selected findings from the pilot phase. In this phase, the evaluation also included an overview of the emerging Associate Regional Tutor and Verifier (ARTAV) role and its contribution to the programme.

In addition to highlighting the key strengths and successes of the implementation and delivery of the YSLP, this evaluation will identify any areas of challenge that have emerged in these early stages of implementation and make some recommendations for going forward. Following feedback and discussions with SSERC relating to the pilot study findings, (outlined in Appendix 1), this final report will focus on four key aims:

Does the YSLP:

- Support conceptual understanding in STEM? (Aim 7)
- Challenge stereotypes? (Aim 3)
- Develop transversal competencies of leadership and mentoring? (Aim 2, 4, 5, 6, 8)
- Improve awareness of STEM careers? (Aim 2, 6)

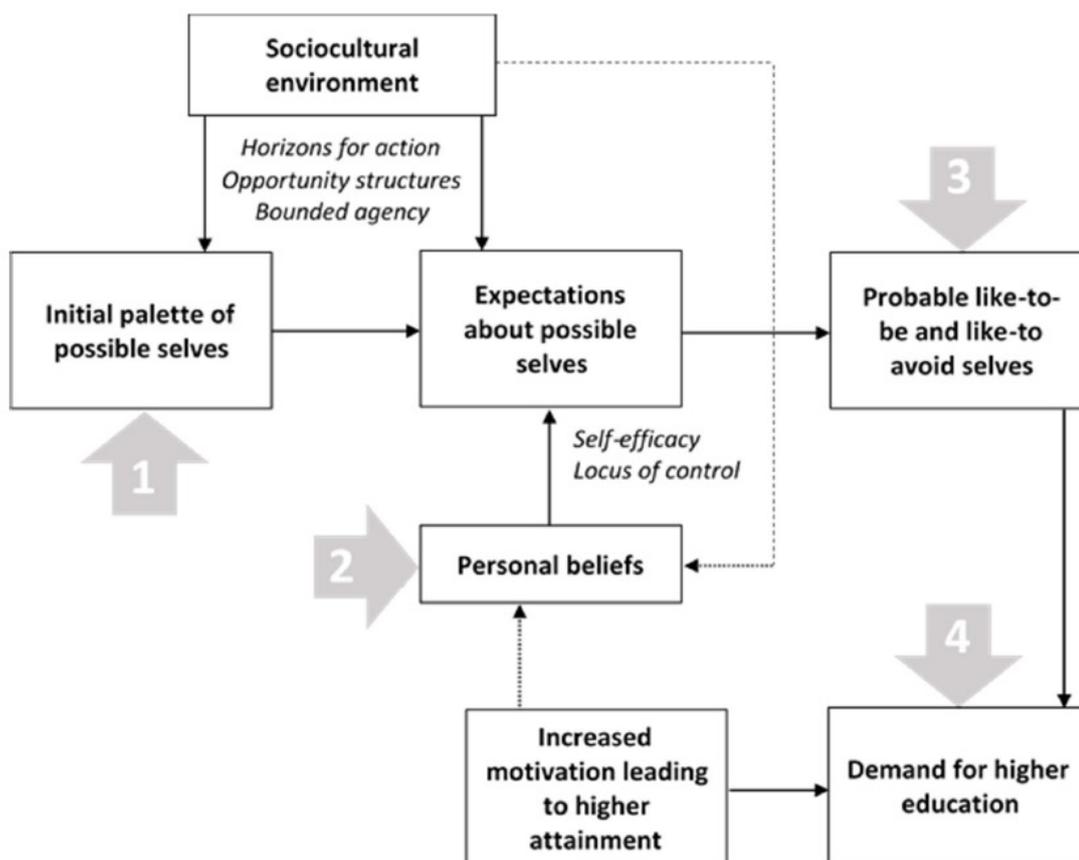
Cross-cutting educational themes, which are considered fundamental to Scotland's Curriculum for Excellence (CfE) such as equity, learning for sustainability and attainment will be considered throughout our analysis.

Research background

A team of researchers from University of Stirling were commissioned to evaluate the programme against its aims. The YSLP is an intervention that provides a structured approach for educators to work with children and young people on STEM projects. Harrison's (2018) research considers where educational interventions might impact a person's vision of themselves (both in the present, which then become past experiences, and in possible future trajectories). Harrison (2018) draws on a theory developed by Markus & Nuriis (1986) – The *'Lens of Possible Selves'*. This theory suggests that an individual's 'possible selves' are a range of visions of themselves in the future which may have an impact on their actions in the present. Including both positive 'like-to-be' selves, negative 'like-to-avoid' selves and 'probable' selves, representing an individual's expectations for themselves.

"The more compelling the possible self, the more vividly it can be elaborated in the present, and the more it will command attention and structure one's current activity."

(Ruvolo and Markus 1992, p. 229)



(Harrison, 2018, pg. 209)

The Lens of Possible Selves and the Young STEM Leader Programme

Harrison (2018) demonstrates how the 'lens of possible selves' can be utilised in educational policy research, highlighting four interventions areas that can help to broaden the opportunities available to young people and help to make the pathways to these possible selves visible and accessible to them. This research will utilise the first three intervention stages;

- firstly, the initial palette of possible selves is the range of 'selves' that are visible to an individual. Their expectations about the likelihood of particular possible 'selves' being possible can be impacted by their sociocultural environment.

The YSLP offers the opportunity to widen the perspectives of young people in relation to possible future STEM selves. YSLP does this by providing resources that TAs can use to discuss STEM careers, focusing on the range of skills and qualities needed to pursue these, and to challenge stereotypical perspectives on accessing STEM careers. This can be found in all levels of YSLP, there is, however a particular emphasis on these ideas in YSL2 (NF) and YSL6 (F).

- Secondly, an individual's expectations about their future are impacted by their personal belief in their ability to control the pathway towards certain futures and the likelihood of success in the tasks that they will face along the way.

The YSLP offers young people the opportunity to succeed in tasks that involve a range of inter- and intra-personal skills alongside conceptual understanding in STEM. YSLP does this by providing resources to help young people to understand the opportunities, pathways and futures in STEM. This is covered in all programme levels but in detail in YSL3 (NF) and YSL5 (F).

- The third intervention stage is the elaboration of possible selves, where young people are given the opportunity to 'try-on' possible identities, potentially through interaction with role models or STEM Ambassadors. Elaboration also involves exploration of pathways to different careers and time spent reflecting on different identities in relation to themselves.

YSLP engages young people with influential adults and other young people who can support their explorations of possible like-to-be and like-to-avoid selves, helping them to make decisions that will align their like-to-be self with their probable self. YSLP does this by encouraging young people to plan, develop and lead their own STEM related activity. In doing so, they can develop their collaborative and leadership skills in a STEM context and explore their own identity as a young person in STEM. This relates most strongly to the YSL 4 (formal and non-formal) courses but is evident across all levels.

This report will outline the ways in which the YSLP connects with the key intervention points of the theory of 'possible selves' and makes related recommendations for the future evolution of the programme in relation to these.

Mixed Methods approach

The research team at the University of Stirling undertook a mixed methods approach to this evaluation project. Across two phases, quantitative and qualitative survey data was collected from young people involved as YSLs and/or participants in STEM events, and from the Tutor Assessors (TAs) who worked with the young people in their settings.

In response to feedback from participants and discussions with the SSERC YSLP team, modifications to the survey were made between the first and second phases of the project. Ensuring that these changes were minimal enables us to draw from both samples in our presentation of findings. We were also provided with organisational data by SSERC which will allow us to report on these elements, noting that as the programme is ongoing, any numbers (of Tutor Assessors enrolled, for example) will be accurate only to the date given.

In addition to the survey responses, we recruited participants to discuss their experiences of the YSLP in a series of semi-structured interviews and focus groups. The emphasis in these interviews was to understand the experiences within the project that were meaningful to the YSLs and the TAs, and to delve deeper into their perspectives on STEM as a viable future career for the young people.

Utilising the intervention stages of the 'theory of possible selves' (Markus and Nurius, 1986), we were able to identify some of the ways in which YSLP as an intervention can contribute to the career decisions of the young people involved.

Data Analysis

Analysis of survey responses (TAs and YSLs) are presented in table form and the associated findings and implications are discussed.

The interview and focus group data was subjected to a rigorous 'Thematic Analysis' (Braun & Clarke, 2021). In this analytical approach, the data is subjected to a process of coding and the subsequent development of 'themes'. These themes are produced in response to the data and reflected upon rigorously in relation to researcher experience and appropriate literature. Each interview/focus group was transcribed verbatim from the recording, listened to, read and coded by at least two researchers. The codes and themes were discussed and finalised, with any disputed codes fully explored.

Sample (Survey)

The online survey (80 completed by TAs, 63 by YSLs) was promoted to all centres and participants. Consideration of the approach taken to ongoing evaluation of the programme should take account of challenges experienced in recruiting participants. Ethics prevented us from mandating participation, however, SSERC may wish to consider an official position on evaluation in order to continue to reflect on and continue to improve the programme.

Online interviews and focus groups were undertaken with the following participants:

Table 1: Sample Details

Setting	Participant involvement	Number of Participants
Community Settings	TA Interviews	4
	Participant Focus groups	8
	ARTAV interview	1
Secondary Setting	TA Interviews	4
	Participant Focus groups	8
	ARTAV focus group	4
Primary Settings	TA Interviews	4
	Participant Focus groups	8
	ARTAV focus group	4

Sample (Qualitative Research)

The participants involved were invited to take part in the qualitative research component as a result of discussions with SSERC. These settings were (generally) felt to have engaged with the programme (in the pilot or year 1 stages) and as such would be able to provide an in-depth reflection on their experiences.

The participants involved represent a mixture of Primary, Secondary and Community settings. They are located in predominantly urban or semi-urban locations and are generally found within the central belt of Scotland. The socio-economic status of the participant settings was mixed.

In order to build on the findings reported here, expansion of the participant demographic would be valuable, however, specific data on the decile in which a Young STEM Leader resides is not collected by SSERC as instructed by the Scottish Government. Focusing on settings which have had partial or limited engagement with the project would allow a deeper understanding of the barriers preventing stronger engagement. Furthermore, a wider geographic spread of participants would enable the research team to identify and interrogate differences in experiences relating to 'cold spots' of YSLP uptake.

Timescale

The pilot study took place in 2020 (the findings of the pilot study can be found in Appendix 1). Strengths of the project included the nuanced nature of the leadership role for young people and the attraction of the formal award. Weaknesses included lack of engagement from the community sector and the impact of Covid. Opportunities identified were the development of the formal award and a desire to build the award into Initial Teacher Education programmes. Finally, identified threats to the programme included staff workload concerns and the risk of the award becoming 'tokenistic' rather than meaningful. Reflections with SSERC on these findings informed the second phase of this research.

The main study took place in 2021/2022, with the data collection undertaken in 2021 and the analysis and presentation of findings in the early part of 2022.

The Covid-19 pandemic had an impact on this research. Two lockdowns resulted in schools and community settings moving online, with significant restrictions on their ability to function. As a result, this impacted on the ability and willingness of participants to reflect on and discuss their experiences. On a more positive note, the expansion of the use of IT in communication meant that we were able to speak to participants from further afield than would have been possible face-to-face, which was particularly important in the ARTAV focus group discussions.

The ARTAV role was formally introduced between the pilot and main study phases of this research. The research team felt it was important to include this development in the report, however, it should be recognised that this was not part of the original research intention. The nature of a 'living' programme like YSLP is that innovations and improvements can be integrated into its development at any time. This research takes account of this flexibility of approach.

Programme Statistics

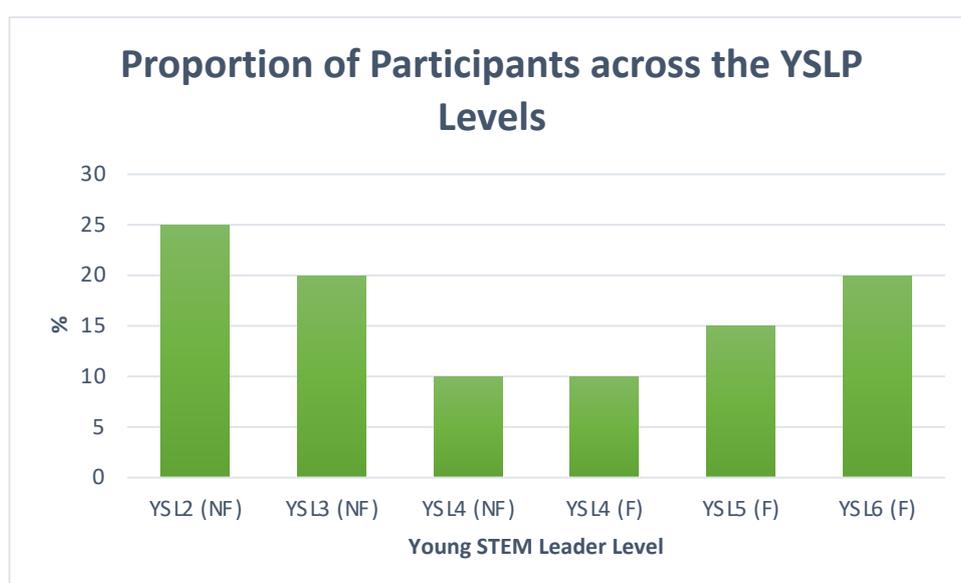
To the 1st June 2022, the following data was provided by SSERC

Table 2: Participation Numbers

Participation Type	Number			
	Primary	Secondary	Community	Total
Delivering Centres	355	250	109	714
ARTAVs	6	9	1	16
Number of Awards	460	548	49	1057

Participation is a little lower in community settings than in formal education settings. In the pilot evaluation, it was suggested that the school-focused language and approach of the award proved challenging in some Community settings. The inclusion of a Community TA as an ARTAV with the intention of developing the programme in a way that is more accessible to Community settings is a response from SSERC to overcome this challenge.

There are currently 1886 Tutor Assessors and over 8000 Young STEM Leaders estimated to be enrolled in the programme across all sectors. Around 20% of active Young STEM Leaders across all levels have achieved certification during 2020-2021.



The greatest participation is at YSL2/3 (NF) and YSL6 (F), YSL2 (NF) and YSL6 (F) were the first launched (in the pilot phase of 2019/2020) and as such have the greatest longevity.

The geographic distribution of participation is currently clustered around the Central Belt, Dumfries and Galloway and West Lothian. Local authority areas with little or no participation include Aberdeen, Orkney and Shetland. A link to a current map of participating centres can be found [here](#).

Going forward, it will be important to gain a greater understanding of the YSLs participation through the award levels and across the country, identifying any reasons for reduced uptake in particular levels/ areas and reasons for non- or partial completion of the award.

Data Analysis

The data analysis will be described in five sections, the first four identified in response to the pilot evaluation findings and echoing the headings of the current Scotland's STEM Education and Training Strategy (2017). Each of these sections corresponds to a number of the YSLP aims and objectives and will be considered in relation to the three key intervention stages described in the 'possible selves' approach; firstly, increasing the palette of 'visible' possible selves, secondly, the creation of achievable pathways towards their future selves, and finally, the opportunity to 'elaborate' or try out possible future selves. The final section will describe the ARTAV role and what it has brought to the programme.

Conceptual Understanding

This relates strongly to the 'Excellence' section of Scotland's STEM Education and Training Strategy (2017). Excellence here relates to the supply of STEM talent and the improvements in STEM learning and teaching.

This section will attend to YSLP aims 2 and 4

Aim 2 being a Young STEM Leader could, in turn, help motivate that young person to follow STEM study or careers and to become a STEM Ambassador in the future. It will also help them develop 'soft' skills that are in demand from employers;

Aim 4 developing skills for the 21st century;

Enhancing or improving conceptual understanding in STEM provides opportunities for young people to see themselves as individuals who can succeed in STEM. This is particularly important in helping young people to have confidence in their ability to navigate pathways into STEM careers, which are often associated with 'elite' or high achieving pupils.

Challenging Stereotypes

This relates strongly to the 'Equity' section of Scotland's STEM Education and Training Strategy (2017). Equity here relates to the challenges in tackling inequity in STEM learning, progression into further and higher STEM education and on into paid employment.

This section will attend to YSLP aim 3

Aim 3 In doing so, we will make sure that Young STEM Leaders help to address stereotypes that act as barriers to participation in STEM. This will include making sure that there is a good gender balance amongst the Young STEM Leaders.

Challenging stereotypes within STEM offers the opportunity for young people to visualise a wide range of possible future selves. Representing a wide range of careers and people working within STEM, the possibility for young people to identify as someone with an interest in STEM and a possible STEM future has the potential to increase.

Leadership and Mentoring

This relates strongly to the 'Inspiration' section of Scotland's STEM Education and Training Strategy (2017). Inspiration here considers the role of STEM role models in promoting the opportunities and benefits of STEM learning and careers.

This section will attend to YSLP aims 1, 5, 6 and 7

- Aim 1** mobilising the enthusiasm of young people themselves will help grow the number of role model and mentoring opportunities for other young people;
- Aim 5** building confidence through a leadership role;
- Aim 6** developing employability and career-management skills;
- Aim 7** increasing STEM literacy, awareness and appreciation;

Giving young people the opportunity to 'try out' the experience of working within a STEM framework connects to the intervention point of 'elaboration'. Enabling young people to be and to see role models from their own community, that they can identify with and have knowledge of, can be a powerful way to facilitate the development of a STEM identity in themselves. The process of engaging with a STEM-related project gives young people the opportunity to explore what STEM means to them, developing leadership and confidence in their own cognitive and practical skills. These important skills also provide tangible and reportable results, which young people may be able to use to access the next stage of their STEM career, should they feel compelled to do so. This has the potential to influence the self-belief of young people in their ability to move into a STEM future pathway, should they desire this.

STEM careers

This relates strongly to the 'Connection' section of the Scotland's STEM Education and Training Strategy (2017). Connection here relates to the provision of information and support for schools to promote and encourage young people into STEM careers.

This section will attend to YSLP aim 8

Aim 8 preparing young people for the ever-changing world

This connects to all three intervention points of the theory of possible selves (Markus & Nurius, 1986); visibility, pathways and elaboration. Bringing all three of these intervention points together through their experience of YSLP, for some pupils, has the potential to open up STEM as a viable and realistic future that they have both the desire and the confidence to pursue.

Data Analysis Part 1: Conceptual Understanding in STEM

Excellence in Scotland's STEM Education and Training Strategy (2017) relates to the supply of STEM talent and the improvements in STEM learning and teaching. Developing future STEM talent depends on a pipeline of young people with a positive disposition towards STEM subjects. In order to achieve a positive relationship with STEM subjects, high-quality teaching and learning are crucial, and as such, professional learning opportunities for teachers and CLD staff are important in providing teachers and community educators with the tools and confidence to deliver in their own unique settings. Improving conceptual understanding can build excellence in STEM by providing young people with the knowledge and confidence to see themselves moving into a STEM career. It can also enhance the scientific literacy of those who are not 'pipeline' scientists.

Findings

The questionnaire considered three areas of STEM learning and teaching. Young people were asked to say how important YSLP aims were; the three aims most relevant to STEM learning and teaching were: supporting the understanding of STEM concepts; increasing uptake of examined STEM courses (eg Nat4, Nat 5, Higher/ AH) and building positive attitudes towards STEM. They were also asked which aims were the most and least important, in their view.

Table 3: The importance of YSLP aims related to STEM learning and teaching, from the perspective of young people

Aim	Proportion who selected important or very important	Number who selected this as being one of the three least important aims	Total
supporting the understanding of STEM concepts	62%	14	14
increasing uptake of examined STEM courses	73%	15	15
building positive attitudes towards STEM	90%	1	27

Table 4: The importance of YSLP aims, related to STEM learning and teaching, from the perspective of tutor assessors

Aim	Proportion who selected important or very important	Number who selected this as being one of the three least important aims	Total
supporting the understanding of STEM concepts	88%	23	8
increasing uptake of examined STEM courses	83%	31	8
building positive attitudes towards STEM	98%	5	21

These data show that building positive attitudes towards STEM was thought to be important or very important by a high proportion of respondents, and that a high number also thought it the most important aim. Only 1 young person thought it was the least important aim and low numbers of tutor assessors felt this way as well. This is much more uni-directional than the other two aims considered here. Supporting the understanding of STEM concepts was thought to be important or very important by 62% of young people, and equal proportions considered it to be the least or most important aim respectively. TAs were more polarised on this, with 23 seeing it as one of the least important aims, and only 8 seeing it as one of the most important. 73% of young people felt that increasing uptake of STEM courses was important or very important, with opinions equally divided about whether it was the most or least important aim. Although 83% of TAs also stated that it was important or very important, 31 selected it as one of the least important aims, with only 8 seeing it as one of the most important.

Reflecting on the questionnaire responses to the interviews with young people, it was clear that the young people did not consider STEM concept knowledge to be the most important part of their experience; however, without high-level knowledge, some of the activities would not have been possible.

"It was helpful to see how the lesson plan changed cause, we're going to teach at Higher level, but it was bringing the idea of Higher terminology into a plan that was created for initially for second years, but actually translated into Higher, that was also interesting."

(Secondary Young STEM Leader)

"Yeah, we also explained the math's because there was measurement, and my partner discussed the background and history of why the catapult was used."

(Primary Young STEM Leader)

Another group of pupils prepared video experiments to be sent to one of their cluster primary schools, this involved not only providing the experimental instructions, but also some background on the concepts involved. The pupils described how they had researched the topic (volcanoes) in order to provide interesting and accessible information for the pupils.

Interviewer:

Okay, so what was on the information sheet?

"I think it was like so for, like the volcano one, it was like about volcanoes and how they happened and then like, about the experiment, and like the science behind that and stuff."

(Secondary Young STEM Leader)

One secondary TA suggested that although content knowledge was a part of the project, it was less important to them than it being fun whilst supporting primary pupils to develop some practical investigative skills.

"What we're going to deliver has to be something that is going to be fun for these young pupils to do. But it's also going to really focus in on the investigation skills, like what we'd need, so they looked at it not necessarily from a knowledge point of view."

(Secondary TA)

In the primary settings, the pupils reflected upon how they had prepared and delivered science activities to their own and other classes. These students linked knowledge and skills from different disciplines to address questions relating to camouflage, catapults and fireworks.

"I've talked about how animals camouflage from their predators, so if they're getting hunted down, so if a caterpillar's getting hunted down by a bird they can just camouflage into their surroundings."

(Primary Young STEM Leader)

Another group of primary pupils described how, when they hosted a whole school STEM event, that everyone was able to learn about STEM, including their parents. This intergenerational learning experience had been memorable for these pupils. The TA in this setting reported the transfer of STEM content knowledge between the children, highlighting a particularly impactful reflection from a primary 1 child.

"One of the young children came back from the P1 session and I asked the teacher, 'how did they get on, what did they do?' And she said, they were a wee bit shocked when one of the primary ones said, 'well, it's the force of the air coming out of the bottle that's going to fly that mouse up into the air.'"

(Primary TA)

In the community setting, the YSLs were able to confidently describe the experiments that they had participated in, from balloon cars and tie-dye t-shirts in one setting, to computer programming in another. These YSLs suggested that the experience had enabled them to gain a deeper love for STEM as a result of engaging more than they had the opportunity to do in their school classes.

"I love it more, I like it more now, because I did always like the idea of science and STEM but I hadn't really done much or some of the things like science I hadn't really done anything in class so after doing it I like it more."

(Community Young STEM Leader)

These reflections suggest that while it may not be the main priority of this STEM project, the young people encountered scientific ideas and concepts that stimulated their curiosity and promoted their understanding of this '[t]hing called science' (Chalmers, 1976), something that had not happened for them in school. Their sense-making of this STEM-related content knowledge was deepened through having the opportunity to communicate it effectively to parents, peers or other children.

Delivering Enhanced Professional Learning

From the individual interviews with the TAs, there was an overwhelmingly positive reflection on the training sessions provided by SSERC. These were felt to be informative and inspirational, emphasising the flexible nature of the programme to fit within the different settings. The ARTAVs confirmed that all TAs received one compulsory training session and that there are optional monthly networking sessions, as well as ongoing optional professional learning opportunities. The uptake of training between the formal and non-formal YSLP levels did not generally differ according to most of the ARTAVs. However, some ARTAVs did note differences in their areas. One ARTAV stated that primary teachers tended to attend non-formal level training whereas secondary teachers might attend training across all YSLP levels (formal and non-formal). Another ARTAV explained that training was led by different ARTAVs – one primary trained and the other secondary and hence primary and secondary teachers attend different level training. In the community, some CLD centres request non-formal training whereas others request both. This suggests that having a flexible model of training provision benefits all Tutor Assessors, enabling them to decide what training approach works best for their unique circumstances.

Findings from the YSLP pilot evaluation study suggested that the CLD sector educators thought the YSLP training sessions tended to be orientated towards school settings. The SSERC team acknowledged this finding and took a number of actions to improve this situation. One example is the appointment of one of the community TAs to an ARTAV role. Their role is to help lead the development of the YSLP in the Community Learning and Development (CLD) sector. (The development and activities of the ARTAV network is discussed further in section xx)

Moving to online delivery through the pandemic has undoubtedly affected how professional learning has been undertaken. On the positive side, enabling TAs and ARTAVs from all around Scotland to be able to work together and engage with the YSLP in a manner that would have been impossible or expensive if held face-to-face. Going forward, as restrictions ease, it will be important to consider the impact of different delivery and communication modes on the experiences of the TA and ARTAV teams.

Summary

- Educators and young people thought that conceptual knowledge and understanding of STEM concepts was important and improved as a result of participation in the YSLP.
- Conceptual understanding was important, but not the most important part of the Young STEM Leader programme.
- The application of conceptual understanding in practical situations was a significant success of the Young STEM Leader activities.
- Training sessions provided by SSERC were felt to enhance the professional learning of educators.
- The development of the ARTAV role enables targeted support and training to be delivered at a centre level, increasing flexibility and responsiveness of the programme.

Data Analysis Part 2: Challenging Stereotypes in STEM

Equity in the Scotland's STEM Education and Training Strategy (2017) relates to the challenges in tackling inequity in STEM learning, progression into further and higher STEM education and on into paid employment. Dawson (2017) describes equity in STEM using a social justice model and considers a spectrum of "infrastructure access, literacies, and community acceptance" (ibid. pg. 540) to help understand the potential impact of interventions intended to widen STEM access. She suggests that attempts to superficially increase access and participation without understanding the more challenging questions of representation and power may result in a weaker type of inclusion than is needed to truly affect change.

Gender inequality in STEM remains a key challenge. The 'third annual report on progress with the STEM Education and Training Strategy' (2021) illustrates that this picture is complex in that females are highly represented in fields associated with medicine and vet studies (83 and 84% respectively) but significantly underrepresented in fields such as computing and engineering/technology (22%). Kanny et al (2014) suggests that despite decades of research and increased awareness of the gender gap in STEM, there still remains a significant gap in representation in many STEM fields. This suggests that the issues around STEM and gender are perhaps deeply rooted and difficult to challenge.

Poverty also has an important influence on STEM progression. Research suggests that "high science achievers often come from more affluent families" (Caspi et al, 2018). Hence, tackling the poverty-related attainment gap, a key policy in Scottish education may have the potential to impact on STEM subject uptake. By encouraging young people to be aware of, and to be involved in challenging stereotypes in STEM, the YSLP experience offers them the opportunity to visualise a wide range of STEM related individuals. This perspective gives them more chances to find themselves in those images, increasing their palette of 'possible future selves'.

Findings

The questionnaire considered two areas of equity in STEM. Young people were asked to say how important YSLP aims were; the two aims most relevant to equity in STEM are: challenging the idea that STEM is for males and challenging the idea that STEM is only for 'elite' pupils. They were also asked which aims were the most and least important, in their view.

Table 5: The importance of YSLP aims, related to equity, from the perspective of young people

Aim	Proportion who selected important or very important	Number who selected this as being one of the three least important aims	Number who selected this as being one of the three most important aims
challenging the idea that STEM is for males	74%	10	29
challenging the idea that STEM is only for 'elite' pupils.	75%	15	25

Table 6: The importance of YSLP aims, related to equity, from the perspective of tutor assessors

Aim	Proportion who selected important or very important	Number who selected this as being one of the three least important aims	Number who selected this as being one of the three most important aims
challenging the idea that STEM is for males	90%	13	22
challenging the idea that STEM is only for 'elite' pupils.	95%	14	33

These data show that 3/4 of young people and almost all tutor assessors felt that challenging stereotypes is important or very important. There were differences in opinion about the importance of the aims; however, both samples tended towards seeing these factors as amongst the most important.

When gender was discussed with pupils, a male pupil suggested that they were not affected by the gender split of the YSLP experience;

"I guess it like whoever wants to take up, in my opinion, it's whoever wants to take up the course and I guess actually, yeah, females into STEM is definitely a positive thing. Definitely. But for me it hasn't actually changed the experience at all, like I feel like I would have had the same experience no matter what ratio of male to female that was in the class. That's why I feel like it didn't change much for me."

(Secondary Young STEM Leader (male))

However, one of the female pupils in the group responded a little more tentatively;

"And I feel like, I don't actually, no, because our science department is very female heavy. So, I feel like our science influences was female orientated and so it just kind of potentially made me more interested in it, maybe if it was more male dominated, I'd be like, I'd probably not do it, I don't know."

(Secondary Young STEM Leader (female))

While it is clear that these pupils have a strong commitment to gender equality in STEM, the structural experiences that they have in their wider school life also play a major part in their expectations. One TA suggested that the younger pupils are less aware of stereotypical perspectives in STEM, as such working with children across the range of YSLP levels may, in the longer term, help to continue raising awareness of, and breaking down their experiences of inequity in STEM.

"It's been very interesting to work with the children on stereotypes, and to see how a lot of attitudes have moved on from when perhaps I was younger and how openminded children are and how well they can offer up solutions to tackle stereotypes that they hear."

(Primary TA)

The impact of poverty on STEM aspirations was discussed by some participants. Among one group of secondary YSLs, there was a clear university pathway identified by the pupils, most, though not all with the intention of studying a STEM subject. The YSLP was described as a programme which could help pupils to access opportunities that they may not have been able to in another way.

"Medicine is extremely competitive, and it has worried me at times, that maybe because I am from a poorer area, that it may try that people may use that against me or see me in a different light. But I think that I've proved that I am just as good as you know, anybody else is (...) the program is a way for people who maybe don't get as much opportunity to show they're just as powerful and just as strong."

(Secondary Young STEM Leader)

This suggests that where a STEM pathway has already been identified, the YSLP can help bridge the opportunity gaps that may exist between more and less affluent young people.

"For me, Young STEM Leader, they're just, people like myself who you know, are then, you know, low percentile SIMD areas, you might not even have the chance to apply for fields like medicine, even experience science. And I think that it was that motivates me. And I can help motivate other people."

(Secondary Young STEM Leader)

One of the TAs suggested that bringing the YSLP to younger pupils in a consistent way may offer an opportunity to continue to challenge stereotypes in STEM with a wider cohort of young people.

"I would quite like to use the Young STEM Leaders to run a STEM club, but an after school one, but not targeting our current Academy students. I would like them to offer it up to primary six, seven students, and then be in a situation where hopefully, you're positively influencing [them]."

(Secondary TA)

Furthermore, the CLD experience of bringing the families of the Young STEM Leaders into the practices of STEM enabled wider discussions which could challenge stereotypical narratives in the home.

ARTAV Reflections

The ARTAVs in a number of settings stated that they had evidence suggesting that in their centres, the uptake in STEM had increased due to the YSLP. One stated that in their setting there had been an increased uptake in STEM clubs and STEM-related subjects. Another ARTAV stated that the YSLP had increased the number of opportunities for the young people to become involved in STEM activities and STEM days. One ARTAV stated that the number of children signing up for the YSLP has doubled in their school which is situated in an area of deprivation. The ARTAV based in CLD stated that there is evidence of increased engagement of young people from disadvantaged areas within CLD. However, access for young people in community settings during the pandemic was challenging. Hence, work on completion of the log-books, for example, to evidence YSLP activity and progress became a barrier. For some young people this has meant no formal accreditation of their work.

The ARTAVs were asked how the level of qualification that students were completing for the YSLP compared with other levels/qualifications they were taking. Five of the secondary school centres stated that the students completing YSL6 were doing Highers or Advanced Highers. Three of these centres state that it was completed in S6 as part of wider achievement/higher leadership and so forth. The community setting differed, offering the level 6 award to all young people regardless of their level of qualification. In these settings, the elite status of STEM is further enhanced by participation in the YSLP, offering only a weak form of inclusion (Dawson, 2017). However, this may be related to the relatively new status of the award, with the community and primary settings describing wide participation, e.g. whole classes taking part. In one particular secondary example, the description of pupils 'that you wouldn't expect' visiting cluster primaries, supported by S6 YSLs offered an opportunity to shape the direction of YSLP participation in the future.

Summary

- There is some evidence that involvement in the YSLP can help to challenge stereotypical perspectives of STEM in Scotland.
- Participants describe thinking that gender stereotypes are being challenged but implicit biases are still present and demonstrated in the language used in discussions with both TAs and YSLs.
- The way that a pupil can move through the stages of YSLP between Primary, Secondary and in Community settings suggests a longer-term pathway to challenging deeply held stereotypical perspectives of STEM careers. The early stage of this evaluation and the young nature of YSLP both suggest that while only superficial intervention has occurred at this stage, there is positive hope for the future.

Data Analysis Part 3: Experiences of Leadership and Mentoring in YSLP

Inspiration in Scotland's STEM Education and Training Strategy (2017) considers the place of STEM role models in promoting the opportunities and benefits of STEM learning and careers. There are a wide range of interconnected sources of influence on the career aspirations of young people (Kanny et al, 2014). School and community learning environments offer a particularly effective intervention here as peer and social interactions are an important part of learning, not only between pupils, but also for teachers and community learning teams. The role of STEM Ambassadors (volunteer employees or students who support school or community STEM learning activity) has been a long-standing success for SSERC, and the evolution of the YSLP builds on that success.

While acknowledging that there can be a wide range of definitions and explorations of 'leadership', in the context of the YSLP, leadership has been described as relating to 'leading learning in STEM'. This incorporates the organisational process of leading an activity or event, and the communication-related competencies of working with others towards a common goal. Mentoring here refers to working with individuals or small groups to support their progress towards an individual goal.

Findings

The questionnaire considered two areas of equity in STEM. Young people were asked to say how important YSLP aims were; the two aims most relevant to equity in STEM are: challenging the idea that STEM is for males and challenging the idea that STEM is only for 'elite' pupils. They were also asked which aims were the most and least important, in their view.

Table 7: The importance of YSLP aims, related to mentoring and leadership, from the perspective of young people

Aim	Proportion who selected important or very important	Number who selected this as being one of the three least important aims	Number who selected this as being one of the three most important aims
Developing mentor skills	85%	18	16
Developing leadership skills	87.2%	7	23
Creating opportunities for pupils to spend time with positive STEM role models	87%	8	20

Table 8: The importance of YSLP aims, related to mentoring and leadership, from the perspective of tutor assessors

Aim	Proportion who selected important or very important	Number who selected this as being one of the three least important aims	Number who selected this as being one of the three most important aims
Developing mentor skills	95%	28	12
Developing leadership skills	97%	7	21
Creating opportunities for pupils to spend time with positive STEM role models	92%	18	17

Although developing mentoring skills was seen as an important or very important aim by 85% of participants, 18 selected it as one of the three least important aims, which was the largest number of participants to select an aim. A similar number thought it one of the three most important. Proportionally comparable high numbers of tutor assessors felt the same way. This suggests that there is less consensus on the value of mentoring skills in this context. One of the participants described the impact of Covid-19 preventing a group of students from running a peer mentoring activity. This may be something to revisit when Covid restrictions are less stringent.

Contrastingly, relatively few thought that creating opportunities for pupils to spend time with positive STEM role models was one of the least important aims, and 20 thought it one of the most important. This suggests that the YSLs valued the impact of their work on others more than their own skill development.

"My favourite part of Young STEM Leader was performing experiments and just doing experiments because I like to lead, I like to lead the dancing raisin experiment, because it was fun to see people's reactions to what would happen."

(Primary Young STEM Leader)

There was a recognition of the importance of professional and public STEM personalities too;

"I also really enjoyed learning about inspirational people as well."

(Primary Young STEM Leader)

And the impact of local and relatable role models;

"I'm always such a believer that children need role models that they can identify, not even just celebrities or kind of these people that have won Nobel prizes, real life models, then they can reflect themselves in somebody that's doing that and they can think, 'right, I can do that too!'"

(Community TA)

YSLP is a leadership opportunity, so unsurprisingly, 87% thought that developing leadership skills was an important or very important aim. Few thought it one of the least important aims and 23 thought it one of the most important. Leadership came below challenging gender and elite stereotypes and developing positive attitudes to STEM as the most important aims.

"I think people that go into STEM careers, generally want to innovate, maybe we revolutionize our society in a way they want to, they're normally strong leaders and have ideas that can help move us forward."

(Community Young STEM Leader)

The development of skills involved in leadership was discussed as a key part of the YSLP, suggesting that the experience not only enabled the young people to consider the theoretical components of leadership, but to relate them to STEM careers and elaborate on these in their own unique context.

"So, they've got to have that passion to work with people, like good communication skills, the competence part, people take leadership, leadership ownership, in their own work and communicate with others. And teamwork is the working as part as a team, but they also have to have that like problem solving, logistical part of a brain, like problem solving as well to work out problems, whereas engineering can be with several different things, to focus on to fix a problem that they may not actually be before."

(Primary Young STEM Leader)

The elaboration of a STEM career was particularly important in the secondary setting. The pupils involved were typically young people studying STEM subjects at SCQF Levels 5 or above and they generally had an expectation of going on into a STEM career. Their experience of YSLP broadened their understanding of what is involved in STEM activities and they were able to improve their self-belief in their ability to go on into a STEM career pathway, not only on the basis of STEM conceptual knowledge, but on a wider range of transferable skills.

"Young STEM Leader, I think you can still explore scientific investigations, you can still do the skills that are associated with running experiments and running investigations, but be doing that and transferring it for other people to benefit from so therefore, as a consequence of that, you're then developing more leadership skills, more communication skills, and their confidence of dealing with people is just better, like the just, I just think it ticks more of the social kind of boxes."

(Secondary TA)

"And most of us really, and most, a lot of people in our class said, well, we're not good at talking to people, we're a little shy and so what we did was we took smaller groups and over the course of the year, when like the maths relay, for first one, took a very small group schedule, it's slowly expanding that for our different activities to develop confidence."

(Secondary Young STEM Leader)

Challenging the expectations of other adults was also reflected upon with a reflection from a secondary TA reporting the surprise at the quality of lessons that YSLs had delivered.

Parental encouragement was found to have a positive effect on STEM learning motivation (Caspi et al, 2018). This was found to be particularly relevant in the learning experiences of one of the Community YSLP participant groups, where engagement with parents/carers in STEM activities was highly engaging for both.

"Well, it's improved my confidence and also the capability to work with people and it's also made me enjoy working on projects and that with my mum."

(Community Young STEM Leader)

Summary

- Developing leadership skills in young people was identified as an important aim of the programme.
- YSLs identified and described a range of leadership skills that they had developed through their YSLP activities.
- Mentoring was not felt to be as key a part of the programme as leadership.
- Being seen as an 'inspiration' to teachers, other children (in particular peers or older children) and their families was a source of pride for some YSLs.

Data Analysis Part 4: STEM Careers

'Connection' in Scotland's STEM Education and Training Strategy (2017) relates to provision of information and support for schools to promote and encourage young people into STEM careers. This includes providing clear and accessible information about opportunities and experiences working in STEM. Bringing all three of the Lens of Possible Selves intervention points together through their experience of YSLP, for some pupils, has the potential to open up STEM as a viable and realistic future that they have both the desire and the confidence to pursue.

Interest in STEM subjects can be found to be present from early in life (Maltese and Tai, 2010). Providing all young people with the opportunity to experience STEM activities in a positive manner throughout their school and community learning experiences is important in enabling them to determine an interest in STEM subjects that they may be able to take into a career.

Findings

Table 9: The importance of YSLP aims, related to STEM careers, from the perspective of young people

Aim	Proportion who selected important or very important	Number who selected this as being one of the three least important aims	Number who selected this as being one of the three most important aims
Increasing desire to work in STEM careers	85%	11	18
Increasing awareness of STEM careers	91%	12	21

Table 10: The importance of YSLP aims, related to STEM careers, from the perspective of tutor assessors

Aim	Proportion who selected important or very important	Number who selected this as being one of the three least important aims	Number who selected this as being one of the three most important aims
Increasing desire to work in STEM careers	95%	13	12
Increasing awareness of STEM careers	98%	5	23

These data show that the YSLP aims relating to career selection were thought to be important or very important. Although a significant minority considered it to be one of the least important of all aims, a larger number considered it to be one of the most important. These data were less polarised than views on the aims concerning stereotypes, but more so than the aims concerning uptake of STEM courses and understanding of STEM concepts.

Respondents were asked whether they thought they would have a career in STEM. 38% said yes, 15% said no with the remainder unsure. Of the ones who said yes, 78% thought they would become a student of STEM at university. Of the ones who said no or not sure, 59% thought they would become a university student.

Engaging with YSLP had an impact on survey participants' knowledge about different STEM careers. Before taking part in the programme, 46% of participants had high or very high knowledge and 29% had low or very low knowledge; after taking part 79% had high or very high knowledge and 4% had low or very low knowledge.

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Before engaging with YSLP, 36% of young people felt they had high or very high knowledge of how to get into STEM careers. At the time of completing the survey, this had increased to 69%. In our discussion, YSLP was felt to be an information source about the possible pathways to STEM, but not the only one;

"We do speak about the importance, about future pathways and careers, they might come in with just that knowledge that they've got from within school but it's opened up because of the award."

(Secondary TA)

We were interested in whether the opportunity was promoted to all students or ones determined by the centre. The questionnaire revealed that 66% of students self-selected; 15% indicated that everyone in their cohort was selected, and 19% were chosen because they favour STEM or another reason. The interviews delved deeper into this question, and revealed that although many students did self-select, they were often encouraged to do so by one of their teachers

"So, we they make these posters up every year that have quotes from our, our previous cohort, of 'I really enjoyed it because I got to do this' or 'when I was writing my UCAS statement this really helped' and things like that and we just put them up in our corridors, so we put them up in all the STEM subject corridors."

(Secondary TA)

Posters placed around the science department would speak to a specific audience; it is unlikely that students who rarely walk through the science corridor would see these. This was recognised by the teacher, who added that;

"(...) each year head then shows that in the assembly as well to make sure that every single student in our school has the opportunity to sign up should they wish to do so."

(Secondary TA)

We found evidence that participating in YSLP led one pupil to change their proposed career path, their intention to go into teaching remained, however the focus had changed from modern studies to biology. The teacher caveats this, suggesting that the experience in her biology class also had an impact. This example opens up the possibility that exposure to positive STEM influences, both in terms of people and practice, can have an impact on the possible future self of a young person, and should be celebrated.

"Um, well, I knew I wanted to be a teacher. But I was more or less leaning towards being a modern Studies teacher, and then you know, sort of through Young STEM Leader and doing biology, I've realised I think I'd rather do biology."

(Secondary YSL)

Recognising and celebrating success

We asked the young people to compare their confidence in STEM at the time of completion of the survey with how they felt before they engaged with YSLP. Before the programme, 48% felt they could do well in STEM areas. Afterwards, this had increased to 74%. This increase in self-efficacy was recognised by the young people when they completed the survey.

STEM careers were an aspiration for many, but not all of the YSLs that we spoke to. This suggests that for the pupils who have an existing interest in STEM, the YSLP gives them the opportunity to deepen and strengthen that interest.

"For actual careers, I'm not sure yet all I know is I want to go into uni for physics, and see where I end up. (...) I'd wanted to do that since before Young STEM Leader. (...) I think it reinforced it, yeah."

(Secondary Young STEM Leader)

Doubts about their ability to actualise a STEM career surfaced in one of the younger pupils;

“Rocket scientist, because it involves both maths and engineering, so it does, and everyone can do it, mostly STEM people cause it’s more delve deep into knowledge, that is improve their likelihood of you getting it and I don’t think I can do it, I think it would be way too complicated.”

(Primary Young STEM Leader)

One of the secondary TAs suggested that the skills and enjoyment of the projects were more important than an emphasis on STEM careers. This highlights the importance of attaining a complete picture of the YSLP experience.

“It was more about the actual project and the interest and what did they learn from it in terms of skill set and investigation procedures, rather than focusing in on careers for that, so people that have received the events I wouldn’t say were in a position to be any more aware of STEM careers.”

(Secondary TA)

Summary

- STEM Careers were envisaged by some but not all YSLs.
- Pathways to STEM careers were not made more explicit for some young people, however, where a young person had already selected a STEM pathway, they felt that YSLP enhanced their progression and experience of this.
- Many participants felt it was ‘too early to tell’ if a young person was more or less likely to proceed into a STEM career.
- YSLP is one of many factors that could influence the pathways of young people into STEM careers.

Analysis Section 5: The role of the Assistant Regional Trainers and Verifiers (ARTAVs)

The formal accreditation of the YSLP requires an in-built process of external verification and quality assurance. Being cognisant of this, SSERC had ring-fenced funding for a dedicated member of staff to be involved in this verification and quality assurance process.

The aims of this verification process are:

- a)
to ensure students' work meets the stated assessment criteria consistent with the appropriate national standard level;
- b)
to ensure accuracy, consistency and fairness of assessment within YSLP;
- c)
to provide assurance for students of fairness and equality of grading.

However, as the YSLP started to take root across Scotland, staff at SSERC began to envision a different way of meeting the needs of the YSLP in terms of verification and quality assurance, which could also expand the reach and visibility of the YSLP. As such this role was reshaped, from the originally planned one or two individuals employed specifically to verify and quality assure the logbook submissions, to a team of regionally employed people who could do verification regionally alongside becoming a regional ambassador for YSLP. In the period after the pilot phase of the YSLP seventeen (eleven females and six males) Associate Regional Trainer and Verifiers (ARTAVs) were recruited, of which there were ten situated within secondary school settings, six in Primary schools and a single ARTAV in the community setting. These individuals were recruited from experienced TAs [teachers and community workers] who had participated in the pilot and early first phase of the project. The job advert called for 'highly skilled, regional ambassadors, providing a positive and knowledgeable voice for the opportunities YSLP offers' (SSERC, 2020). The research team sought to find out more about these individuals, their role as ARTAVs and, the nature of this role in meso curriculum making (a space between school (micro curriculum making) and national (macro curriculum making)). These considerations offer insights into what the ARTAVs brought to the YSLP, but also what affordances the role brought to their professional lives as these practitioners experience forms of curriculum making across multiple sites of activity (macro, meso, micro, nano): Scottish Government, SSERC, RICs, different community and school settings, and different classrooms/youth groups.

The ARTAV role

This newly formed ARTAV role asked practitioners to operate beyond their individual school or community settings in a more intermediate, meso curriculum making role. Hence, the ARTAVs, alongside their micro (school/community) and nano (classroom/youth group) curriculum making activities, were expected to support tutor assessors in their school/community setting and other centres in their region, support and work with their regional RIC/CLD team and work with the YSLP team at SSERC. The ARTAVs recognised the challenge of this type of role, but also noted the opportunities involved through moving beyond their immediate area:

"I thought it would be quite a challenge, the bit that I liked about it, [...], it had the word region in it, that I think, sometimes within our roles, we can be quite shoe-boxed into a local authority, so I thought that would be quite good to challenge myself to be looking outwards."

(Secondary ARTAV)

The ARTAV in the community setting expressed slightly different concerns, compared with the teachers. The comparison of being a community educator rather than a teacher was raised and the differences between the voluntary and compulsory nature of each setting:

"[I]t's interesting, I did feel a little bit out of my depth at first, because I am the only community kind of person [...] I'm with like, 19 other teachers, I am not a teacher and for me as well, there was that elitism around being a teacher and 'oh well, I'm, I'm just a community educator, I'm just, I just work for young people', so that it has been interesting and I still do go to some, some kind of meeting sometimes and think this is all very, very schools focused, you know, so, but again, that is my role to be like, hey, like, 'you know, do you want to engage with the CLD sector, is this you know, what', and they do, and I can see that but obviously, again, the schools, it's a captive audience, it is the Scottish schools Education Research Center [SSERC]."

(Community ARTAV)

The original role of the ARTAV was training and verification of the logbooks. The ARTAVs recognised the importance of this aspect of their role:

"[I]t's been made very clear from the outset that you're upholding a certain level of expectation and quality within the programme, especially the, particularly the secondary aspect of it is verified by and accredited to the SQA [...] Scottish Government's taking an active role in what the programme is doing, so I know that what we're feeding back to them [SSERC] is then being fed back and they're accountable to ministers."

(Primary ARTAV)

Partly due to the COVID 19 pandemic, the training and verification aspect of the role has emerged more slowly, allowing for growth in other areas. The ARTAVs noted that this has enabled them to become more comfortable and confident in their new role and hence this slight delay in this aspect has not been a drawback but a benefit:

"I guess I've not done as much yet of the actual training and verifying as I thought I might, but that I'm okay with that, you know, what I thought just with the role being trainer and verifier, would very quickly be trained up to deliver and then also to then start verifying schools, and I guess that stuff is going to come later and that takes a little bit of time to get us up to speed with that, because I think if it's if we were thrown in the deep end straight away to begin just starting to train up schools, I think, you know, when you see how smoothly [SSERC staff] do things, I think I'd be really worried about not being up to scratch and not doing the same job that they would. So, I'm kind of, I guess I expected that quicker, but I'm kind of glad that it hasn't been that way and I feel, I'll feel a lot more confident, a lot more comfortable doing all that stuff in the future, as I'm kind of settling in and getting to know people and just getting to know how the program works."

(Secondary ARTAV)

The ARTAVs, to whom we spoke, appreciated the emergent nature of their role and the opportunities this has given them to help shape developments and in expanding networks.

"[S]o when they came up with the ARTAV role, [...] they didn't really know what we are going to do and obviously, it, it's like a clay, you know, it's going to be moulded and whatever we can, ARTAV's put on the table, our networks, [...], our connections, and also, us ARTAV's put together into the region, regional improvement collaborative (RICs), so we are working together and that's just expanding the whole, whole thing, [...] it's really flexible but in a good way, so, not everybody's going and doing whatever they want, it feels in a nice way we are working together."

(Primary ARTAV)

The sense of working together was a strong theme emerging from our conversations with ARTAVs. The ARTAVs also commented on how this sense of community has helped the role grow and exceed the original job description. This respondent below notes that the diversification of opportunities available through the ARTAV role has exceeded the programme designers' expectations.

"There is extra things though, it's [the ARTAV role] kind of grown arms and legs, and I think, in a good way, in a positive way, because as we've all started working together, we've kind of branched off and started working on other projects and it's kind of opened more opportunities, so I would probably say if you were to re-write the job description or whatever, it would probably be a lot larger than what it is officially, but that's a positive thing because it's opened a lot of, a lot more opportunities in terms of, things even that [SSERC], would agree with this, that they didn't envisage the ARTAV's doing."

(Secondary ARTAV)

The community ARTAV explains the direction her role has taken in terms of awareness raising within the CLD sector. However, they raise a query about the network of people attending these sessions as they seem to be more populated by local authority employees rather than community-based groups:

"So, my role particularly, has been more about supporting the CLD sector and kind of like raising awareness here, 'here's the young STEM leader program, what do you kind of think about that?' [...] In two weeks, we've got a working group, with a number of representatives from the CLD sector, to really kind of unpick their experience of delivering the Young STEM leader program, which I think could be really, really interesting and from that, we're gonna say, you know, what are the barriers, what do we need to do to make it more CLD focused, you know, and I wouldn't personally like to see the award change at all, or be any different for the CLD groups, because it, I think it should stay the same, but maybe it's the activities, maybe it's something else that will come out of it, that that we need to kind of make it more CLD friendly. Again, an interesting thing about that is that most of the people that have signed up are from local authorities, again, so I'm kind of like, 'okay, where's, where's the kind of grassroots community involvement here with'."

(Community ARTAV)

The Community ARTAV's question regarding the type of audience attending the CLD sessions and the current presentation of the YSLP might suggest that SSERC could further attend to the differences in the school and community sectors to help promote a broader engagement. As noted earlier, this might include the type of funding available to grassroots community groups to enable them to fund projects such as YSLP. Moreover, it might include working with a group of young people to develop the YSLP in the community setting.

The ARTAV network of relationships

The development of the ARTAV role has provided ARTAVs with opportunities to build connections with each other and across networks. This has had a positive impact on the ARTAVs themselves in terms of confidence. Their increase in confidence and access to networks and connections feeds into the work that they do with TAs in their settings and subsequently to the experiences of the YSLs.

"[S]o it's making connections with people and establishing partnerships with people, obviously through the STEM Leader programme but also it's filtering into other things as well just because you're getting to know them and then you get other information or they help you with other things, so it's developing that networking as well at a professional level rather than it, you know just in terms of the Young STEM Leader but as a, on a personal level we're getting that network developed as well."

(Secondary ARTAV)

The ARTAV focus groups spoke of their strong supportive connections with SSERC staff and how helpful it was to speak and learn from other ARTAVs. One ARTAV explained that understanding the difference of the YSLP in school provision gave them insights into how and when the YSLP was offered. In some schools the YSLP was embedded as part of every student's core STEM curriculum, whereas in others it was offered as an enrichment activity either in a co-curricular (timetabled periods where young people can choose between a number of options put on by staff) or extra-curricular (clubs operating outwith school timetabled time for example, lunchtime/after school where staff and students opt-in) manner. This expansion of knowledge provided ARTAVs with ideas for development in terms of both training of TAs in their region but also their own school YSL programme.

"For me it's about sharing good practice, and it's about again it's about not being in that little bubble of your own school and own cluster and hearing little stories about how things are running nearby, it's about hearing how other primary schools are running the programme and personally since I've become an ARTAV, my mind has been blown by all the different ways it's possible to run this programme."

(Primary ARTAV)

Moreover, the broader connections the ARTAV role provided were surfaced in the discussions regarding the links of the ARTAVs to their (generally) local RICs. The ARTAVs provided a supportive role to the RICs regarding the YSLP but also, in some cases more broadly.

"You've also got the freedom to tailor what your ARTAV role is in terms of your RIC and what they need and how you can support them with that and we're kind of supporting them in things, not necessarily Young STEM Leader based, but using our expertise to kind of help them with other things as well, so it's kind of opened other doors."

(Secondary ARTAV)

In the community setting the ARTAV noted that links with organisations such as Youth Link Scotland was seen to be an important development and offered interesting ways forward for the YSLP.

"We have we have linked up with Youth link Scotland, at the moment they have, so Youth link Scotland are kind of a partner with SSERC and there's a kind of program at the moment where two youth organizations are embedding the Young STEM leader program into a piece of work that they're doing at the moment, which is great and it's really interesting to see how that's going to come out. So, I'm kind of like, just had one initial meeting about that just now, so kind of engaging with them but that means that I'm getting to work with other organizations in the sector as well."

(Community ARTAV)

Some of the ARTAVs noted their role in data collection to understand where the YSLP was taking place, or other related STEM programmes. Other ARTAVs found that whilst the networking is important, they can spend time emailing and compiling lists of possible contacts which draws them away from other possible activity to promote and develop the programme.

Availability of resources

The ARTAVs thought the YSLP website and resources were easy to access. The support notes and ideas provided by SSERC were generally considered to be very helpful, however they have tended to be focused on the teaching audience. Hence, there is a need to make adaptations, so the resources are more accessible for the community setting.

"I think it is very schools-heavy and very focused on that side of things, which again, you know would just have been the natural way that they would have went, being the organization [SSERC] that they are, so I think in order to kind of rectify that, obviously they've brought a community, like a CLD person in and, and there's that commitment there to say 'right, how do we how do we get to the next stage? So, I can see that commitment with engaging me in the ARTAV role."

(Community ARTAV)

The ARTAVs are involved in the initial information and mandatory training sessions for new TAs in their area. SSERC has provided the resources for these sessions which the ARTAVs have found supportive.

"We've had, a few of us have run some training sessions already for tutor assessors, and I found like, I found the training for that was great because we got individual time with Jamie to go through everything and we got time to develop slides, again in whatever direction we wanted it, they were very clear that if we wanted to add our own case studies and add our own twists, you know, we didn't need to, we weren't given a prescribed set of slides and we had to do this exact training, following this exact script, we were encouraged, I would say, to put our own slant on things and you know, bring in our own experiences as much as we could, and just kind of personalise it a bit, so we were given you know, paid time to do that, which was great."

(Primary ARTAV)

"And what was good, when, like we ran the training sessions, [SSERC staff] would probably be dotting about in the background and at the end they actually gave you feedback on things that they thought were really good and things that maybe you could do differently next time as well, I found that really beneficial, especially with it kind of, being like, the first training session, especially over, like Teams and things as well, it's always hard to gauge engagement and things, so it was quite good having those pointers at the end, for next time, we'd be ready to do it differently or improve if we needed to."

(Primary ARTAV)

The ARTAVs found the provided resources and the assistance from SSERC staff to be supportive and developmental. They mention above that there was also room for maneuver to personalize the slides and bring in their experiences. The exposure to other ways of doing the YSLP was also noted illustrating how these connections can provide powerful interruptions to practice and prompt possibilities of thinking differently.

Summary

The findings above illustrate the potential of the ARTAV role and network in developing professional agency. Professional agency provides a powerful conceptual tool to provide insights into the possibilities offered to any professional taking up role of the ARTAV. We consider agency (Emirbayer and Mische, 1998) as something that does not reside within people but as something that is achieved by means of a specific context at a specific time. This ecological form of agency is informed by an individual's past histories (iterational), their future imaginings (projective) and what is then made possible by the conditions of the present (practical evaluative):

"[T]his concept of agency highlights that actors always act by means of their environment rather than simply in their environment [so that] the achievement of agency will always result from the interplay of individual efforts, available resources and contextual and structural factors as they come together in particular and, in a sense, always."

(Biesta & Tedder, 2007, p. 137)

Priestley, Biesta and Robinson (2015: 30) provided a framework for professional (teacher) agency. Their framework is useful as they analytically distinguish between key aspects within each orientation of agency (past history, future imaginaries, present affordances and constraints). In terms of the present environment, they consider three aspects: cultural (values, beliefs and so forth), structural (social structures – relationships, roles, power, trust) and material (resources, physical environment). In this context, the relational affordances available to the ARTAVs to achieve agency are, for example, relationships between ARTAVs in their network, ARTAVs and SSERC and ARTAVs and other tutor assessors, and the material affordances available in this context are, for example, SSERC resources (Priestley, Biesta & Robinson, 2015). This is important as ARTAVs are involved in meso curriculum making. Meso curriculum making lies between micro (school/community) and macro (national) contexts (Priestley et al., 2021). Curriculum here is understood not just as material content but as different practices, such as pedagogy, assessment and provision, and hence curriculum making is understood as a 'set of social practices' (Priestley et al., 2022:1039). Priestley et al. (2022) make the point that agency is key for curriculum making and indeed curriculum making needs agency:

"Two facets are of crucial importance in understanding how teacher agency is essential for constructive curriculum making by teachers: personal capacity, in terms of professional knowledge, beliefs, dispositions and confidence, as well as the ability to form expansive aspirations for practice; and the affordances for agency that are available in the professional contexts within which, and by means of which, teachers work. Conversely, curriculum making as social practice – especially where actors move across sites – affords important experiences and resources, originating from different settings/ environments in an interplay between actors and different agendas, for fostering and enhancing teacher agency."

(Ibid., 2022: 1039)

Whilst here, Priestley et al. (2022) refer directly to teachers, we would argue that different actors are involved in curriculum making, and in the case of ARTAVs we refer to educators in both school and community settings.

We see, though, the potential importance of the ARTAV role for enhancing agency as these professionals (actors) are experiencing different agendas and cultures, accessing different resources and being engaged in professional dialogue that can both challenge and affirm personal and professional beliefs. The networks ARTAVs develop could afford possibilities in terms of the expansion of their web of professional relationships and consequently provide spaces for other different voices and practices to be made visible, including external professionals, expert knowledge and so forth. These expanded relational and material resources offering possibilities of supportive relationships, of expertise, of increased skills and knowledge impact the environment by means of which professionals achieve agency and have the potential to shape how expansive the professional agency of ARTAVs might be. Moreover, the capacities of ARTAVs to engage in curriculum making may then be enhanced providing a context for richer STEM educational experiences for children and young people.

In Conclusion

Does YSLP support conceptual understanding in STEM? (Aim 7)

- Educators and young people thought that conceptual knowledge and understanding of STEM concepts was important and improved as a result of participation in the YSLP.
- Conceptual understanding is important, but not the most important part of the YSLP.
- The application of conceptual understanding in practical situations was a significant success of the YSLP activities.
- Training sessions provided by SSERC were felt to enhance the professional learning of the participants
- The development of the ARTAV role enables targeted support and training to be delivered at a centre level, increasing flexibility and responsiveness of the programme.

Does YSLP challenge stereotypes? (Aim 3)

- There is some evidence that involvement in the YSLP can help to challenge stereotypical perspectives of STEM in Scotland.
- Participants describe thinking that gender stereotypes are being challenged but implicit biases are still present and demonstrated in the language used in discussions with both TAs and YSLs.
- The way that a pupil can move through the stages of YSLP between Primary, Secondary and in Community settings suggests a longer-term pathway to challenging deeply held stereotypical perspectives of STEM careers. The early stage of this evaluation and the young nature of YSLP both suggest that while only superficial intervention has occurred at this stage, there is positive hope for the future.

Does YSLP Develop transversal competencies of leadership and mentoring? (Aim 2, 4, 5, 6, 8)

- Developing leadership skills in young people was identified as an important aim of the programme.
- YSLs identified and described a range of leadership skills that they had developed through their YSLP activities.
- Mentoring was not felt to be as key a part of the programme as leadership.
- Being seen as an 'inspiration' to teachers, other children (in particular peers or older children) and their families was a source of pride for some YSLs.

Does YSLP raise awareness of STEM Careers? (Aim 2, 6)

- STEM Careers were envisaged by some but not all YSLs
- Pathways to STEM careers were not made more explicit for some young people, however, where a young person had already selected a STEM pathway, they felt that YSLP enhanced their progression and experience of this.
- Many felt it was 'too early to tell' if a young person was more or less likely to proceed into a STEM career
- YSLP is one of many factors that could influence the pathways of young people into STEM careers.

The role of the Assistant Regional Trainer and Verifiers (ARTAVs)

- The ARTAV role gives educators the opportunity to enhance their professional agency.
- The networks ARTAVs develop could afford the expansion of their web of professional relationships.
- The capacities of ARTAVs to engage in curriculum making may be enhanced providing a context for richer STEM educational experiences for children and young people.

In response to the overarching question guiding this report:

How successful was the implementation, delivery and impact of the Young STEM Leader Programme?

We can say that the Young STEM Leader Programme has had many successes since its roll-out. We show here how it meets the key intervention points as described in the 'possible selves' framework.

The palette of possible selves was increased for young people involved in the programme. Young people were encouraged to identify a wide range of STEM careers and consider the characteristics needed to undertake these. Attempts to challenge stereotypical perspectives of STEM were identifiable and with consistent engagement, the YSLP has the opportunity to enact real change for young people and adults alike.

Developing knowledge of the pathways into STEM careers was less visible in the sample participants described here, however, building self-belief in their ability to follow a STEM pathway was impacted in a positive way.

Providing opportunities for elaboration (where young people are given the opportunity to 'try-on' possible identities, potentially through interaction with role models or supported exploration) was a key strength of the programme. YSLs were able to enact STEM roles and determine the aspects of these that were desirable (or otherwise) for their 'future selves'. The young people and their TAs really valued the opportunities that the programme afforded in terms of practices that were seen as different to traditional classroom learning, opening up the possibility of a STEM future for some participants.

The development and implementation of the ARTAV role provided material and relational resources to the participants, initially through networks with themselves and TAs, and subsequently to the YSLs through the TAs. A more in-depth consideration of these important relational networks would be a valuable addition to any future research.

Significant barriers remain which impact on the potential success of the YSLP

- Organisational barriers, such as available time and resources, contribute to challenges within schools and community settings. The flexibility the YSLP offers in terms of adaptability to different settings was highlighted as a strength and continuing to build this flexibility into the programme is encouraged.
- Attitudinal barriers, such as gendered expectations of career pathways, continue to be demonstrated in the language used around some STEM experiences. Engagement across all YSLP levels, along with increased visibility of the successes of the programme may offer opportunities to challenge these in the longer term.
- Structural barriers, such as the impact of poverty on access to STEM career pathways, remain visible in the findings of this evaluation. YSLP offered some pupils experiences and accreditation that mitigates for some of the perceived gaps in opportunity for young people from areas of deprivation. However, as this is a voluntary programme, dependent upon the availability and ability of Tutor Assessors, it is not a fully equitable solution. SSERC, as a meso-level actor, have an opportunity to report on these challenges and highlight the strengths and limitations of interventions such as YSLP in order to make visible, challenge and propose ways forward to those persistent inequalities.

Recommendations

Building on the recommendations made in the pilot study report;

1. The YSLP should take greater account of the differences between formal and non-formal settings and provide targeted support that meets the needs of the different settings more closely.
2. Greater flexibility in the reporting mechanism would make the process accessible to a wider range of young people, enhancing their likelihood of achieving success in the programme.
3. Greater elaboration of the pathways to particular STEM careers was expressed as a need by the participants in the pilot, however, as this is covered in the other levels of YSLP, an overview of where different content is covered may be useful in illuminating the 'bigger picture' for those involved at the early stages.
4. Formal and non-formal routes providing advice and support on overcoming structural barriers to programme completion would enhance the community nature of the programme and deepen confidence in both TAs and YSLs.

We are pleased to recognise the progress that has been made in these areas and make the following recommendations going forward;

1. The inclusion of a Community ARTAV within the ARTAV network, and the development of a working group led by the community ARTAV goes some way to attending to the differences between the formal and non-formal settings. Increasing the number of Community ARTAVs and developing the YSLP to better fit the CLD context will help ensure that the YSLP experience in Community settings is different, yet equivalent to that in School settings.
2. Significant improvements have been made to the functionality of the Log procedures. Some settings still found these challenging, however, and as such, continuing to work with settings, in particular in the Community settings, to ensure that equity of opportunity to deeply engage with the programme is not discouraged as a result of the reporting mechanism(s).
3. The release of the full programme of six YSLP levels has mitigated for this recommendation. Elaboration of the pathways into STEM careers, however, remains a challenge for the settings involved in this evaluation. As such utilising the ARTAV network and training sessions to provide an overview of the whole programme may help to build confidence in YSLP as an activity that can be engaged with throughout a young-persons learning experience. Widening the award to early years (CfE Early or First Level) and post-16 (SCQF Level 7) offers opportunities to more fully demonstrate a range of pathways into STEM for young people.

4. The development and implementation of the ARTAV network has provided a layer of support to TAs which can help to overcome some of the barriers to programme completion and build confidence in the delivery and reporting components of the programme. Supporting the ARTAV network to make connections across the Scottish STEM community, including at policy level, offers the opportunity to influence structural change in STEM education in Scotland.

Finally, two recommendations focus on the ongoing research engagement of the YSLP

1. An ongoing evaluation strategy should be developed which includes a mixture of 'broad and shallow' mapping exercises. These include mapping the reach (across levels) of the programme, but could be expanded to consider, for example, topic coverage, YSLP destinations or TA confidence. Engaging with YSLs and TAs at enrolment and as they reach certification are the key 'entry points' to gaining this important data.
2. The co-creation of research/evaluation work with ARTAVs, TAs and YSLs should be considered as an opportunity to deepen understanding of the impact of YSLP in a way that is also meaningful for the participants.

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Appendix 1: Pilot Study Summary of Findings

Obj1: Develop CfE Second Level and SCQF Level 6 frameworks which deliver the aims of the Young STEM Leader Programme

Does the YSL programme:

- Improve awareness of STEM careers? (Aim 2, 6)

In all settings there was an improved awareness of STEM careers, however this was not exclusively due to the YSLP, existing work in some settings such as careers fairs also had an impact on this. The settings in which this was most effective (Secondary A and Primary) utilised the YSLP experiences alongside existing initiatives, for example our world of work week and the STEM ambassadors programme. In the Community setting there was an existing focus on women in STEM careers with YSLP providing a source of further discussion and reflection that the TA reflected could be better co-ordinated in future years. Even within the least successful setting there was felt to be a general increase in awareness of the range of STEM careers available within the Scottish context and the importance of these roles to the economy and society.

- Improve attitudes towards STEM? (Aim 1,7)

Attitudes towards STEM were generally positive across all the settings. The predominantly voluntary recruitment of the YSL's could suggest that the young people involved were already pre-disposed to have positive attitudes towards STEM, however the participants of the YSL's activities were varied, including nursery children, S1 pupils and Guides. The positive responses of these participants, as reflected upon by the young people, suggests that there may be a wider impact on attitudes towards STEM from those who had not previously considered it attractive. The impact of the young people as peer role models was felt to be a success by the adult participants. In the setting in which the least impact on attitudes was made (Secondary B) it was felt that attitudes had improved within the YSL's and with the teacher directly involved, but the programme had not been able to make an impact on the wider school community that would be needed to achieve this aim in a meaningful way.

- Support conceptual understanding in STEM? (Aim 7)

This aim was less confidently achieved by the YSLP, from each setting, the participants were able to give a list of topics covered by the YSL's activities, however, there was little articulation of the ways in which the YSLP activities had contributed to or supported the conceptual understanding of the topics in question. This was also an area that was felt to be among the least important aims of the programme in the TA survey. This will be interrogated further in phase 2.

- Improve STEM uptake and retention? (Aim 2, 7)

The TAs were very positive about the STEM futures of the YSLs involved, and while the young people spoke positively about their future STEM decisions, there were some contradictions in the discussions. One of the YSLs preferred to wait until secondary school to make a decision, and one of the TAs suggested that the programme had little impact on STEM uptake due to its lack of impact more widely within the school. Furthermore, the uptake of STEM courses was also felt to be among the least important of the aims in the survey responses.

Does the YSL programme:

- Challenge stereotypes? (Aim 3)

All participants spoke with confidence about the important role of challenging stereotypes in the YSLP. Challenging gender stereotypes was evident in two of the cases (Secondary A and Community), while one (Primary) recognised that they still had some challenges in that area but were confident that going forward a more balanced gender split would emerge. Challenging the conception of STEM as an elite subject was also discussed, however there was less consensus on the impact of YSLP on this area. There was some suggestion from the questionnaire that YSLs in secondary school may have been students already on a university STEM trajectory; however, responses were not high enough for this to be statistically significant. This will be explored further in phase 2.

- Develop transversal competencies of leadership and mentoring? (Aim 2, 4, 5, 6, 8)

This was an area of significant strength for the YSLP. All participants spoke of the impact that the programme had on the organisational, inter- and intra- personal skills of the young people. The young people spoke with pride and care about the way they prepared and reflected upon the activities that they led and the reflective process encouraged by YSLP enhanced these experiences and gave them confidence continue on their YSLP journey. The adults interviewed spoke of the impact the young people had on the wider community, with other staff seeing the growth in confidence in the YSL's leading activities. The opportunities for reflection encouraged by the completion of the logbook were felt to contribute to this success, however the process was felt to be cumbersome in most settings. Further consideration of this will be undertaken in phase 2.

- Have an impact on staff expectations? (Aim 1, 3)

Staff expectations of the young people progressing in STEM was high in three of the four settings involved in the interviews, and the survey supported high expectations for young people progressing into STEM futures. This may be a further example of those with existing STEM aspirations getting involved in the YSLP, however in one setting in particular (Secondary A), the YSLs included pupils with a wide range of interests, including football, dance, languages and the environment, potentially opening up STEM futures to a wider cohort of individuals. In the least successful setting (Secondary B), the limited progress towards the leadership element of YSLP limited the ability of the TA to reflect on any change in the STEM aspirations of the pupils.