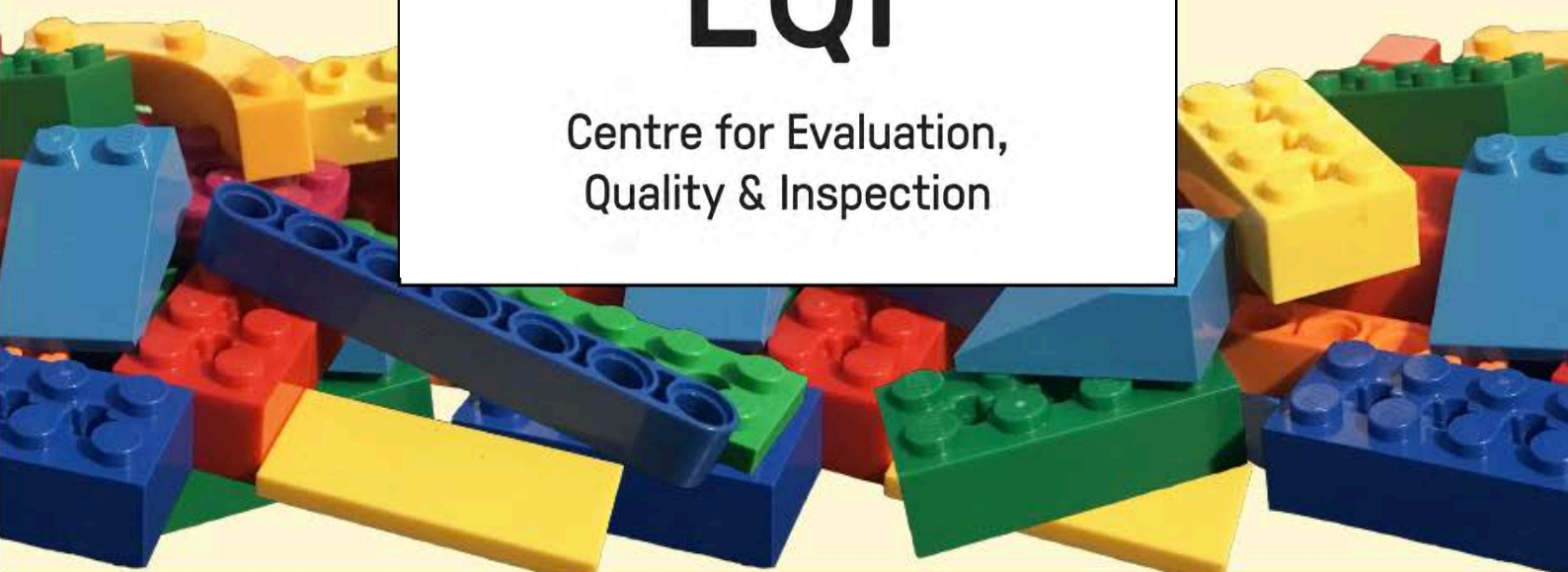
Evaluation of the WEAVE Project in Irish Primary Schools 2021-2023 :

Teaching Computational Thinking Skills and Developing Cultural Responsivity Through LEGO Robotics and Coding

Dr Martin Stynes

(EQI) Centre for Evaluation, Quality and Inspection



About (EQI) Centre for Evaluation, Quality and Inspection

The Centre for Evaluation, Quality and Inspection (EQI) is a multidisciplinary research group based at Dublin City University (DCU) Institute of Education. It brings together evaluators, policy analysts and economists from within DCU, from schools and other educational institutions within Ireland and abroad and from a range of other organisations.

Our work encompasses schools, other learning centres and the wider public service. EQI is primarily concerned with governance and accountability mechanisms including quality assurance processes, school inspection and organisational self-evaluation.

As a research centre specialising in the evaluation of educational policies, programmes and personnel, EQI undertakes research to make data informed judgments about organisational and professional performance.

EQI also studies thematic areas such Culturally Responsive Evaluation and Assessment (CREA). EQI hosts the Irish Evaluation Network (IEN) – the national database for evaluators working on the island of Ireland.

About the author

Dr Martin Stynes is a senior EQI DCU research associate. His role with EQI involves teaching on the Professional Doctorate in Leadership programme (Ed.D.). He authors and edits work on school leadership, on educational disadvantage and on qualitative research methodologies.

The author tutors at undergraduate level and also supervises Ph.D. and Ed.D. candidates at DCU. His previous evaluation work with EQI has investigated school inspection systems and anti-bullying.

The author is the recently retired principal teacher of a DEIS band 1 primary school in Kilmore West, Dublin 5. In previous employment, Martin was a mainstream and special class primary school teacher. He also worked in a remand school and was principal of a special school for children with visual impairments.

Dr Martin Stynes was awarded DCU Alumni of the Year 2021 for his school community leadership during the Covid-19 pandemic response.

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Abbreviations

BNS Boys' National School

CPD Continuing Professional Development

DCU Dublin City University

DE Department of Education

DSS Digital Strategy for Schools to 2027

EPE Education for Public Engagement

EQI Evaluation, Quality and Inspection

GNS Girls' National School

ICT Information and Communications Technologies

NCCA National Council for Curriculum and Assessment

NCSE National Council for Special Education

NSF National Science Foundation

OECD Organisation for Economic Cooperation and Development

PDST Professional Development Service for Teachers

SETU South Eastern Technological University (Carlow)

SFI Science Foundation Ireland

STEM Science Technology Engineering and Mathematics

TPL Teacher Professional Learning

Acknowledgements

The author wishes to thank Ms. Jennifer McGarry for her collaborative engagement and commitment to the EQI WEAVE project evaluation and for her shared insights and knowledge on continuing professional development and teacher education. Without her personal and professional dedication to the evaluation and to the WEAVE project itself, this publication would not have been possible.

To Professor Deirdre Butler, to Dr Monica Ward and to Dr Yvonne Kavanagh for their initial vision and steadfast efforts in bringing the project into Irish school classes. A special thanks to Professor Kimberly Scott from the Center for Gender, Equity Science and Technology (CGEST), Arizona State University for her collaboration throughout and for sharing her wisdom and insights, both online and during her visit to Ireland in June 2023.

A sincere debt of gratitude is owed to the teachers who undertook the WEAVE project and who assisted so openly with the EQI evaluation. In a demanding workspace that is crowded by curriculum overload, their enthusiasm and energy for innovation is matched only by their dedication to the welfare and interests of their pupils.

Finally, and most importantly, to the pupils involved in the WEAVE project – for having so much fun working so hard - for offering amazing solutions to tricky problem – for excellent LEGO builds and coding genius – for exciting WEAVE showcases - for making a better future for tomorrow for us all. You have made the vision of this Science Foundation Ireland & National Science Foundation project, a reality in your own classrooms. Well done.

List of participating schools (in alphabetical order): Askea BNS, Carlow: Askea GNS, Carlow; Bishop Foley BNS, Carlow; Mary, Help of Christians GNS, Dublin 7; Our Lady of Victories BNS, Dublin 9; St Catherine's Senior GNS, Dublin 7; St Finbarr's BNS, Dublin 7; St John Bosco BNS, Dublin 7; Scoil Mhuire Gan Smál GNS, Carlow.

Images: Courtesy of WEAVE project team

EXECUTIVE SUMMARY

In 1997, The Department of Education launched its 'Schools I.T. 2000' report with a stark assessment that Ireland then lagged '*significantly behind its European partners in the integration of information and communication technologies (ICTs) into first and second-level education*' (p.2). As the new millennium dawned upon schools, it was accompanied by unprecedented Government investment in technology and a targeted action plan of infrastructure resourcing, teacher TPL and education policy research and development. The National Centre for Technology in Education (NCTE) and Scoilnet were established and in an ambitious vision, a plan was launched to embrace emerging, and now more readily accessible computer technologies, and to reshape education for social, vocational, economic and pedagogical advancement. Significantly, it was noted that '*it is clearly important that all young people, regardless of economic background, should have equal access to new technologies*' (p.5).

By 2008, the DE publication, '*Investing Effectively in ICT in Schools*', reports a significant advance, with 82% of teachers having used computers in their teaching, at least on a trial basis. There is a perception that '*learning is changing*' as a result of the enrichment brought about by the introduction of digital technologies in schools and it is recognised that '*the pursuit of creativity and inventiveness are now pivotal skills in a knowledge economy*' (p.1). Apart from the obvious need to consider upgrading and maintaining hardware, the updated DE ICT plan places a particular focus on the importance of teacher engagement and the introduction of effective TPL to ensure that pedagogy not only keeps pace with rapid developments, but advances ahead of trends, particularly in terms of exploring and showcasing digital technologies innovation. Notably, the 2008 document looks ahead to a future where technology in the classroom is seen as more than simply a supplementary teaching tool. Computers and other devices are envisaged optimistically as a '*learner-centric*' digital learning tools (p.13); although how this may be fully realised is yet understandably unclear.

The later DE 'Digital Strategy for Schools' plan (2015-2020) does however offer clarity of purpose on this point. This more recent document is again supported by substantial Government investment and it gains headway both practically and in terms of educational aspiration in schools across Ireland. Hardware and infrastructure improvements are

accompanied by policy development and for the first time on a nationwide scale, the focus on teachers' professional learning and on school development planning shifts significantly towards digital learning planning. The embedded potential of using digital technologies in teaching and learning processes across the entire curriculum is now realised. A key development of the strategy is a deliberate and clearly stated orientation towards constructivist pedagogy, a process aimed to include the pupils centrally in hands-on experiences of active learning and self-assessment. An important, and equally clearly defined element of this constructivist pedagogical orientation, is the potential support offered for inclusion and diversity.

Educationally, the current DE Digital Strategy (2020-2027) offers a veritable quantum leap from the original 1997 model, not simply in terms of presentation and design, but more importantly by way of recentering the child and not the technology as the singular and significantly most important part of the learning engagement. An ambitious plan, commenced in 1997, grown by national investment and brought to reality in classrooms across the country by over a quarter of a century of patience and ingenuity by principals and teachers, has produced widespread positive change in education in Ireland. A plan to enable schools to operate as '*effective digital education ecosystems*' (p.11) aims to ensure that all children can become critically engaged active learners and grow to be global citizens in a digital world. Such a world, with its unpredicted happenings and societal trends can however present seemingly indomitable challenges to education at times. The impact of Covid-19 on schools and the unprecedented disruption caused by time out of school has caused researchers and educators (Butler and Leahy, 2020) to rethink how our education systems are designed and to question the roles that digital technologies have come to play in them. Rethinking the use of technology in education, in order to meet new demands, must surely maintain the primacy of learner engagement, and in ways that are culturally responsive also.

An additional significant influencer in how one might re-think or re-shape digital technologies policy and practice is to found in the EU (2021) Digital Education Action Plan (13). In an era where gender balance is arguably perceived in most quarters as a societal norm, the EU report notes that '*fewer women are interested in participating in the digital sector, be it in the field of higher education, jobs or entrepreneurship … women represent only 20% of ICT graduates and only 17% hold tech sector jobs. Women also represent only 24% of self-employed professionals in technical professions, such as science, engineering or ICT*'. The EU (2018)

study '*Women in the Digital Age*' also reports significant and disproportionately low figures for women in digital entrepreneurship and e-leadership compared to the figures for men. Importantly, and of significance for education policy and practice, is that the gender difference is attributed, at least in part, to '*citizens' attitudes towards technology and innovation*' (p.8). Arguably, and in an education system informed by national gender equality policies (Ireland, 2018; OECD, 2018; OECD, 2023), attention should be paid to addressing any imbalances, perceived or otherwise.

Research by Accenture (2016) attests to a similar imbalance in the US, noting that the numbers of women in computing jobs there is actually declining. It suggests '*that universal access to computing in schools will not address the gender gap*' (p.2) and instead, courses must be tailored to meet girls' specific needs and interests. The problem, and the solution they claim, rest in the classroom. Their research demonstrates that direct targeted interventions can inspire and empower girls in coding. Sustained learning programmes that meet girls' specific needs and interests can deliver dramatic increases in female participation in coding and computing.

It is commendable that the DE 'Digital Strategy to 2027' provides for accessibility for all learners, '*particularly those at risk of educational disadvantage and those who have additional learning needs*' (p.15). On the same page, it is notable that attention is drawn to the Baseline Report (Butler and Leahy, 2020) where the gender gap in digital skills is again highlighted and where the authors note the following: '*Addressing the underlying causes of gender disparities in the digital and STEM fields requires targeted interventions as early as possible in a child's life, to raise awareness and interest, tackle gender stereotypes, provide role models to combat underrepresentation of women in STEM and particularly digital technology roles*' (p.59).

Against such a backdrop therefore, WEAVE is presented to us as a learner-centric, interwoven, culturally responsive, cross-curricular, computational thinking enterprise – a project that embraces all of the best advances in digital technologies in Irish education since progress began in 1997, as outlined above. Funded by Science Foundation Ireland and hosted at Dublin City University, WEAVE applies a co-development approach to build primary teachers' capacities to effectively and sustainably deliver STEM Education, and Education for Public Engagement (EPE) in Ireland. This 2-year initiative, in partnership with South Eastern Technological University (SETU) Carlow, partners with the Professional Development Service for Teachers (PDST) and with Professor Kimberly Scott, an expert in women and the area of STEM who is

based in the United States and has a long history in developing, implementing and researching programs funded by the National Science Foundation to empower girls and women in the STEM fields, to co-develop a cross-curricular culturally responsive computational thinking framework for primary schools. The programme aimed initially to iteratively implement this framework in all-girl primary schools and co-develop professional development experiences for pre and in-service teachers to scale curriculum in mixed-gender primary classrooms throughout Ireland. In order to develop the framework in a sustainable and scalable manner, a 'buddy' support system was used in and across the participating schools. In Year One, four all-girls' schools and eight teachers (two teachers per school) worked with the Project Coordinator to implement the framework and develop computational thinking skills in a culturally responsive manner. In Year Two, the girls' schools joined up with a local boys' school. The purpose of this was to share the knowledge developed during Year One and to establish a community of practice to ensure that the work of the WEAVE Project would endure past the project itself coming to an end. The outputs of the WEAVE project are intended to include a framework to be implemented in Irish primary schools, a range of mentoring resources for primary school teachers and a suite of TPL resources that PDST can use for their national programme.

The Centre for Evaluation, Quality and Inspection (EQI) at DCU was engaged to assist with the evaluation and delivery of the project. EQI is a multi-disciplinary network that specialises in the research and evaluation of educational policies, programmes and personnel. Dr Martin Stynes, a senior EQI research associate with EQI, led the WEAVE evaluation. Collaboration with the project organisers provided access to background materials for documentary analysis. Collaboration with participating school principals and teachers, provided data for recorded interviews and focus groups. Attendance at TPL events and pupils' showcases provided other significantly important field data. An estimated three hours of recorded interviews with school principals (20000 words transcribed), an estimated six hours of focus group interviews with participating teachers (28700 words transcribed), researcher notes/observations, as well as photographic evidence of outcomes were analysed using NVivo 14 (Lumivero, 2023). Guskey's (2000, 2002) five critical levels of evaluation for effective TPL, provided an effective inquiry lens.

Detailed interim reports, with progress updates and recommendations, were provided to the project organisers throughout the process. EQI also provided support, based on the research outcomes, that assisted the co-development of a cross-curricular culturally responsive computational thinking roadmap for schools. The evaluation process concludes with a full written report and a PowerPoint presentation to the school principals/teachers, the project organisers, the PDST and SFI in June 2023.

The evaluation process and the overall outcomes are very positive. When participants' reactions to the WEAVE project were evaluated, principals and teachers indicated that the WEAVE project was received very positively initially and that the perception among those involved and among other teaching colleagues continued to be very favourable. Issues arose due to a global shortage of parts in 2023 and teachers were unprepared for this unexpected logistical problem. In spite of these unexpected demands however, principals and teachers remained very positive and enthusiastic in their reports about WEAVE learning activities and outcomes. When participants' learning was questioned, principals and teachers indicated that the WEAVE project involved new learning for both teachers and pupils alike. Teachers learned to collaborate collegially and to develop group work competencies. Pupils learned new skills such as coding in tandem with their teachers. Often, the pupils' progress outpaced their teachers' progress. The learning for teachers also prompted increased awareness of and involvement in whole school cross-curricular planning. The learning engagement on all fronts was reported as a very positive experience.

We also examined issues of organisation and support as part of Guskey's (2000, 2002) evaluation framework. Principals and teachers indicated that the WEAVE project delivered considerable levels of practical and material support for their schools. LEGO kits had been introduced to schools with a 'wow' factor. Principals had used timetabling, school planning and staff meetings to discuss and effectively support the project. Teachers had worked creatively to solve practical day-to-day issues, such as the sharing of school digital technology resources. Pupils responded well to the new responsibility of auditing and caring for LEGO resources. A lack of available digital technology resources was reported as problematic in some schools due to the limited number of devices available and/or to limited broadband coverage. Some principals and teachers report that the project operated very successfully when the DES Digital Strategy funding was directed to support the learning.

Questions about participants' use of knowledge and skills guided the fourth critical level of inquiry. Principals and teachers indicated that involvement in the WEAVE project had developed participants' attitudes as well as their pedagogical knowledge and skills. Teachers had adapted to new teaching approaches. There was increased staff engagement in cross-curricular school planning and resource management. The challenges of implementing WEAVE as a new learning programme were recognised and were everywhere met with successes. Finally, and most importantly, the fifth level of Guskey's (2000, 2002) inquiry model focuses on pupil learning outcomes. Principals and teachers indicated that involvement in the WEAVE project had generated significant positive and sometimes unforeseen outcomes for pupil engagement and learning. The impact on pupils has been very positive, and it is reported as noticeably most positive on children with additional learning needs and on those who are integrating into the Irish system from abroad. LEGO and coding offer a widely understood and accessible means of communication. The evidence from the study is that the WEAVE project impacts positively on pupils' behaviour, attitudes to learning and on their attainment and wellbeing.

Two additional considerations were explored as the EQI evaluation moved beyond Guskey's (2000, 2002) framework of questioning. When school principals were asked to contribute an overall evaluation summary, the following was reported: In spite of the daily demands imposed upon school principals due to resource management issues and staff shortages during 2021-23, all of the principals involved in the WEAVE project were highly supportive of it and they recommended its continuation into the future. There were no significant suggestions for change or improvement noted. When teachers were asked to contribute an overall evaluation summary, the following was reported: Teachers spoke positively about the impact of computational thinking skills development in their classrooms. While both the coding and the LEGO building caused some difficulties due to global supply-chain issues in 2023, teachers remained optimistic for the project and offered constructive advice going forward. There was strong evidence of teachers' culturally responsive practices, particularly inclusive practices for pupils in socially disadvantaged settings, those with additional learning needs and pupils of migrant and new-comer families to Ireland.

The EQI WEAVE evaluation aimed to provide a systematic and objective assessment to first determine the effectiveness of the programme and then, to shape its sustainability. Firstly, a formative evaluation aimed to provide a number of interim reports that would support the development of the WEAVE TPL programme by collecting data from participants as they progressed through the learning, by providing an embedded analysis and by offering evidence-based recommendations and explanation building (Yin, 2018) that shaped TPL outcomes. Secondly, the evaluation sought to engage participants and support the collegial co-creation of a roadmap for sustainability; one that could be provided to the PDST in order to support the continuation of the project into the future. Lastly, the evaluation aimed to draw together multiple social perspectives in a summative report for a public audience. The target set for the final report, was to provide an informative balance between the professional integrity of the WEAVE pedagogy and the obvious fun and enjoyment of the human enterprise of learning.

The EQI WEAVE Report

Chapter 1: The Weave Project

1.1 Introduction

This document is a summary of a formative and summative evaluation process undertaken by the Centre for Evaluation, Quality and Inspection (EQI) to support the development of the WEAVE project (Dublin City University, 2022). Chapter 1 opens with a brief outline of the project and considers its background and key components. We considered it important to introduce the schools that participated in the WEAVE project to date and the opening chapter therefore presents information supplied by them for the report . In chapter 2 we explain the research methodology and the methods in our data gathering. We describe the elements of a multi-layered evaluation framework that examines the aims of the project, its TPL effectiveness and its outputs. We also explain how we used data analysis to make sense of and draw meaningful conclusions from a wide range of data, gathered at focus groups, interviews and consultation meetings as well as attendance at TPL sessions and a final DCU project showcase.

We present our findings in chapters 3 and 4 and accompany these findings with supporting empirical evidence. In chapter 5 we offer an analysis of the outcomes of the WEAVE project with information about the final DCU project showcase, a summary of school principals' perspectives and importantly, a roadmap to support project sustainability following hand-over of the initiative to the PDST. The report concludes in chapter 6 with practical recommendations that are drawn from the data and these are supported by empirical report evidence. This chapter also includes an easy-to-read summary for WEAVE pupils. A bibliography is provided to offer signposting and direction to readers who require more detailed information about the topics covered in the report. A brief Appendices offers insights into the research methods.

1.2 Background

DCU Faculty of Engineering and Computing (2022) presents WEAVE as an exciting SFI-funded national-level project in collaboration with SETU Carlow, the Professional Development Services for Teachers in Ireland (PDST) and Arizona State University - Center for Gender Equity in Science and Technology (CGEST). The project aims to increase pupils' awareness of the different ways that coding, computational thinking, and computer science can

be used in our society today. It also encourages the pupils to develop a critical eye and to question the application of new technologies in our world.

Raising awareness of coding/computational thinking and computer science at a young age is important to help pupils develop the type of skills that will be required of them in the 21st century. Throughout the Weave Project, teachers and students work together to develop resources and activities that lead to the development of a computational thinking framework for Irish primary schools. The Weave Project is described as a great opportunity to develop coding and computational thinking learning activities in the context of the school and wider community.

Over the last two years, the WEAVE Project has worked with nine schools in total from the Carlow and Dublin areas. The project took a bottom-up, co-development approach to the creation of a computational thinking framework that would support the participating teachers in developing their computational thinking skills and designing cross-curricular learning experiences for their pupils. At the start of year one, four all-girl schools and 8 teachers were involved: two Dublin schools and two Carlow schools. By the end of year one, the number of teachers in these participating schools increased from 8 to 14 as teachers paired up with other teachers in their schools to support them with developing computational thinking skills. The total number of pupils involved in year one was approximately 198. In year two, the number of teachers on the project increased to a total of 28 as the all-girls schools joined up with the local all-boys schools to widen their community of practice. The total number of students involved in year two was approximately 650. The schools involved were located in a mixture of rural and urban areas, and all were located in areas designated as socially and educationally disadvantaged.

Image: Courtesy of WEAVE project team

1.3 Computational Thinking

Millwood, Bresnihan and Hooper provide a concise rationale for and explanation of computational thinking skills in their 2018 NCCA review paper. The coining of the term 'computational thinking' is attributed to Seymour Papert and focuses on the construction and comprehension of computational objects (Papert, 1993). It encompasses getting computers to perform tasks efficiently and reliably, along with utilising them to understand natural and social phenomena (Butler, 2017). In the context of the Irish policy literature, computational thinking is currently defined as 'competence in problem solving & design to create useful solutions, informed by the possibilities that computing offers' (p.8). As a taught problem-solving approach, computational thinking directs pupils' interests and actions based on perseverance, openness to collaboration and shared input, as well as a concern for quality and successful outcomes.

Image: Barefoot Computing: Computational thinking (2023)

Teaching computational thinking problem solving, or in a sense providing structured opportunities for children to develop the skills in learner-centric encounters, is promoted as a purposeful activity in primary education. Within the WEAVE TPL model, it aims to support teachers in developing an understanding of the possibilities of computing to augment teaching and learning across various subjects in their classrooms. Computational thinking involves problem-solving strategies rooted in computer science principles, such as breaking down complex problems, identifying patterns, and using logical and algorithmic thinking (Millwood

et al., 2018). Through engaging in the process of computational thinking, learners' systematic thinking and analytical problem-solving abilities are enhanced. As well as offering fun, enjoyable and achievable learning outcomes, it is considered that the acquisition of such skills also prepares children for life beyond school; particularly in terms of digital literacy competencies, broad social engagement and participation in the technology sector. The latter is considered particularly relevant when one notes the gender imbalance in areas of digital technologies and computing employment, discussed in later chapters in this review.

That the kind of problem solving skills used by adult computer scientists could be taught to and developed in pupils in primary schools is not new. Arguably though, it is underdeveloped in the Irish primary school curriculum, to the point that highly experienced teachers on beginning their TPL engagement, report having no knowledge of it. The WEAVE project seeks to develop computational thinking skills by engaging children in practical and meaningful projects. Challenges are set for pupils with tasks that involve building LEGO robotics models and operating them by writing computer code on iPads and Chromebooks.

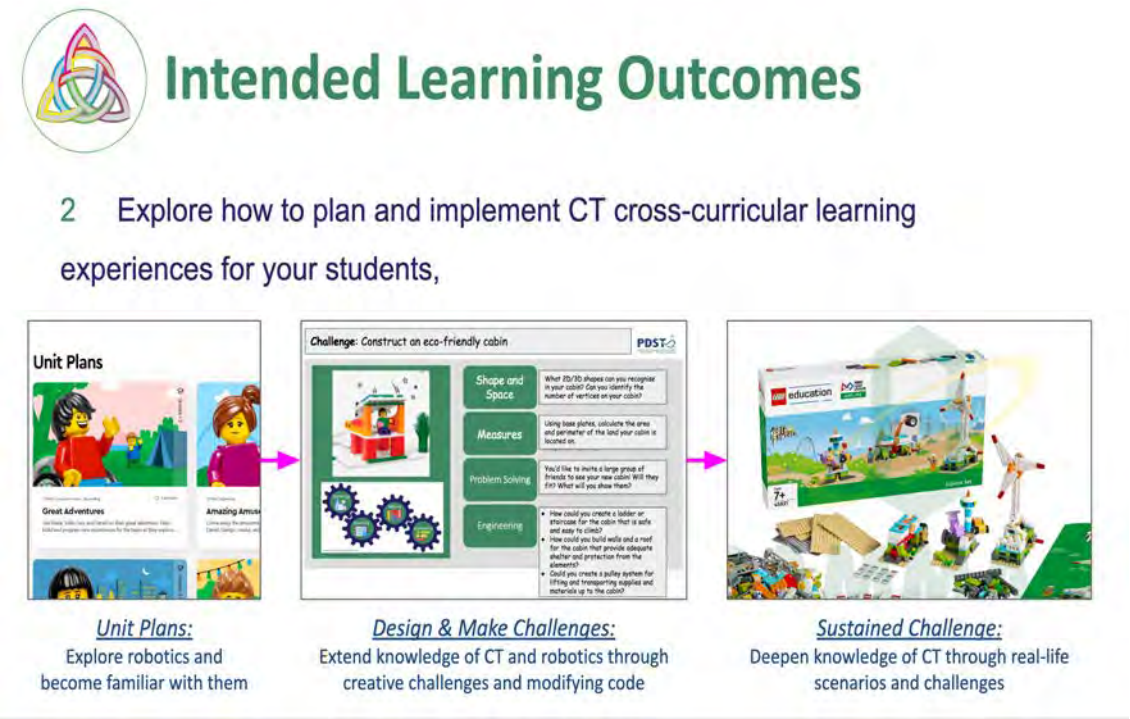


Image: Courtesy of WEAVE project team

The ‘wow’ factor, as described by teachers in this research, of exploratory play in senior classes is a definite positive motivator for pupils. Development of computational thinking skills throughout the WEAVE Project are nurtured through an inquiry-based, integrated approach to the primary subjects. Such an approach is rooted in a constructivist theory of learning; which aligns with the primary school curriculum aims and is action based - promoting learning and engagement through the act of doing whereby the focus is on the process - for example prototyping (Kenna, 2022). One such inquiry-based task involved figuring out how to get large vehicles into the Phoenix Park through narrow gates. The problem of the historic Phoenix Park gates being too narrow for large vehicles to pass through had been overheard on the radio by a pupil of one Dublin school. She proposed this as the topic for her group’s investigation and the child, plus her group, developed computational thinking skills as they came up with a solution to this problem. This is one example of a culturally responsive WEAVE investigation, one firmly rooted in a meaningful real-world context and one that engages pupils’ interests.

Image: Courtesy of WEAVE project team

In relation to computational thinking, the National Council for Curriculum and Assessment (NCCA) has been exploring various strategies for introducing computational thinking and coding in primary schools for almost a decade (NCCA, 2016; 2017; Millwood et al., 2018). The 2016 *NCCA Coding Pilot* aimed to evaluate the feasibility and effectiveness of teaching coding in primary and post-primary schools across 22 jurisdictions and gathered feedback for

potential curriculum development. This was followed by a more in-depth analysis of six jurisdictions (New Zealand, Scotland, England, the USA, Finland, Northern Ireland) due to their unique, integrated approach to coding within primary curricula and also due to the range of pedagogical practices used. The findings demonstrated that coding and computational thinking should be integrated throughout a number of primary curriculum subjects and that practical investigations with schools should be carried out to "understand and frame the potential benefits and challenges of implementing a playful, thematic or project-based learning approach to teaching code in Irish primary classrooms" (NCCA, 2016, p.34). The WEAVE Project outputs, including a framework, a roadmap and a comprehensive resource bundle, contribute to the ongoing work in this area to understand the benefits and challenges of implementing a project-based learning approach to developing computational thinking skills and teaching code in Irish classrooms. The EQI evaluation offers insights into the progress of the WEAVE project based on both formative and summative engagement. Significantly, the EQI evaluation recommends the continuation of WEAVE project into the future.

1.4 Cultural Responsiveness

As we consider '*culture*' to be a cumulative body of learned and shared behaviours, values, customs, and beliefs that are common to a particular group or society, we attempt to investigate how the WEAVE project influences such an understanding among pupils and teachers in classrooms and beyond. Specifically, we attempt to address how children's learning about computational thinking may provide opportunities that are sensitive to and respectful of cultural variations. The WEAVE project was conceived originally as a cultural response to the gender imbalance in digital technologies education and in future employment prospects for girls in technology related industries.

The focus, in implementing the WEAVE programme initially in Ireland therefore, was on promoting a specific form of STEM education in a selection of all-girls' schools, a form that

taught real-life problem solving in a way that mirrored how adult computer scientists work systematically to solve their own problems. The schools involved are located in both urban and rural settings in Ireland and different issues of cultural responsiveness come to light as the project rolls out.

Image: Courtesy of WEAVE project team

Developments within the Irish education system in the past decade, with regard to the education of children with additional learning needs in particular, have brought significant changes and adaptations to mainstream classrooms. In more recent times, an influx of families fleeing wars and oppression has added to school enrolments and many of the newly arrived have little or no English. Some of the WEAVE schools are DEIS schools and these operate daily against a backdrop of socioeconomic disadvantage and a culture of deprivation.

All of these issues impact upon how a school might meet the challenges of adapting culturally to new learning programmes. One of the tasks set in the EQI WEAVE evaluation was to seek answers as to how computational thinking skills could be introduced to groups of pupils classes in ways that allowed for cultural responsiveness. As the WEAVE project formed and grew through its early and later stages of implementation, teachers in this research commented insightfully about changes in cultural diversity in Irish society generally and on the implications of such changes in their own classrooms. Teachers in this research express an

acute awareness of gender, neurological, racial and cultural difference and they offer professionally informed insights into how schools can meaningfully respond.

Image: Courtesy of WEAVE project team

1.5 Effective Teacher Professional Learning

Brown et al. (2017) comment that 'professional learning is recognised as an important and ongoing aspect of a teacher's working life because it has the potential to impact positively on teachers' performance, effectiveness, professional development, identity, sense of self-efficacy and job satisfaction' (p.13). They cite Clarke (1991) who defines continuous professional development as '*any activity or process intended to change any combination of the following: teachers' beliefs and attitudes, teachers' knowledge and teachers' classroom practice*' (p.13). This understanding of continuous teacher professional learning (TPL) is reflected in the new '*Digital Strategy for Schools to 2027*' (DSS), which notes the empowering potential of TPL to support teachers in enhancing their skills and abilities, in order for them to design learning experiences that will enable their pupils to develop the 21st century skills they need to be successful in the world of today and tomorrow. Furthermore, the DSS also advocates for digital technologies to be embedded "*at each stage of the continuum of teacher education, that is; initial teacher education, induction and continuous professional development*" (2022, p.30).

It can be argued therefore that TPL in education involves more than simply an upskilling of performance and should encompass teachers' cognition, their orientation towards pupils, their professional attitudes and identity, specific subject knowledge and pedagogical knowledge and skills for the topic at hand (PDST, 2023). Worthwhile or effective TPL involves shared practice, collective learning and supportive conditions; including the support of school leadership.

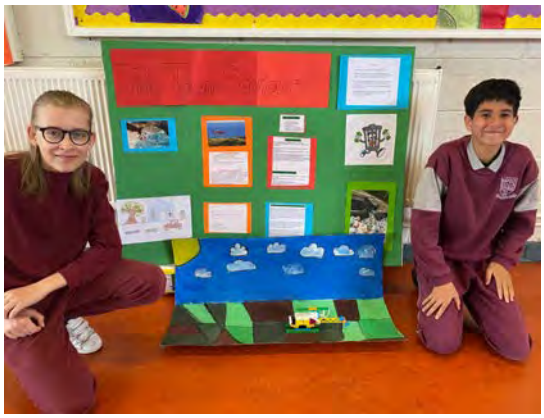
A popular model for evaluating TPL effectiveness in education, and one commonly used and cited, is Thomas R. Guskey's levels of critical inquiry. Developed in 2000, and refined in various iterations since then, the (2002) model used in this research offers a questioning framework that assists researchers to systematically study the quality of TPL courses, based on response data from participants. Researchers use the model to determine what questions are to be addressed, how information will be gathered, what is to be measured or assessed and how information will be used after it is collected. Questions are directed at participants' reactions to the usefulness of the programme design and the materials involved. Researchers ask about participants' learning and if the intended skills and knowledge were acquired. It is important to consider if any aspects of practice have changed after the TPL and if newly acquired skills have been implemented successfully. Finally, and arguably most importantly, questions are directed at how pupils will benefit from teachers' TPL investments.

The first aim of the EQI WEAVE evaluation was to provide evidence-based formative input into the development of the programme. To cite Weiss (1998), evaluation is a practical craft designed to help programmes work better and to allocate resources to better programmes. This aim was achieved by collecting data from participants during their progress through their TPL sessions, by analysing the data and by returning evidence-based recommendations to the WEAVE team during programme delivery. This formative input also assisted with the co-creation of a roadmap for programme sustainability. The second aim, a summative evaluation of the WEAVE project was also delivered, in the form of this final report. This report reflects the collaborative input from all participants, teachers and pupils, and it formally showcases the value of the investment to date.

1.6 The WEAVE Participants

1.6.1 Holy Family BNS, Askea, Carlow.

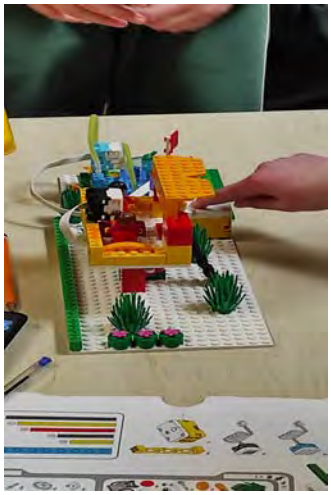
Holy Family BNS is an all-boys vertical school with an enrolment of 291 pupils, located in Askea in Carlow town. We wish to thank the principal Ms Mairéad Mullally and the following staff, Ms Aisling Carroll and Mr Alan Corcoran for their support with the EQI WEAVE evaluation.

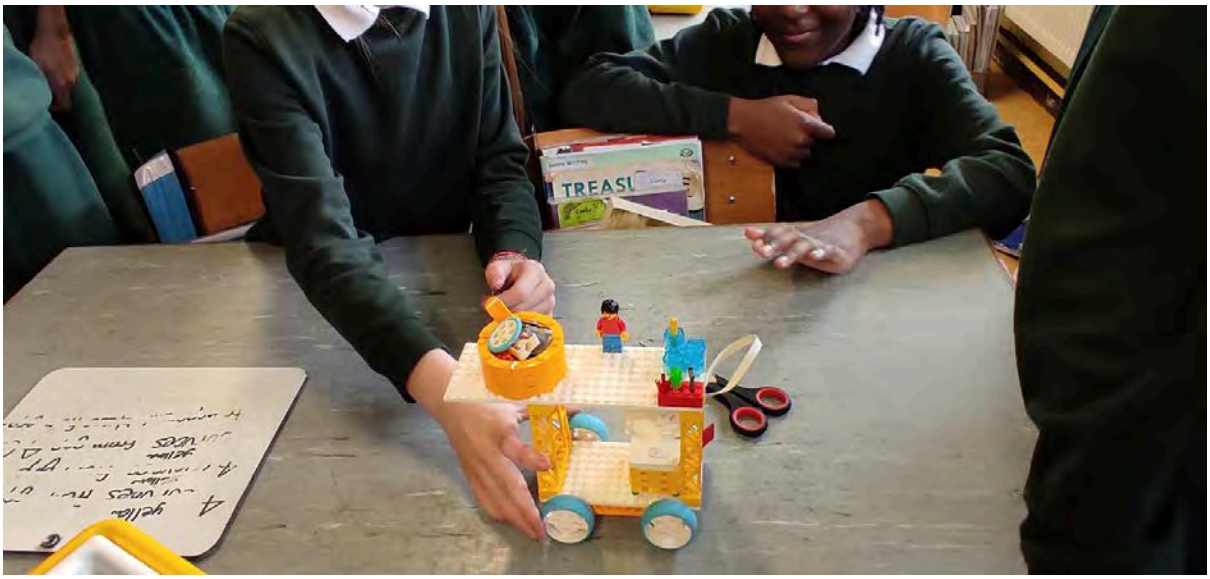


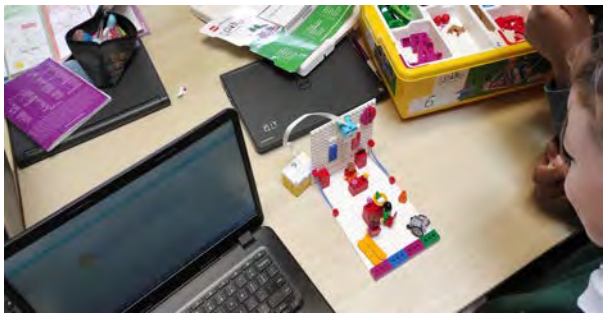
Images: Courtesy of WEAVE project team

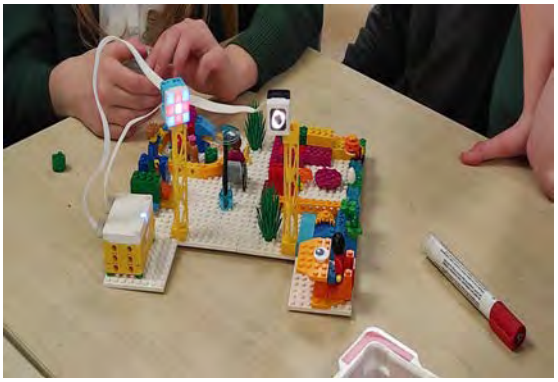
1.6.2 Holy Family GNS, Askea, Co. Carlow.

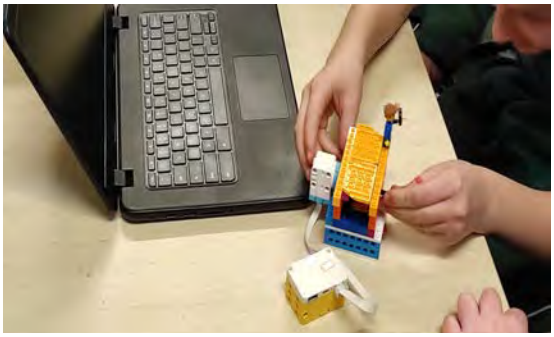
Holy Family G.N.S. Askea, Co. Carlow is an all-girls' vertical school with a current enrolment of 340 pupils. The school has been involved in the WEAVE project since September 2022 with four classes participating at 5th and 6th class levels. We wish to thank the principal Ms Anne Fitzpatrick and the following staff, Ms Lorraine Mullins, Ms Aimee Murphy-Atkinson, Ms Mary Kehoe and Ms Marian Maher for their support with the EQI WEAVE evaluation.







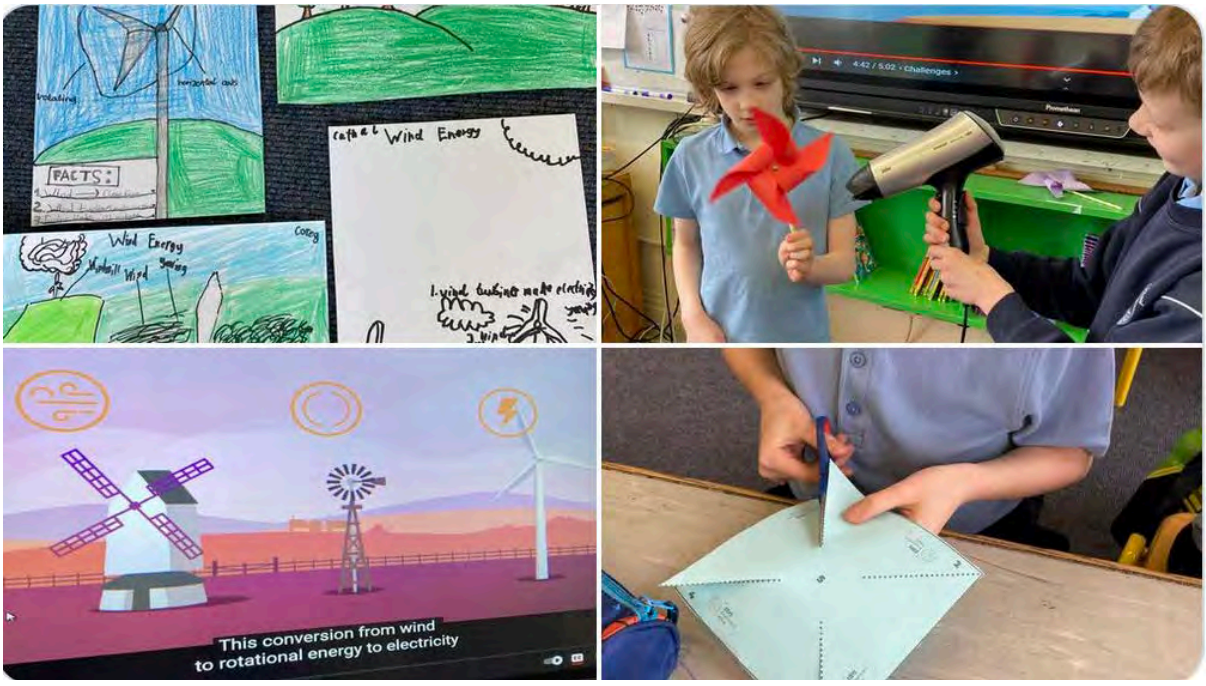





Images: Courtesy of WEAVE project team

1.6.3 Bishop Foley BNS, Carlow.

Bishop Foley Memorial School, Carlow is an all-boys' primary school with an enrolment of 221 pupils. We wish to thank the principal Mr. John Kelly and the following staff, Mr Séan Kelly, Mr Philip Mullins and Mr Peter Doran for their support with the EQI WEAVE evaluation.



Images: Courtesy of WEAVE project team

1.6.4 Mary, Help of Christians GNS, Navan Road, Dublin 7.

Mary, Help of Christians GNS is a vertical all-girls' primary school in Dublin 7 with a current enrolment of 383 pupils. Since September 2022, five classes have participated in the WEAVE project from 2nd through to 6th class. We would like to thank the principal Ms Renee Moran and the following staff, Ms Michelle Ryan, Ms Nora Anderson, Ms Sarah Jordan, Ms Sarah Scully, Ms Germaine Fagan, Ms Laura Noonan and Ms Susan Naughten for their support the EQI WEAVE evaluation.






Images: Courtesy of WEAVE project team

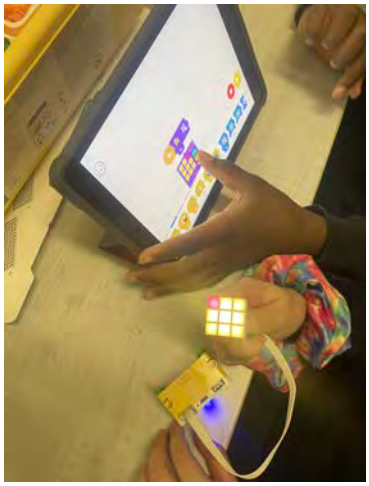
1.6.5 Our Lady of Victories BNS, Ballymun Road, Dublin 9.

Our Lady of Victories is an all-boys' senior school in Dublin 9 with a current enrolment of 195 pupils. We wish to thank the principal Ms Róisín Hickey and the following staff, Ms Michelle Brady, Mr Eoin Flanagan, Ms Aoife Moore and Mr Gary O' Meara for their support with the EQI WEAVE evaluation.

Images: Courtesy of WEAVE project team

1.6.6 St Catherine's Senior GNS, Cabra, Dublin 7.

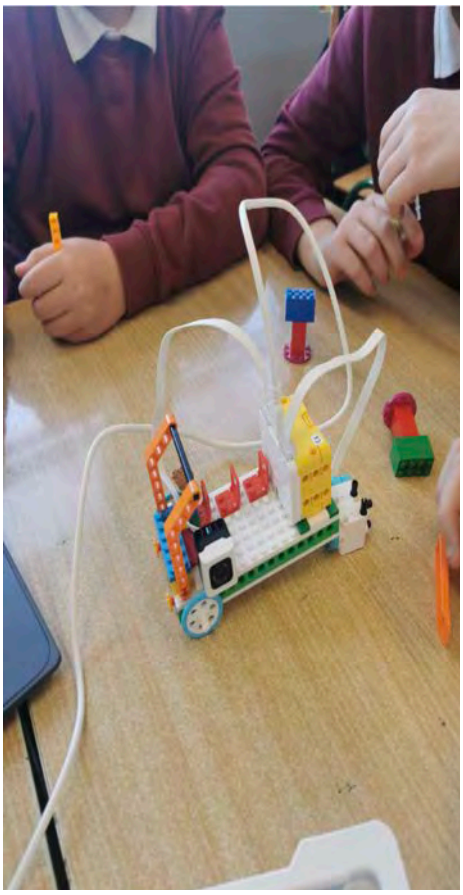
St. Catherine's is a senior all-girls' primary school in Dublin 7 with a current enrolment of 133 pupils. Since September 2021, four classes have participated in the WEAVE project. We wish to thank the principals who worked in the school during the project, Ms Cynthia O Reilly and Ms Michelle O'Farrell, and the following staff, Ms Ailbhe O'Sullivan, Ms Megan Cukur, Ms Maria Bourke and Ms Claire Smith for their support with the EQI WEAVE evaluation. A special thanks also to Bernie, Anthea and Annette, the SNAs in the WEAVE classes.



Images: Courtesy of WEAVE project team

1.6.7 St Finbarr's BNS, Cabra West, Dublin 7.

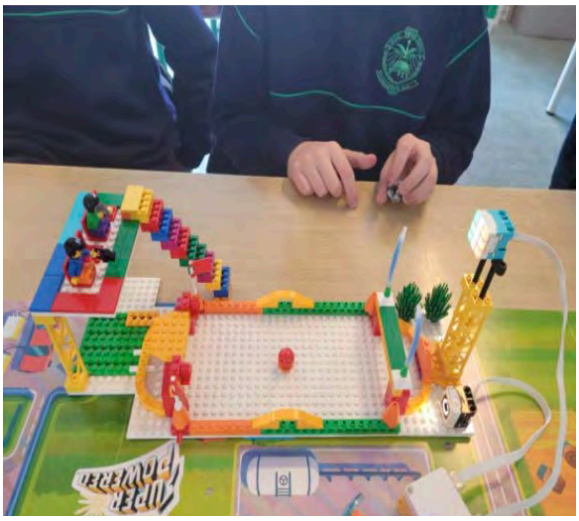
St. Finbarr's BNS school is an all-boys' vertical school in Dublin 7 with a current enrolment of 133 pupils. Since January 2023, two classes have participated in the WEAVE project at 5th and 6th class. We wish to thank the principal Ms Maeve Daly and the following staff, Ms Emma Nyland and Ms Fiona Feeney for their support with the EQI WEAVE evaluation.



Images: Courtesy of WEAVE project team

1.6.8 St John Bosco Senior Boys' School, Navan Road, Dublin 7.

St John Bosco Senior School is an all-boys' senior primary school (2nd-6th class) in Dublin 7 with a current enrolment of 350 pupils. Since January 2023, two classes (one from 4th and one from 5th class) have taken part in the WEAVE project. We wish to thank the principal Mr Emmanuel Bourke and the following staff, Ms Meghan O'Boyce, Mr Colin McCarthy, Ms Jennifer Delaney, Ms Anne Perry and Mr Brian Gaffney for their support with the EQI WEAVE evaluation.



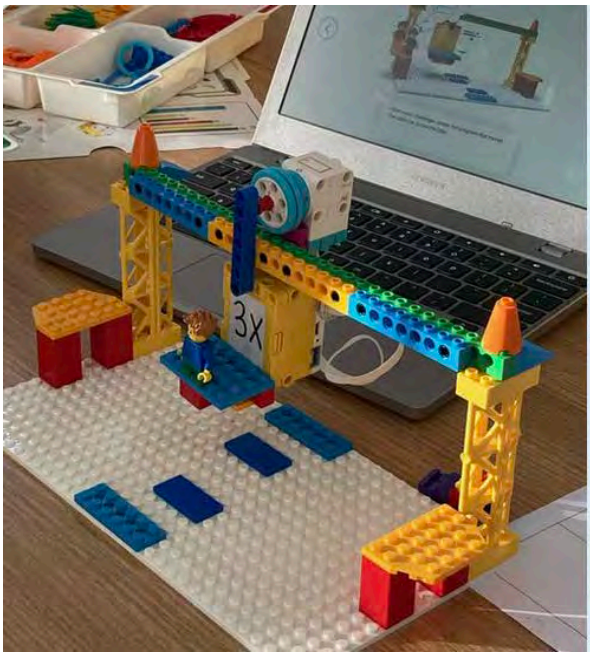





Images: Courtesy of WEAVE project team

1.6.9 Scoil Mhuire Gan Smál GNS, Green Lane, Carlow.

Scoil Mhuire Gan Smál is an all-girls primary school in Carlow town with a current enrolment of 362 pupils. We wish to thank the acting principal Ms Mary Woods and the following staff, Ms Siobhán Kirwan, Mr Martin McEvoy, Ms Colette Conway, Ms Muireann Whyte and Ms Kate Calvey for their support with the EQI WEAVE evaluation.



Images: Courtesy of WEAVE project team

Chapter 2: Evaluation

2.1 Introduction

In this chapter we explain the research methodology and the research methods undertaken to conduct the EQI WEAVE evaluation. We outline the data gathering and data analysis processes. We consider some limitations also.

2.2 Research Methodology and Methods

The EQI evaluation of the WEAVE project involved a systematic collection and analysis of qualitative data. In evaluating how teachers and pupils encounter teaching and learning about a new learner-centric computational thinking programme, how they interact with each other, how they interact with the demands of coding and LEGO robotics and how they evaluate the TPL programme, we can best investigate the lived reality of the situation in a system of individual and shared reasoning, described by Flick (2018, p.3) as '*the pluralisation of life worlds'*. In practical terms, we plan a systematic inquiry, we implement a series of fieldwork research actions and we then analyse the data in an accountable and meaningful manner.

Fieldwork data in this investigation includes verbal data, observation data, digital data, documentary data and visual data. '*Data beyond talk*', or having the EQI researcher become more or less a part of the action through active immersion in the WEAVE process, also added constructively to the evaluation process (Flick 2018, p.313). The EQI WEAVE evaluation aimed to undertake a systematic and objective process to first, determine the effectiveness of the programme and then, to shape its sustainability. Firstly, a formative evaluation aimed to provide a number of interim reports that would support the development of the WEAVE TPL programme by collecting data from participants as they progressed through the learning, by providing an embedded analysis and by then offering evidence-based recommendations and explanation building to shape TPL outcomes (Yin, 2018).

Secondly, the evaluation sought to engage participants and support the collegial co-creation of a roadmap for sustainability; one that could provide the PDST with direction for continuing the project into the future. Lastly, the evaluation aimed to draw together multiple social perspectives in a summative report for a public audience. Our target for the final published

report, was to provide an informative balance between the professional integrity of the WEAVE pedagogy and the obvious fun and enjoyment of the human enterprise of learning. The inclusion therefore of a strong infographic and visual component in the report is deliberate, as is a child-friendly summary in chapter six.

2.3 The Evaluation Framework

Focus groups or group interviews are described as a means organised discussion whereby researchers gain both individual and group perspectives on research topics (Gibbs, 2017). The interactive process of guided group discussion serves a multitude of purposes from gathering information about everyday experiences to the co-construction of professional knowledge. Multiple, and sometimes differing perspectives may be expressed and discussed in real time in focus group interviews and in the dynamics of group interaction (Jarviner and Mik-Meyer, 2020). Often, as was the case in this research, collegial interactions served to generate rich data through stated agreements and contradictions. For the purpose of the WEAVE evaluation, focus group interviews were scheduled into the WEAVE TPL calendar of events. The EQI researcher explained the purpose of the activity to participants at the beginning of each session, noting the importance of the co-construction collegial dimension of the WEAVE project. In simple terms, the success in developing and sustaining the programme depended as much upon the contributions of participating teachers, as it did upon the input of the course organisers. An inherent part of the programme involved inquiring about, recording and analysing participants feedback, so that the ideas and attitudes of the participating teachers could underpin future programme sustainability.

The focus groups were guided by an open-format question schedule (Appendix 1) and at all times and before each interview, ethical assurances and operational transparency (Gronmo, 2020) were guaranteed. The conversations departed at times from the set questions to discuss the progress of the WEAVE project. The practical challenges and rewards of working with Scratch coding and with LEGO robotics were investigated also. The objective was to gain an understanding of a number of highlighted topics, those central to the core aims of the WEAVE project. The atmosphere was relaxed, informal, positive and cooperative throughout. The interviews operated more as collegial professional conversations rather than question and answer sessions. There was a clear sense of enthusiasm as participants discussed learning

outcomes that had been achieved on the programme. The benefits to pupils in their classrooms were clearly stated and noted. There was a sense of openness and honesty about discussing the challenges involved and about making recommendations too.

Rigorous standards of data stewardship and security were applied throughout (Swain, 2017). Anonymity was ensured at all times. All contributions were offered voluntarily and there was a right to withdraw information at any point. Transcripts of individual interviews with school principals were returned for member checking to ensure validity and also to offer a reflective space for further engagement (Candela, 2019). All verbal data were recorded on the iPhone Voice Memo App, with a Zoom H1 Dictaphone used as backup. Data were transcribed manually by the principle researcher, Dr Martin Stynes, and were analysed on a secure and password protected iMac with DCU licenced NVivo software. All data are due to be deleted following the issuing of a final report to the WEAVE project team in June 2023. Along with this final report, a number of EQI interim evaluation reports were also provided to the WEAVE project team.

EQI WEAVE interim report #1 (10th November 2022, 26 pages, 13178 words) contained evidence of data gathering from four focus groups with full written transcripts and preliminary open coding. Findings from preliminary data analysis related to participants' understanding of computational thinking, cultural responsivity, co-developmental group work, communities of professional practice and effective TPL for cross-curricular learning. Recommendations addressed challenges and opportunities in classrooms, curriculum overload, and issues of time and resource management.

The EQI WEAVE interim report #2 (14th April 2023, 46 pages, 20832 words) contained further evidence of data gathering at five focus group interviews with full written transcripts. Findings from preliminary coding in NVivo were introduced and evidence related to participants' further understanding of computational thinking, cultural responsivity, cross curricular learning, group work, communities of practice and effective TPL. Recommendations outlined ongoing TPL challenges and opportunities, issues of progress and project sustainability, road mapping and peer learning.

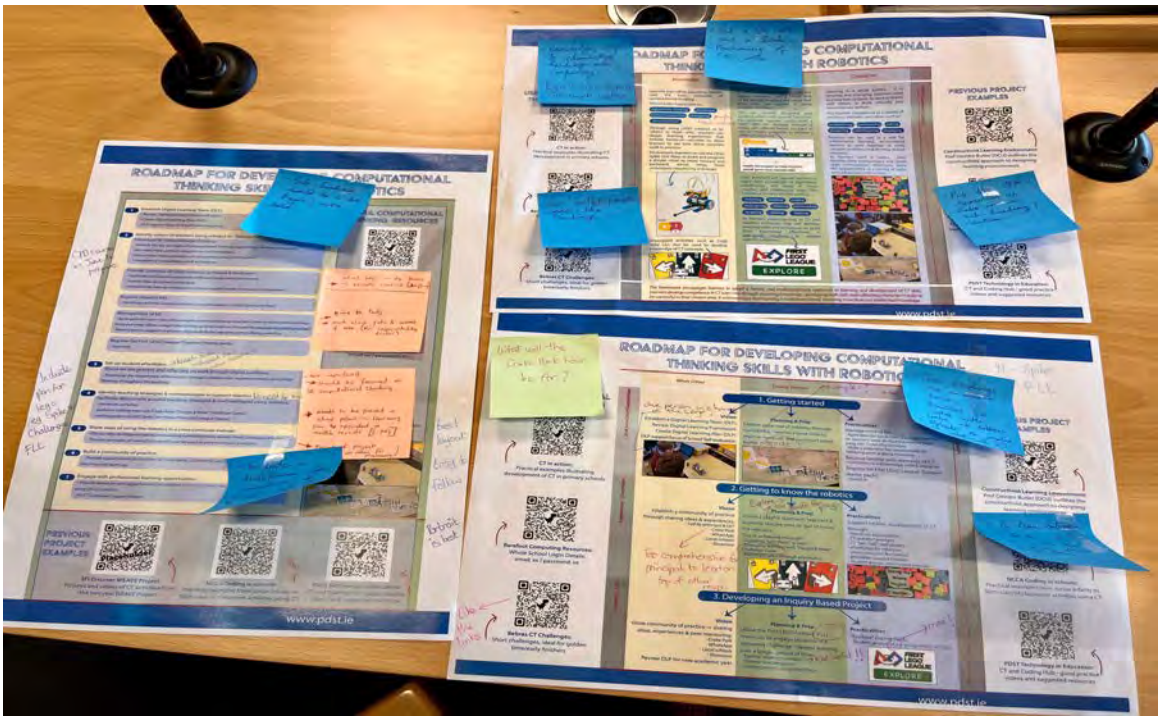
As the final TPL sessions drew towards a close in May 2023, the format of the discussions changed and it came time to reflect on the learning and achievements of the previous two years (Appendix 2). Traditional summative TPL evaluation methods arguably add little to enhancing

learning outcomes and experiences (Mujis et al., 2004)). Instead, Guskey's (2000, 2002) three and five-stage inquiry frameworks offered an alternative, ideal, tried, tested and highly regarded lens through which we might conclude our evaluative data gathering. At this point in the process, we still faced the challenge of co-creating a culturally responsive computational thinking roadmap, one that could assist the PDST with the potential sustainability of the programme. Guskey's model was considered both contextually appropriate and methodologically robust to assist with the task.

The flexible and collegial nature of the focus group discussions and the willingness of participants to give forthright and honest input, actually led us beyond the Guskey's model and into new territory. The themes investigated were as follows: Participants' initial and on-going reactions to the WEAVE TPL, participants' learning from the TPL, organisation and practical support for the programme, participants' use of knowledge and skills, and importantly, teachers' assessments of pupils' learning outcomes. To this, we added a further layer, enquiring if principals would recommend the programme to other schools. We also asked about what could be changed or improved in any way for schools taking up the programme in the future.

EQI WEAVE interim report #3 (45 pages, 24205 words, 14th May 2023) contained the full data set from the three final focus group interviews, transcripts of interviews with school principals, along with digital and visual data from WEAVE TPL workshops where teachers worked with the WEAVE tutor and with the EQI evaluator to develop a culturally responsive computational thinking roadmap to assist co-created peer learning and empower communities of practice. An

interim analysis of the data set was also provided, using Guskey's (2000, 2002) critical levels of evaluation inquiry as a focal lens.

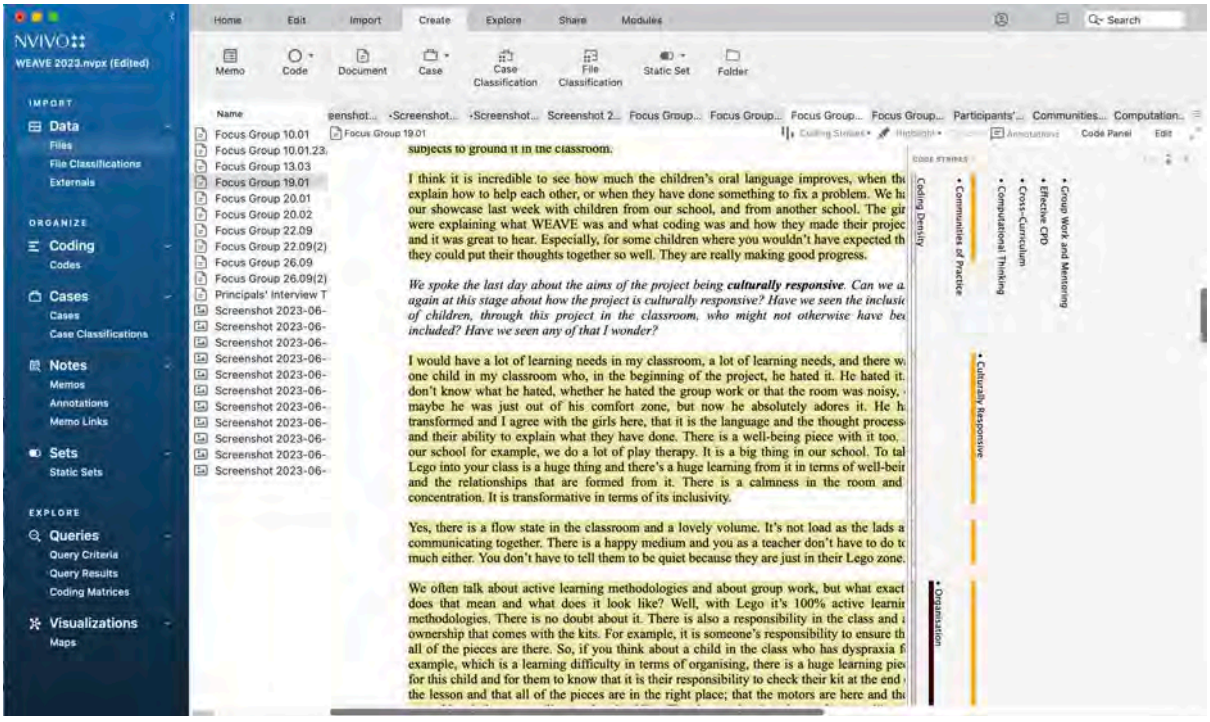


Images: Courtesy of WEAVE project team

2.4 Analysing the Data

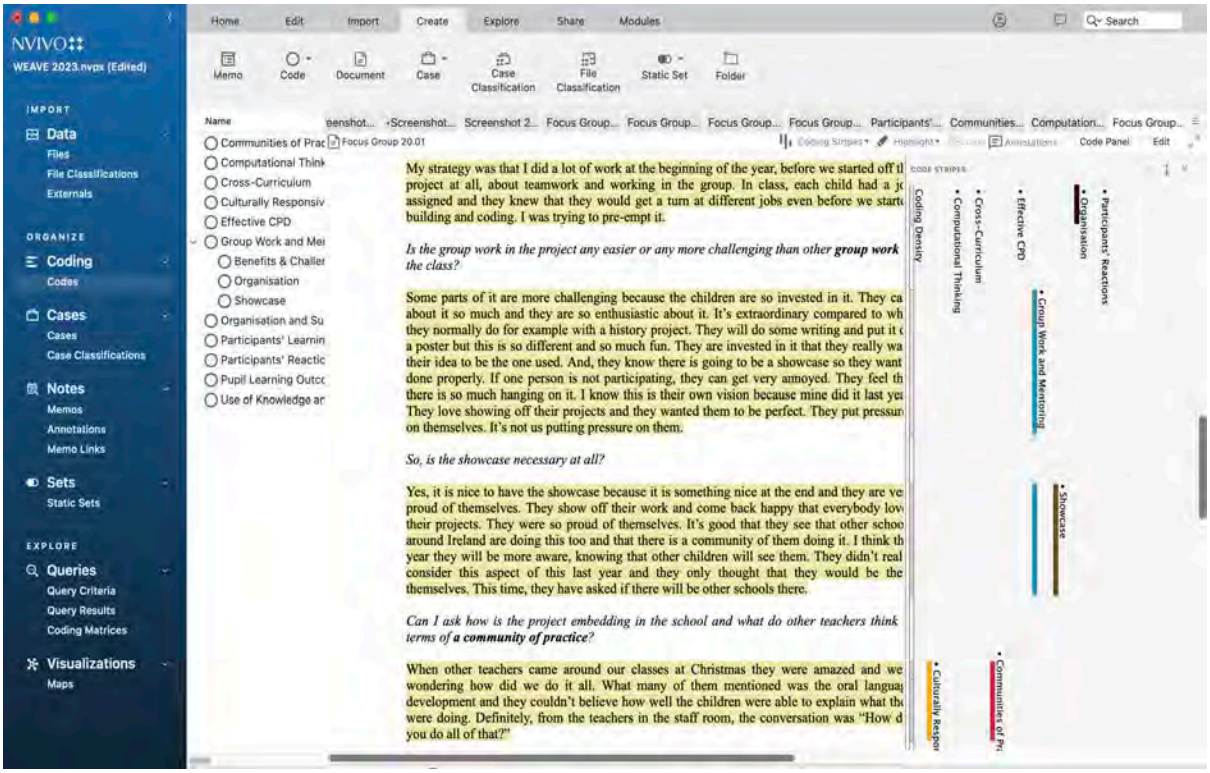
In total and in preparation for a final report, along with digital and visual data, over 48000 words of transcribed verbal data had been collected for analysis in NVivo 14, the newest version of a world-leading qualitative data analysis software programme (Lumivero, 2023). Typically, such programmes assist researchers as they classify, sort and arrange large amounts of information, and sometimes unstructured conversations and discussions, in order to present conclusions and recommendations about the overall meaning of what was captured, with an assurance of clarity and reliability.

In qualitative research analysis, phrases and sentences are generally coded or labelled, either inductively or deductively, depending on the mode of inquiry. This analysis used inductive coding initially, based on the thematic structure of the fieldwork questioning. Transcribed responses, in WORD documents, were entered into the NVivo programme and it was then possible to query, refine, align the data to produce strong empirical evidence. This second round of investigation involved an iterative cross-referencing of codes and sub-codes. NVivo tools, such as matrices and hierarchy charts, offered useful visual representations of the analysis process to further inform evidence outcomes. No cases were classified that could create descriptive attributes of staff or schools, as no comparisons were sought.

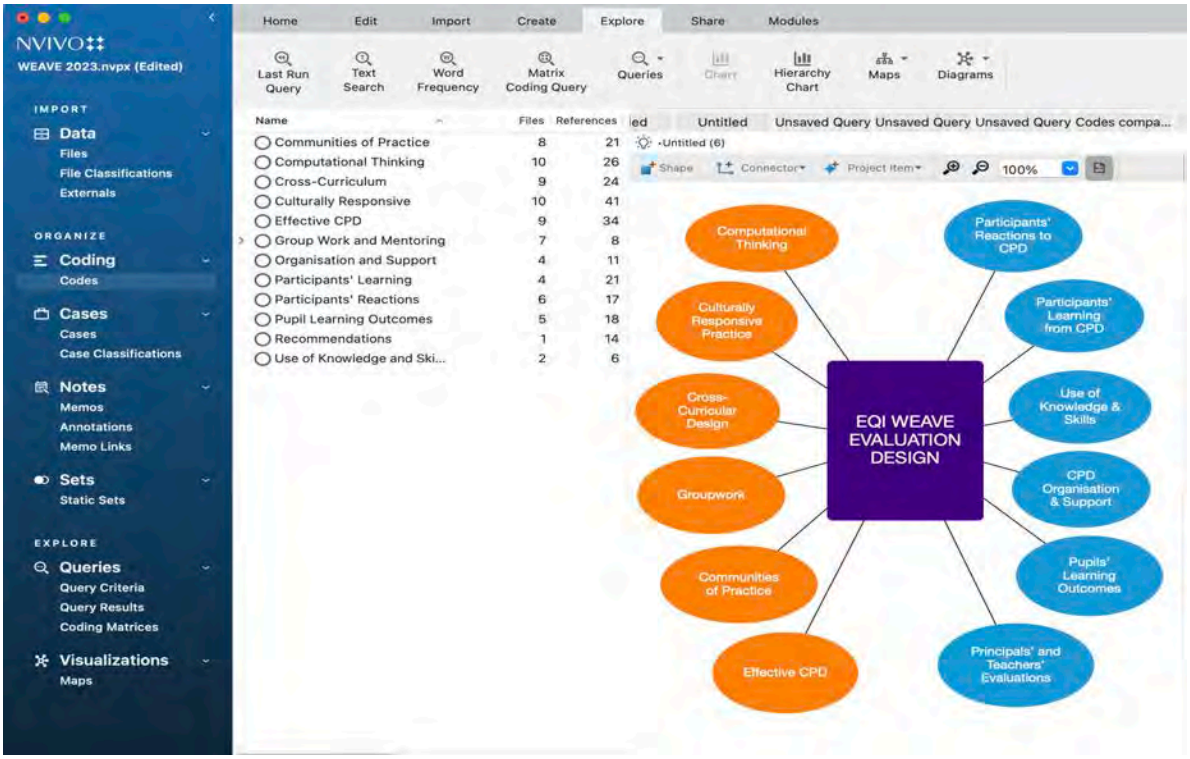


Images: NVivo Screenshots Dr M. Stynes EQI DCU

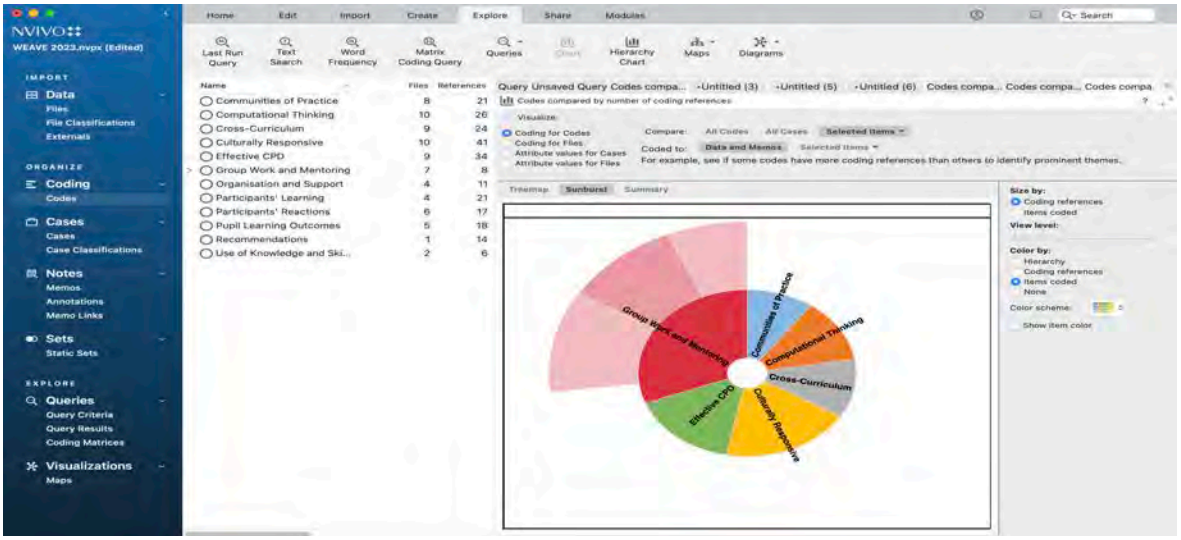
The NVivo screenshots in the report are included to inform readers as to the rigour and validity of the analysis process. Data from each focus group is transcribed and is entered into the software programme. From left to right, the image above shows the range of files entered, including focus groups, interviews and visual images. It displays a sample of interview transcript and the coding process used. The following screenshot offers an example of how a passage of text is examined and how statements are highlighted or colour coded with coding stripes. Note the codes to the left and the colour coding stripes to the right.



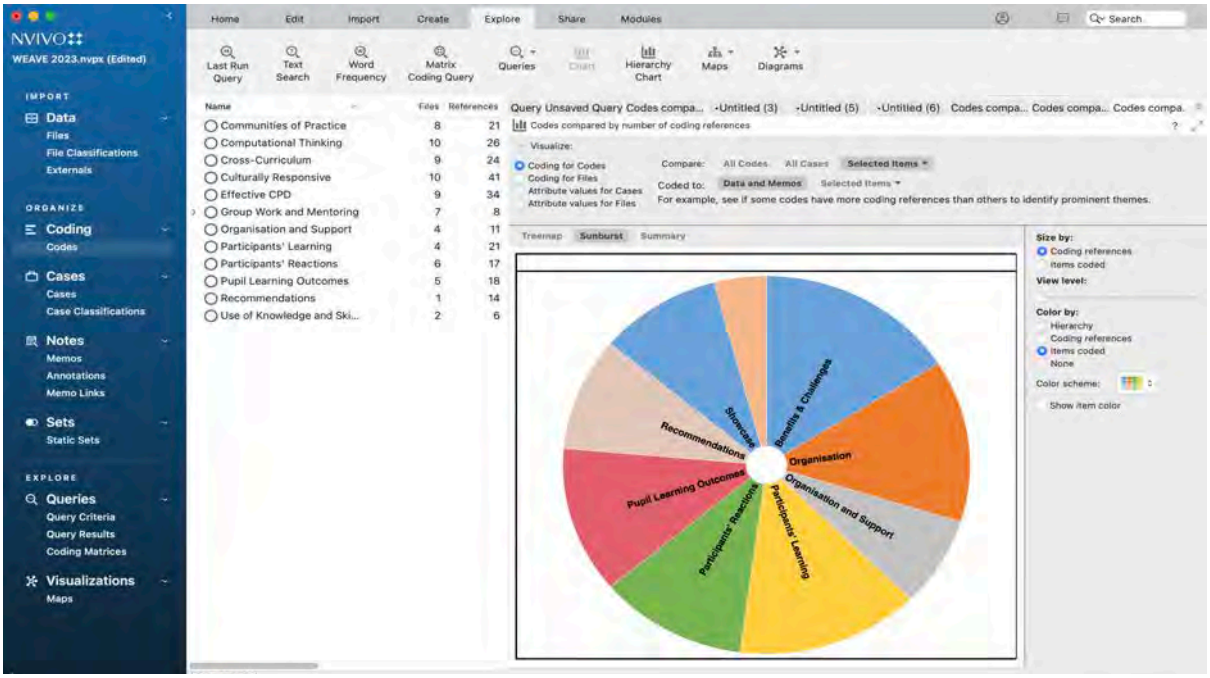
In our initial fieldwork, we began somewhat informally by discussing the aims of the WEAVE project with participants and by exploring the meanings of some of the specific vocabulary involved (Appendix 1). These introductory interviews were later supplemented with Guskey's (2000, 2002) more systematic investigation model (Appendix 2). Both sets of inquiry were concept mapped in NVivo and both formed 'top level codes' in the data analysis. In simple terms, 'codes' might be considered as headings under which large amounts of information may be categorised, sorted and cross-referenced as part of a sense-making process.



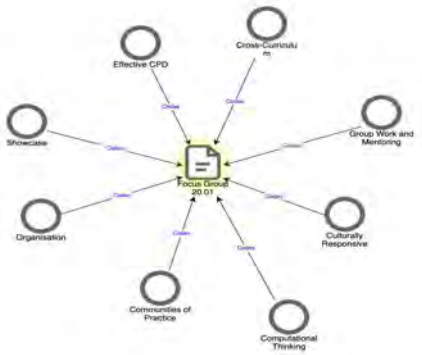
NVivo makes it possible to query participants' feedback in relation to certain selected sets of codes. The image below demonstrates how we explore participants' understanding of key terminology and of the stated aims of the WEAVE TPL programme, including its effective use for cross-curricular groupwork in classrooms.

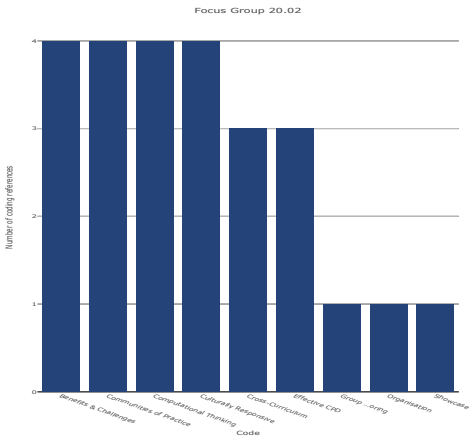


Similarly, NVivo enables us to investigate different sets of codes. In the example below, we organise, analyse and visualise data using Guskey's (2000, 2002) model as an inquiry framework.

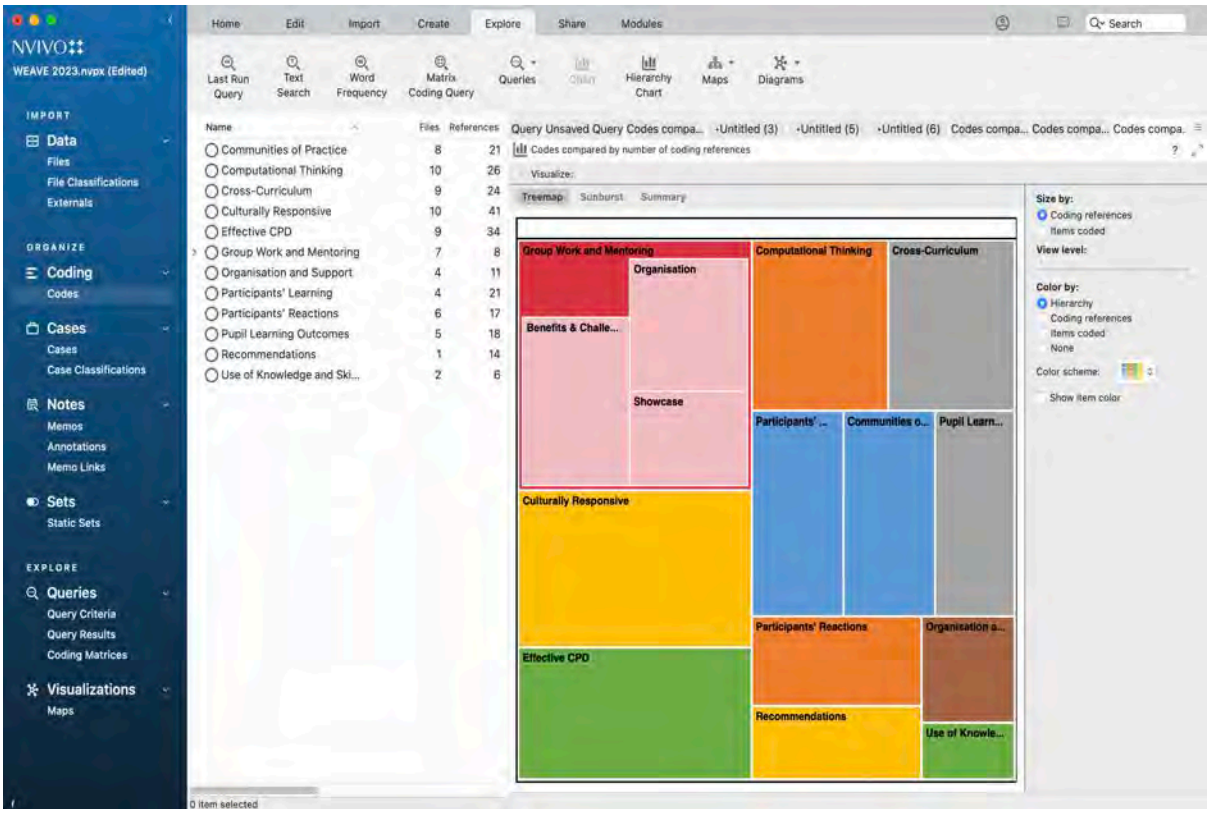


The programme offers an interactive format that is used iteratively, or so that information may be double-checked back and forth to chart occurrence of common themes within individual focus groups or interviews. This is helpful for example in noting the development of awareness between those new to the TPL and those with 1-2 years' experience of the programme. It was evident that teachers with more experience offered more elaborate explanations when questioned about computational thinking and cultural responsiveness. They also had developed greater insights into effective WEAVE groupwork and resource management.





Matrices, hierarchy charts and a range of diagrams allow for the clear representation of information in ways that prompt a meaningful and detailed investigation; one that leads to reliable conclusions and offers potential for informed presentation to intended audiences.



2.5 Limitations of the Study

There are a number of significant limitations to the evaluation of the WEAVE project in its current format. Firstly, the initial implementation of the programme was reported to have been interrupted by the Covid-19 pandemic and some of the earlier work is reported to have taken place online. This would have been less than ideal for a hands-on learner-centric programme. Also, at that time and due to obvious circumstantial difficulties, EQI was not engaged to assist with formative evaluation processes. Following the pandemic, there were interruptions to global supply chains. The manufacture and distribution of items such as LEGO, iPads and Chromebooks were slowed considerably and this caused difficulty in sustaining the roll-out of the programme to schools.

A second and significant limitation to the potential value of the evaluation is the absence of the voice of the pupil. While the WEAVE team and the schools involved did acquire approval for the inclusion of pupils' image content, interviewing pupils about their own first-hand direct experiences of learning about LEGO robotics, coding and computational thinking would have added value to the summative output. Such a plan would have involved significant additional research input however, such as visits to classrooms at appointed times, and it would also have involved additional ethical considerations such as Garda or police clearance for researchers at each school involved.

2.6 Conclusion

In this chapter we have explained the research methodology and the research methods undertaken to conduct the EQI WEAVE evaluation. We have outline the data gathering and data analysis processes and have provided infographics to provide an understanding of how computer software helped us to question large amounts of interview and other data. Some limitations were also considered.

Chapter 3 Research Findings: Meeting the Aims of the WEAVE Project

3.1 Introduction

In this chapter we offer empirical evidence from the data analysis and present findings from the research that relate directly to the stated aims of the WEAVE project. Teachers speak about the development of their understanding of computational thinking skills and about cultural responsivity. They provide insights into working together in co-creational group TPL and how these insights influence classroom practice among their own pupils. We hear of why teachers would voluntarily engage in such a model of TPL as developed through the WEAVE Project and what benefits they, and their pupils, gain from their efforts. We see that building an understanding of the computational materials to support the curriculum in an integrated manner necessitates a broad approach to TPL which goes beyond merely equipping teachers with new skills for specific tasks or incorporating the computational materials into their current methods. Rather, it entails a transformation of beliefs around the materials though space for reflection, hands-on practice and dialogue in order to rethink what effective use of the computational materials looks like in the classroom (Butler & Leahy, 2021). Through the work of the WEAVE Project, we see how effective TPL is helpful in this regard.

3.2 Computational Thinking

The evidence shows a considerable development in teachers' understanding of how computational thinking skills may be applied in classrooms. Teachers new to the project were generally unfamiliar with the concept of computational thinking and when asked about it, they offered honest responses:

- *I'm not really sure what it is.*
- *Thinking like a computer?*
- *Thinking outside the box?*
- *It's the use of technology in learning I suppose?*
- *I would love to say yes, but I have no understanding of it!*
- *I see it as practical learning and problem-solving, but beyond that I'm not too sure.*

Teachers who had engaged in the TPL and who had returned to their classrooms to apply the programme learning outcomes offered more elaborate and experience-based explanations. These responses demonstrate a significant and practical pedagogical progression.

- *It's coming up with an idea and feeling the need for that idea to be created and how we could possibly create it. What tools could be used to create it? What is the tinkering and reflecting throughout the whole process and what is the tweaking that we are doing? What do you want it to be and what do you not want it to be? And looking back on the whole process, one that is reflective for a teacher and to facilitate and to allow for a formative assessment approach.*

- *It is quite a broad term and overall, it's a skill that brings in logical reasoning and pattern recognition and debugging.*

- *It's all about problem-solving and about new ways to work out problems. And to achieve an outcome. That would be my understanding of it. It's not a standalone thing is it? It involves problem-solving teamwork and collaboration. When you see it in the classroom, it is a little bit different to how you picture it.*

Teachers who have undertaken the WEAVE TPL and importantly, who have brought the content back to their classrooms as an active learning methodology, offer explanations that are more complete and that are based in practical and logical cross-curricular problem solving strategies. The application and benefits of computational thinking strategies beyond the scope of LEGO and coding are evident:

- *I decided with my class from the outset, when they were doing things, that they would label it from the outset. We were talking about "de-bugging" and we started to use computational thinking language in our classroom all of the time. So now I say, if there is a problem, can you "debug the problem? We have to tinker with it so what can we do?" We have started to use the language very fluidly … (and) … we are applying logic. We have normalised the language of it and there is a flow. It has become a natural thing and we can use that language across other subjects to ground it in the classroom*
.
- *It's problem-solving in other subjects in school. I wouldn't have always associated it with computing … It can be used in Maths and applied to other subjects such as English or history.*

- *(Computational thinking develops) enhanced behaviour, cooperation and sharing of ideas, and patience especially. (The pupils) weren't as frustrated, looking for an instant result in the process. The feedback from parents was that they noticed the effects at home as well … There were really positive unintended consequences too, yes.*

- *For me, I would say that it is the ability to break a problem down into parts and to evaluate what is relevant and what is not relevant, to deconstruct the problem and to come up with a solution and to put together a series of instructions that is going to help solve the problem.*

- *It's a bit like making a recipe. You have to follow the steps (and) if you do them, but in the wrong order, you won't get the cake that you want at the end. You have to follow the process to know what the outcome is.*

- *The step-by-step computational thinking approach is nice and if you apply it to Maths, like if you are doing a division sum, you must do the first step first and to check if the number fits into the next one. If it doesn't, that's okay we will go to the next number. We will work step-by-step. Instead of saying that a sum is wrong or right, we can say that we need to do a part of it again and to retrace our steps to see where the error is. A lot of that approach comes from SPIKE as well, where they need to retrace their steps if something isn't working. It's not that a whole*

thing is wrong because you're not good at Maths and that you throw in the towel, there is an objective step to fix a problem.

The evidence highlights an important pedagogical progression in the developing computational thinking skills. Through the TPL, teachers report that they develop an awareness of how their own pupils interact with learning process and how they advance towards independent knowledge construction. Engaging pupils in computational thinking by providing opportunities for practical learner-centric interaction, often beyond the reach and influence of the teacher in co-constructed peer groupwork, yields significant progress:

- *The children's understanding of computational thinking has definitely improved, particularly from using Scratch. This comes from learning to fix the problems themselves. Computational thinking is all about following exact instructions and predicting outcomes.*
- *In today's world, (computational thinking) is linked to so many things and it has been good for the children to see that.*
- *I see it as working more practically, rather than just rote learning. It's figuring things out for yourself and doing practical work, instead of just using books to learn.*
- *Yes, that they could do it all themselves and they were teaching me! … They don't even realise what they are doing.*
- *Well, because you don't sometimes know what is wrong yourself in the (Lego) build as a teacher, you actually don't know why it is not working. Obviously, you haven't built it, so you don't know why it's not working. A wheel could be stuck or a motor could be connected wrong. You don't know what the problem is, so you actually have to ask (the pupils) to go back and to look at it again and to go through the steps. It is good for them to see that you can't have everything right from the start and that it won't be spot-on from the beginning.*
- *When we were doing procedural writing in our class, I linked it in but without using the phrase computational thinking. We were making sure the steps were in the correct order. It was for pancake Tuesday … The students have definitely benefited from it.*

Image: Courtesy of WEAVE project team

3.3 Cultural Responsiveness

Similarly, when teachers who are new to the project were asked to define or explain the concept of cultural responsivity, there was evidence of a general unfamiliarity:

- *I haven't a clue. I can't even guess.*
- *Is it something along the lines of using your local environment? Or are getting familiar with it? So that the children are familiar with their locality?*
- *I'm not sure as well. If I were to hazard a guess, it's to see is there an issue with your surroundings or how you could help? I suppose I'm not sure.*

It was notable also that teachers who were new to the course offered explanations that focused on local, environmental or community issues when attempting to explain cultural responsivity.

- *Is it something along the lines of using your local environment? Or are getting familiar with it? So that the children are familiar with their locality?*
- *It's a self-awareness of pupils' own communities and of the different communities they would be involved in.*

A considerable development in understanding was evidenced among teachers who had participated in the WEAVE TPL learning for extended periods of time and who had subsequently applied it in their classrooms. Interestingly, while this understanding was still grounded on an awareness of local, environmental and community issues, it had developed into an understanding of the lived experiences and interactions of those involved in such settings:

- *It's responding to what is around you, to the needs of society.*
- *It's responding to your locality and it's about inclusivity, in terms of children who are getting on board … We came up with the idea of playgrounds in Lego and how could you make inclusive swings, that kind of idea … Just looking at the bigger picture, at diversity that is around you and how to cater for it.*
- *It's all of the skills that we learn in school, but going deeper. If there are problems in society that need to be fixed, in terms of engineering, can you fix things, make things better or make life easier for people?*
- *There can be a difference of opinion and learning to manage when somebody has a different opinion to you and how to go about that. That helps in life too and not just in school.*

While the idea of cultural responsiveness was described as "*quite broad and abstract*" in general, teachers were very much attuned to its classroom application. They offered a variety of general insights as well as insights that applied specifically to work on the WEAVE project:

- *In my own class, I have 11 or 12 different nationalities … it's not what we grew up with … now you are celebrating Ramadan or Eid or Easter or Christmas. We, the teachers, have to be aware of the different sorts of cultures and how to respond to them. I suppose that's being culturally responsive … we just have to educate ourselves a little bit to see what it means to them, to the 11 and 12-year-olds of different nationalities (in our classes).*

- *Even though we may come from the same area or the same county or neighbourhood, my idea of what is culturally responsive could be entirely different to what another teacher would think. It's like the idea of stepping away from it and from imposing your ideas on the children. It's about collating their ideas. I suppose, being realistic, it's not as easy as it sounds because you do have children coming from different socio-economic backgrounds, different cultural backgrounds, different religious backgrounds and this does require some element of thinking outside of the box … Yes, it's a challenging question certainly.*

- *We have had children from other different nationalities come recently and this project is a huge chance for them to sit down and discuss things with each other. This is largely bypassed when you have to just come in and do your Maths or whatever together. They might not have had a chance to discuss where they are from. Some children, like Ukrainian children, might not want to talk about it either, but (the project work) does give a chance to talk about what is going on there, if they want to.*

- *Classrooms nowadays are full of lots of different cultures and you can take time to look at something from somebody else's perspective or point of view, and things that may not have occurred to them, or that they take for granted. It's like the inclusive playground, they can see things in a way that they never thought of before.*

- *There is a change in culture in Ireland and I suppose religion would be a big one. Maybe, in our parents' generation religion would be much more central to culture in Ireland where is it now, it's a lot more diverse and there are more diverse religions and there are non-religious outlooks on life as well. Maybe that is part of the culture that is changing?*

- *Our school has a massive diversity of backgrounds. We have children from all over the world. When it comes to doing projects, you can give the children a chance to speak about where they are from, the background and the differences. We have a good few Ukrainians as well and we give them the opportunity to talk about where they are from and to talk to the class. Life is different here from where they were born.*

- *Yes, we have to allow them to bring their cultural needs into the classroom and not put it to one side. There should be no tunnel vision about the ethos of the school or what this means to you.*

Cultural responsiveness requires being respectful of pupils' social perspectives of culture and requires respect for how pupils communicate and identify with other. Teachers are aware of such requirements, particularly in terms of the language barriers that may exist:

- *I have a pupil who is Ukrainian and the project has given her a brilliant platform to get to know the other students and to work with them. She struggled a little bit in class but with this program, from the minute she started it, she enjoyed it and really got stuck in with the class. For our showcase last Friday, she was so eager to try it to explain to the younger students who were coming along. It gave her huge confidence and it was lovely to see her participating in it*

and trying to explain and to demonstrate what they were doing. From that point of view, I thought it was brilliant for her and she has really enjoyed it.

- *I had language problems in my class last year and this year I have Ukrainian refugees and I find LEGO to be a brilliant resource. It takes the language barrier out of it and it's an activity that is fantastic.*

- *LEGO is a universal language and it wouldn't matter what background a person was from, because children can all access LEGO in their own way and according to their own interests and experiences. It sounds like a really good resource to have.*

- *I think it is incredible to see how much the children's oral language improves, when they explain how to help each other, or when they have done something to fix a problem. We had our showcase last week with children from our school, and from another school. The girls were explaining what WEAVE was and what coding was and how they made their projects and it was great to hear. Especially, for some children where you wouldn't have expected that they could put their thoughts together so well. They are really making good progress.*

- *Yes, I had two pupils who arrived with little or no English language and they started working with the blocks and they were able to figure them out. We printed out the names of the blocks on the sheet and they were able to point to the sheet to say which blocks we needed. They built up their English slowly but at the start they were sitting out and not getting involved at all because it was all too overwhelming with the chat and the excitement. We used more practical things to bring them into the activities.*

Respect for the cognitive perspective of culture requires respect for a student's preferred learning style. This is particularly relevant in WEAVE project activities where pupils with additional learning needs may encounter challenges with aspects of the learning, such as group work or the organisation of learning tasks. Teachers report a high level of awareness about such demands:

- *I would have a lot of learning needs in my classroom, a lot of learning needs, and there was one child in my classroom who, in the beginning of the project, he hated it. He hated it. I don't know what he hated, whether he hated the group work or that the room was noisy, or maybe he was just out of his comfort zone, but now he absolutely adores it.*

- *A child in the class has dyspraxia for example, which is a learning difficulty in terms of organising, there is a huge learning piece for this child and for them to know that it is their responsibility to check their kit at the end of the lesson and that all of the pieces are in the right place; that the motors are here and then everything is here according to the checklist. That is massive learning and ownership and responsibility.*

- *I have a child in my class with special needs too and she loves the building and she loves the coding, from start to finish. However, the aspect that she found most difficult was working in the group and sharing out the job with others. She couldn't really understand that if she built something, why couldn't she code it as well.*

- *I had a girl in my class with dyslexia and she would struggle a lot with literacy but she's really good at making LEGO. She makes lots of LEGO at home so she is really thriving at school and it is nice for her because in her group, the other girls see her as being an expert at making LEGO. This is so good for her and also for her confidence, because she really does struggle with some of the academic work in the classroom. I actually heard one of the other girls telling her that she is so brilliant at this and this was so good for her because that is something that maybe, she doesn't hear very often, especially from her peers about her school work.*

Images: Courtesy of WEAVE project team

3.4 Co-creational and Co-developmental Group Work

Classroom engagement in WEAVE programme activities requires teachers to plan and implement effective groupwork. It is recognised that groupwork may pose a range of practical challenges, particularly for some children who experience difficulties with aspects of socialising, such as sharing, turn-taking or expressive communication for example. Teachers offered a range of helpful insights:

- *(Even as a teacher), I totally understand the notion of not wanting to work together. I'm in college at the moment and I hate the thought of having to work with other people. I work well with other people but I like the autonomy of doing things on your own. Yes, and being responsible for your own results.*

- *You will always have stronger personalities in group work and some children might sit back a little bit. Some have lots of ideas but maybe are not as vocal. We should encourage everyone to participate and that is a challenge.*

- *A lot of children might not realise that they are overpowering in the group. So, to teach them the skills of how to work well together. Yes, the idea of allowing them to take on their own role is quite nice. It just depends on what you're doing. Some days they might work well together and some days not.*

- *With EAL students, they have difficulties in using expressive language to communicate … Definitely within a team, sometimes we obviously have to find roles within groups but allow choice. By actually allowing the pupils to be part of the choice of the role that they will play and to explain why, and then to offer rotation for that. The point with the child who is not vocal, is that maybe they are given a role that they are not confident in. Whereas, if they are given a choice in choosing, they could have the confidence to express themselves naturally and then obviously to offer rotation, so we will see if that works.*

Co-created learning and peer support among pupils operate as the drive train and energy interface of the WEAVE experience. Teachers reported on the significant practical challenges of organising any group learning activities in classrooms and were forthcoming about the advantages and rewards to pupils during WEAVE activities when planned properly; particularly in relation to showcases in their own schools and in DCU. Teachers at senior class primary level recognised the practical and real-world benefits of engaging in co-created learning as a preparation for second level schooling:

- *Yes, we all know that about our classes. For example, that you can't put A with B because they will argue and nothing will get done. Or, that nobody else in that group will be able to do anything. It is the same for PE or school trips. They need to be split into groups that will not create friction. The composition of the group is an important factor.*

- *It would be important to pick the right groups. There are some personalities in my class that I could not have on a project like this, because they would want to take over for example. That would take away from the whole aspect of it and the group would fall behind with the work within the project. Planning for a mixed ability group with maybe one leader and others that would be willing to take part, from my own point of view and knowing my class, that would be important.*

- *It's extraordinary compared to what they normally do for example with a history project. They will do some writing and put it on a poster but this is so different and so much fun. They are invested in it that they really want their idea to be the one used. And, they know there is going to be a showcase so they want it done properly. If one person is not participating, they can get very annoyed. They feel that there is so much hanging on it. I know this is their own vision because mine did it last year. They love showing off their projects and they wanted them to be perfect. They put pressures on themselves. It's not us putting pressure on them.*

- *From what we have seen, the children who shine as this would not have been the children who would have been considered traditionally academically successful. This would make a huge difference to their self-confidence. They are coming, taking on the role of leaders, taking on the LEGO and organising other type of project work. Before, some have might just sat back, but these are the ones who are shining.*

- *When it comes to the presentation, and being able to speak in front of one or two people or in front of a crowd, this would build self-confidence. I have a class where some of them don't like speaking in front of others, but if you ask them to talk about Minecraft games that they play at home, they will happily talk about that for hours. Being able to talk about LEGO would definitely help them and it would build up their confidence.*

- *When we paired our classes together we knew that they didn't know each other very well, but it worked a dream … This was brilliant because when there were problems, we had two teachers there in the room to help with coding. This was great for collegiality and for the showcase, we knew that we had done this together … We were delighted with our showcase and felt that it went very well with group work. And, they struck up a new friendship and they were chatting on yard together … Yes, it worked very well for us.*

- *I think that for groupwork, it is fantastic. The children were working in pairs and then, for the project, they've worked in groups of four. We had a chat about the groups and about the ones who take over in groups. We talked about girls who are quieter and maybe who wouldn't speak out in groups. Some of them got much more confident in terms of using LEGO and began to speak up. They have started to listen to each other and to really compromise.*

- *Some children don't cope very well with group work and they want to make all of the decisions. So, getting the groups right is very important. It is a good lesson for them, letting them see that they just have to work well together. There can be clashes of personality but they have to see that they have to learn to work well together because when you go into the workforce, you are not going to get on well with everybody and you have to learn to work with them. Yes, it has been really beneficial I think. It is fine in primary school to structure of the group to get the perfect outcome but after primary school it's "Off you go!" So, this is a very good skill for them to develop in a sixth class.*

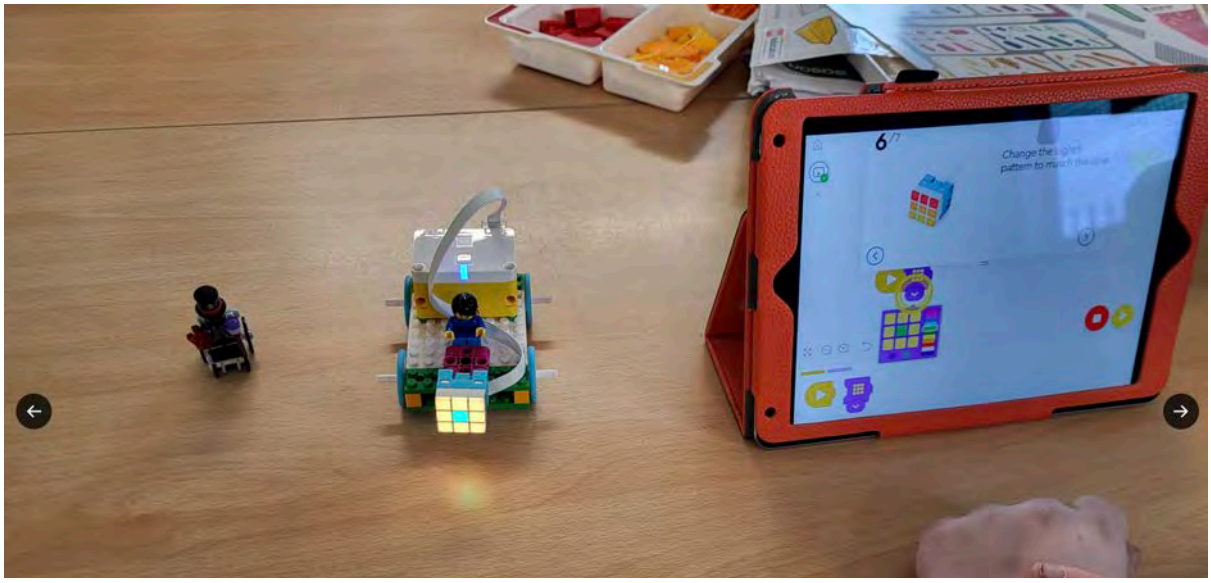


Image: Courtesy of WEAVE project team

3.5 Communities of Professional Practice

It is important to note that the focus group interviews began with questions about why teachers joined the WEAVE project initially and how their interest was sustained. It is equally important to state that all teachers reported that they engaged completely voluntarily due to their professional and personal motivation. None had dropped off or abandoned the project. We also asked about the perceptions of other teachers in the school about the WEAVE project work.

- *I wanted to get involved this year because of the digital learning framework. I am on the digital learning committee in school and we have a new set of iPads and laptops and chrome books. But they're not really used to the best, as they could be. I just wanted to get involved. We are using them just to get involved in reading but I don't think this is developing the pupils' computer literacy. It's just an object. Yes. We could do the same work with pencil, paper and pen. Yes. They are using them just for the Apps that are on them. They are forced to work in a certain way, rather than exploring key skills.*

- *What really has made this course appealing to me is that it's looked at from a whole school level and it will hopefully have that wonderful effect throughout the whole school. It is backed by the principal of the school. We have been afforded the time to leave a classroom and to actually do the TPL. It's not done after school, when we have busy lives. The principal is fully on board with it and this is something that is really important with TPL.*

- *I just thought that this would be a way to further educate myself, as well as educating the kids. In this world, there is a lot about technology advancing so much and keeping up-to-date, even yourself and modelling that for the kids.*

- *I don't really have any experience of this. I've always seen coding as abstract. I'm hoping that I will be able to make sense of it because I'm fearful of that kind of stuff (laughs).*

- *It wouldn't be very comfortable area for me. I did digital learning in college and I always found it a challenge. It's nice to come back a few years later and try to overcome that.*

- *I think it's just upskilling myself and updating my knowledge. I like the resources for teaching and finding new ways to engage students. As they get older, you want to keep them engaged as much as possible and it's nice to have another notch on your belt to share with them.*

- *I agree with that and from a TPL point of view and from the children's point of view, as we mentioned inside this morning about future curriculum development, it is about upskilling yourself as much as possible and in as many ways as you can for the times we are living in.*

Teachers also engaged in forthright and open discussions about the demands placed upon schools and on them by a seemingly never-ending range of new initiatives, many of which seem unwanted and unnecessary in an already over-loaded curriculum space. In general however, and particularly with teachers who were invested in WEAVE over the period of time that included the showcases, there was openness and positivity towards the project and an acceptance that the additional workload involved was worthwhile. As an activity-oriented

learner-centric project, WEAVE is well-received by teachers – a perception that is aided no doubt by the evidence that it is so well received by the pupils in the first instance:

- *It has been a big take-on in a way, but now that we are settled into it and are in the swing of things, the others see that it is definitely is a big area that we are working on.*

- *And, you also need to build on teachers' interests and the skills that they have because there are teachers in our schools who run sports teams or who are more interested in art. They may not want to get involved in coding, which is fair. It may not be everybody's cup of tea. But, it is a great project though.*

- *The reality is that when teachers see the SPIKE kits, they know it's a lot of work and they're not going to sit at home playing with spike kits. That is not a reality. To get a genuine buy-in from teachers, they need to see the end product and they need to be given time to make curriculum linkages, perhaps at Croke Park hours.*

- *There was a reluctance in the beginning but once it kicked off and it spread across the school, classes did want to join in. I suppose there was just a fear of the unknown. But, once they were shown as leaders and as teachers in their classrooms, through TPL in the school, and once you take away the fear of the technology and the newness of it, it works.*

- *It is running well. This is because of the buy-in from the children. They just love it so much. Because of that, it is much easier for the teachers to actually have it going on in their classrooms. The children so much look forward to the sessions during the week. They have already had a showcase. We have invited in the parents to the school to showcase what they were already able to produce. This was a huge success and when you see the success that is already there, it makes others more interested and they want to be part of it.*

- *A couple of new teachers have come on board and we have a WEAVE WhatsApp group. There are conversations in the staffroom about equipment being charged and about what is happening today. The showcase in particular, both this year and last year created a huge awareness in our school in general and amongst the other classes about what is going on. It has sparked a bit of curiosity amongst other children and other teachers. They are keen to get their classes on board.*

The reported success of the WEAVE project is attributed by participants to the expertise of the tutor, to the support of the TPL course materials, to the follow-up school support and to the availability of resourcing and material infrastructure. This is recognised openly by the teachers involved, who see the benefits not only in terms of their classroom experiences but in terms of their schools and the wider community. Teachers attribute the benefits of the TPL to the active and skills-oriented learning component. They speak positively about the unique pedagogical framework offered by WEAVE as teachers and pupils encounter coding and construction challenges, almost as equals in the knowledge acquisition encounter.

- *You need to be able to experience the learning for yourself on a course. With the LEGO, we will be able to try it ourselves and experience it ourselves. It will be easier for us to learn it that way.*

- *I think working with the Lego is great and when we are here we get to try out things ourselves. This is useful. As you were trying it out you can see what problems the children will face and what skills they will need to know to make something. You can then pre-teach that. If you don't make it yourself you might not know what problems arise. That is helpful.*

- *From my own point of view, I have always been interested in digital learning but I didn't have the resources really. We have gotten these now and for over the last year. We have over 18 iPads and 30 chrome books but I still think we have a lot to do in terms of our digital learning plan and our organisation in the school. But, this has given us the basis to get involved in digital learning, and the confidence as well.*

- *If you are doing something that the children are interested in, for example … this wasn't really TPL. I just wanted to learn so that I could facilitate the children in the class … I really enjoyed the practical use of it in the classroom and I enjoyed doing it. I wanted to be better able to facilitate their learning.*

- *(WEAVE) gives children access to something that they wouldn't necessarily have at home. It shows them that there is more to school then just books. There is that aspect of it as well, but it's about trying to get everybody on board with the learning process … I wanted to work it in with other subjects and to learn about it myself.*

Images: Courtesy of WEAVE project team

3.6 Cross-Curricular Learning and Effective TPL

During the research fieldwork, teachers spoke openly about the demands of an already over-loaded national curriculum and how WEAVE activities might or might not fit into teachers' timetables. As with other technology-enhanced learning activities in education, teachers who were new to the project experienced the initial time and work challenges of adaptation. However, those with more experience of the adaptation process, developed practical solutions for more purposeful implementation:

- *I think it would take a lot of creative planning to see how you could integrate (WEAVE) into the learning of different curricular areas and what the objectives are in the real classroom. I feel you might be letting a lot of other things go.*

- *Integrating it into the curriculum can also take up so much time. It can take an hour or an hour and a half sometimes in my room and it takes the children a while to get their ideas sorted. So, it does take up a good bit of time. Maybe, if it was more linked to the curriculum I wouldn't mind spending as much time on it. There are particular areas in SESE where it just doesn't fit and you don't want to rush it.*

- *Some of the teachers in our school are part of the previous cohort and we can see how they have integrated the project into the curriculum and use it across other subjects. So, yes, I definitely think it can be integrated.*

- *I think it probably needs a bit of a change of mindset of our own. We don't need to use the books. Sometimes we are too keen to use the books or the workbooks and to finish them but sometimes the children learn way more by going "Here you go, here is the problem, figure it out yourself!" But, it is hard for us to let go a little bit and to see where they go themselves. We are sometimes always focused on the way we have always done it, like these are our learning outcomes and this is what we have to achieve. But, if we have a project and if we let it see where it can go itself, the learning outcomes might look after themselves.*

- *There isn't room in the schedule to slot in anything else new for 40 minutes for a week and some of the projects that we were shown inside, they're brought in as part of the curriculum that is already there, such as history. Maths and science and other different subject areas can also be combined as part of the project.*

- *I found last year that it integrated into the curriculum and that you could bring it into genres of writing and you could bring it into SCSE topics with a senior class … After a few weeks though, it all started to fall into place for me and I was able to integrate is better. Then, it was fine. Anyway, this was good because they probably needed a few weeks to develop their pre-knowledge of it, rather than going straight into something new.*

The WEAVE project aims to develop cross curricular learning therefore, through directed and effective TPL. When asked about their professional experiences and personal opinions of what might constitute effective TPL, the teachers involved were forthcoming:

- *It should be accessible with good support afterwards and that the people providing the TPL realise what it is like to be in the classroom.*
- *TPL should be manageable and it's what you take from the course that you can realistically use in the future and apply in the classroom in the future.*
- *Why I really wanted to be part of this project is because we were provided with the resources needed for this to work.*
- *To improve myself as a teacher and to become more competent. To integrate the laptops and the digital technologies into the classroom in a way that is more beneficial and more useful for the kids. And to develop girls I suppose in STEM.*
- *With something like this it's amazing to see how it can be integrated into other areas of the curriculum as well. With this project you can integrate so much.*
- *I would like to be able to approach coding in a practical way, instead of seeing it as something that's not tangible. I'd like to have the confidence in using new technology and introducing it to students.*

3.7 Conclusion

This chapter has explored how participants voice their perspectives on the aims of the WEAVE project and how their expectations have been met in TPL as a community of professional practice. Teachers have also spoken about how the successful meeting of these aims transfers into classroom practice that benefits pupils, particularly pupils with additional learning needs.

Image: Courtesy of WEAVE project team

Chapter 4 Research Findings: Guskey's Five Levels of CPD/TPL Evaluation

4.1 Introduction

The evaluation of effective continuous professional development (CPD), or teacher professional learning (TPL) as it is more recently termed, using Guskey's (2000, 2002) models, involves the collection and analysis of data using five critical levels of questioning. In this chapter, we present a synopsis of evidence derived from an analysis of 12 focus groups, 9 interviews, observation data, documentary data and digital data. It is drawn from the expertise of those engaged directly with the course content. The evidence leads us to conclude that the 2021-2023 WEAVE TPL has demonstrated effectiveness across all of Guskey's (2000, 2002) five categories.

4.2 Participants' Reactions

Guskey's questioning framework is introduced with a general introductory inquiry:

What questions are addressed? An open-response questioning schedule was agreed collaboratively between the WEAVE team and EQI researcher (Appendix 1).
How is information gathered? The researcher recorded focus groups and interviews with ethical and participant approval.
What is measured? Participant satisfaction & engagement, degree & quality of TPL implementation and evidence of learning outcomes among pupils.
How will information be used? To validate, improve, reshape or redesign the WEAVE programme delivery.

Then, questions are posed about participants' reactions to their TPL course. In this research about WEAVE TPL, participants' responses are positive: How did the teachers in the school respond to the idea of the WEAVE project initially? What is the general reaction now in the school … among those involved … among others?

- *I just thought that this would be a way to further educate myself, as well as educating the kids. In this world, there is a lot about technology advancing so much and keeping up-to-date, even yourself and modelling that for the kids.*

- *I would be no way strong at IT myself. I found it really interesting and I think it would be really good for me as a teacher to enhance my own skills, to interact with the resources and to benefit from them. I think that's a big interest for me, and for the students as well.*

- *We are finding it a little bit tricky because we only have two Lego boxes ... It was difficult enough to get my head around it, not to mind teaching it ... Hopefully, when all of the kits arrive it will make it a little bit easier ... There is a global shortage of them and that is why there is a delay ... so there is definitely a sense of worry that it won't look so good ... We are worried now that they will be disappointed ... We were lucky enough in our school. It is all going well in our school now.*

- *I was delighted to come on the training course ... I had no real experience of coding so that was my initial response ... I had an interest in this ... I wanted to learn more about coding ... there is a change in the attitude towards it ... amazed to see the children's work ... Coding for the teachers ... it's easier than you might expect ... Our whole school plans (is) something that the school needs to focus on.*

- *Well, our principal came down and asked us ... I would say now that we are under time pressure. There is a big workload involved in this ... The classes that we have are quite enthusiastic about coding ... In our school, people think that it is a huge amount of work ... It would be better to know in advance and to integrate it into our plans.*

When interviewed separately, in one-to-one interviews, the school principals' responses were equally positive:

- *Oh, it was very positive ... and it was oversubscribed ... and they reacted very well.*
- *Other teachers say that it is ... It is all very positive. All of the teachers are very keen.*
- *I had a mixed bag of reactions ... but once they began to unpack it and to talk about it, it seemed appealing and there was a sense of "Let's try it!" to be involved.*
- *We had a really positive interaction ... there was a general buy-in to the project itself. In general, teachers like to do new and interesting things... It's exciting.*
- *There is a huge curiosity ... I would hazard a guess that we will have 10 more teachers doing a summer course in this area, because they are really keen on it.*
- *Therefore, we had a little bit of knowledge about it and an interest in what was involved ... that was to look at computational thinking and to see could we encourage computational thinking among girls so as to get away from the idea of a job in technology having a certain image for a child.*
- *If we were to be honest, the others are saying that it is brilliant, but it is a lot of work and they say that. The teachers involved in the WEAVE project are so focused on it and on what they are doing.*
- *There was an excellent response initially ... Teachers were interested ... We are two years into it now... Those involved are still very interested but they have been overwhelmed at times by the work... Among others... some of them are asking to take it on next year.*

Principals and teachers indicate that the WEAVE project was received very positively initially and that the perception among those involved and among teaching colleagues continues to be very favourable. Issues arose due to a global shortage of LEGO parts for the kits in 2022-2023. Teachers were unprepared for time management issues as a result and this became stressful. In spite of the increased workload involved, principals and teachers were very positive and enthusiastic in their reports about WEAVE learning activities and outcomes.

4.3 Participants' Learning

When the following questions were posed in focus groups about participants' learning, teachers offered a range of insights: What has WEAVE brought to the school in terms of new learning for teachers? Has practice among teachers changed in any way due to this TPL?

- *I think it's just upskilling myself and updating my knowledge. I like the resources for teaching and finding new ways to engage students. As they get older, you want to keep them engaged as much as possible and it's nice to have another notch on your belt to share with them.*

- *It definitely makes the children more responsible for their own learning … They are doing their own thing but the teacher has to encourage them.*

- *This is like any project work that a teacher would do in the classroom, but this is Lego-based and coding-based. It's not hugely different in that sense … The children are more independent than in my other lessons because, as other teachers have pointed out, the children know more about it than I do. There is more of a release of responsibility involved and the teacher has to take ownership of what the children are doing … Some children are brilliant and they will help the other children. Peer learning is great!*

- *The children's understanding of computational thinking has definitely improved, particularly from using Scratch. This comes from learning to fix the problems themselves … It would be important to look ahead in September, to look at the books and see which themes can fit in. Construction for example, is part of art. It is also easy to fit renewable energy into the curriculum but it does take some planning. I think there is a lot of scope for it but it is a matter of putting some time into planning.*

- *In terms of technology being used in schools as a direct substitution for what we have already there, using tools like these and the resources available, we are very privileged to be a part of this.*

When interviewed separately, in one-to-one interviews, the school principals' responses were equally insightful:

- *Well, they (the teachers) had to learn how to code. There was a lot of new learning as well with regard to wind energy. They had to do a fair bit of research and they had to look at what was happening locally. Yes, there was a lot of new learning involved.*

- *Yes, definitely they have been put out of their comfort zone and bringing in technology and devices into the room, yes, that has been a challenge … but WEAVE has brought a cross-collaborative approach … on the ground, people are being collaborative with each other and … the activity is embedded now.*

- *The learning is very children driven. I see them really explore their creativity as the teachers just give them more space. It is definitely more group-driven with pair-work and team-work. Yes, I have definitely noticed louder classrooms with more energy around lessons.*

- *I know that the teachers found that aspect of it hard. We are very lucky here in that teachers are very organised and doing WEAVE, like doing an art lesson, means being very organised.*

The resources have to be accessed in a timely manner and teachers plan the lessons really carefully and that is a big part of it, so that the children can get the most out of it.

- *We have fabulous teachers already doing activity-based group work in our school so some of this was not new.*

Principals and teachers indicate that the WEAVE project involves new learning for both teachers and pupils alike. Teachers learn to collaborate collegially and to develop group work competencies. Pupils learn new skills such as coding in tandem with their teachers. The learning for teachers also prompts increased awareness of and involvement in whole school planning. The learning engagement on all fronts is reported as a very positive experience.

Images: Courtesy of WEAVE project team

4.4 Organisation and Support

When the following questions were posed to teachers in focus groups about how their schools received organisational support to implement and sustain the WEAVE project, their responses were wide-ranging and reflected the realities of daily school life: What resources have been involved in implementing the WEAVE project here? Would it be obvious through teachers' planning or their interactions with each other, or through staff meetings that the project is receiving school support?

- *The biggest challenge in our school was to find a time to meet with other teachers and to have Jennifer come out. Another big challenge for us was having the digital equipment. We just had 15 iPads at the start in the school. That was for the entire School and it was timetabled. You would find them coming to you not charged but now we have another 15, so there are 30 in the school. Not having the equipment was a challenge.*

- *There is new technology involved and this time last year I suppose, our school wouldn't have had a lot of technology. We only had six iPads shared in a school of more than 400 pupils. Now, we are up to 31 iPads and in the large part, thanks to various grants that we are given, the WEAVE project was a huge accelerator for us. It has been fantastic for us as a staff. Our experience has been a positive experience as a staff and it has been backed up by providing resources.*

- *In our school, storage is definitely an issue. We are very short on storage in our classrooms. Storing the LEGO and the boxes and keeping everybody's set separate and then, finding somewhere to put the builds. The builds are on the windowsill and they can get knocked over with schoolbags and then children get upset … One thing that I find, is that we inherited Lego from last year and it is pretty much useless in terms of doing that project again because it was all just dumped into one box afterwards … we end up with a big Lego box that can't be used … We went and got Ziploc bags and I had to stay back after school and do that, otherwise they couldn't figure out the bags for themselves. I labelled them … It is up to the children to check. They need to be taught this at the start of every year in the same way that they are taught how to look after their pencils and so on. The initial training is with the pupils who have to be told that they are responsible for the kits.*

- *The materials are all excellent. We would have liked more boxes because we have two teachers working together and if one class builds things first, we would have to take them apart for the other class. We would need enough boxes for each class so that the pupils could work away themselves … In our school, we share Chromebooks and iPads and we have to coordinate this because we can't all do it at the one time … What we found is that we almost had to take ownership of the devices and with that, there was always somebody else losing out. It needs to be structured … We are in an ideal situation because our senior classes have got an extra set of Chromebooks and we have the LEGO, so at any time of the day, we can do the project. This is fabulous. Each class would need their own set of Chromebooks and their own boxes of LEGO.*

When interviewed separately in one-to-one interviews, school principals' responses were equally down-to-earth about the demands of daily school life:

- *The first resource involved in implementing the project here was teacher time. We had to make the decision to release teachers and there was a fair bit of release time involved. … As far as physical resources, we used our digital strategy money this year to buy a class set of chrome books. These were shared between the classes so that children could use them when they were doing their coding. Then, we got the LEGO sets through WEAVE and that caused huge excitement. It was fantastic.*

- *There has been a number of devices, iPads and models deployed … the only request I had was to try to facilitate storage, to keep everything safe … my sense is that the people involved have enjoyed being the managers of this project themselves … The one recommendation that I made of them was that I would put it on the agenda for every staff meeting because I wanted it to be shared with the whole staff … Going by the quality of their reports at staff meetings, yes! I feel it is sincere and that they are enjoying this.*

- *One of the things that I would say about it, is that we have been really lucky to have gotten the LEGO … you have to acknowledge the real cost and that it's not just about Lego. If you have a digital learning plan in place, a school would want to be taking a large part of the budget and putting it into the practical running of WEAVE. It needs up-to-date hardware and good software but this has been ring fenced here this year to work with WEAVE … Having worked with (the tutor), yes and this is a personal thing, she is phenomenally organised, she is very adaptable and she gives plenty of notice*

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- *From another point of view, time is a huge resource that we have to put into it. There were meetings to be organised inside and outside of school hours and our SET team came on board … We cannot complain about any of the resources given or any of the support … This year, none of the teams involved in the WEAVE project were part of our whole school plan for certain subject and I supporters that. I am happy to stand over the idea that this was a project that we got involved in and therefore we introduced a different element and topic to our SESE school planning for these classes … We used quite an amount of a digital grant to increase the number of iPads that we had. We didn't have enough. To do the WEAVE project, the school needs to prioritise the WEAVE classes for technology.*

- *The LEGO that was delivered was amazing … We had enough iPads in the school already to share them around… There have been some Wi-Fi problems in the school on and off that have affected it too.*

Principals and teachers indicate that the WEAVE project has benefitted from considerable levels of organisational support. Lego kits have been introduced to schools with a 'wow' factor. Principals have used timetabling, school planning and staff meeting input effectively to support the project. Teachers have worked around practical day-to-day problems and have involved the pupils in the responsibility of caring for the resources. The use of digital technologies is reported as problematic in some schools due to the limited number of devices available and/or limited broadband coverage. Principals and teachers report that the project operates very successfully when the DES Digital Strategy funding is used to support the learning.

4.5 Participants' Use of Knowledge and Skills

When the following question was posed to teachers in focus groups about the knowledge and skills gained on the WEAVE TPL course and how this might be put to use in classrooms, a range of professional competences were clearly evident: Have you seen any development or benefit to individual teachers or to groups on staff as a result of engaging in the WEAVE TPL – in terms of professional learning?

- *People rightly have the perception that it is a lot of work but they have also seen the showcases in the school. They have seen the project and the work that we did on the iPads. The records of this work are very impressive. People have come in and have seen the girls working in ways that they would not have expected in our school.*

- *There is a need for a school to look at a roadmap of how it could move forward with this type of project. Part of the core expectation for example is that you are doing Lego once or twice a week … The resources of the LEGO League, when used with geography and science and oral language in my own class has improved conversational skills. These are dramatically improved. Sometimes we try to develop conversational skills without an actual purpose to make it meaningful and it doesn't work. But, with the Lego they have a reason to know how to use this language, to clarify their thoughts and to get across what they mean.*

- *When we were doing procedural writing in our class, I linked it in but without using the phrase computational thinking. We were making sure the steps were in the correct order. It was for pancake Tuesday … It would be easy to link it very naturally in Math's, like if you were teaching long division. You must follow the correct steps to get the right outcome. If not and if it goes wrong, you have to go back and debug. This will rectify the problem.*

- *We are approaching the learning from a coding and STEM viewpoint but other teachers prioritise English and literacy and they want the devices too. What they are looking for is equally valid. I don't think that we understood the amount of ICT that was needed in the beginning for the project … We need everybody to buy into it, from the top down and if it doesn't come from the top down people will argue, saying that they need the devices for this or that. If the decision is made that you have two months to get your WEAVE done, then you have your two months.*

When interviewed separately in one-to-one interviews, school principals were forthcoming about the benefits of the WEAVE TPL for teachers' professional learning:

- *When a teacher goes in to teach a classroom that is jampacked and that has particular needs and when the teacher has to bring in a project like WEAVE as a teaching and learning experiment, it is a success to get all of the pupils to buy into it. Before, we were dealing with a lot of behavioural concerns and these were the sorts of meetings that I was having about particular classes. Now in these classes, I can have conversations about WEAVE and about the showcase and about visiting the neighbouring school to see what they are doing.*

- *You have to let go of the idea of teaching as a person standing at the top of the class because we all know that the idea of 'chalk and talk' is gone and has been gone a long time. But, WEAVE brings that to a whole new level by allowing children to forge the pathways of what they want to learn. We were re-writing our science plans, geography plans and our history whole school plans lately, and instead of defining topics like Greece and Rome or whatever, if the children are motivated to do something themselves, is that not more valuable.*

- *I did hear from the teachers that they were covering sustainability and energy and we didn't have that in our school plan. Maybe we should have and we are doing that now! This is something that the children are hearing about all of the time in the media and in their own homes. So, maybe we should adapt our plan a little. The message now from the Department is that the school plan should meet the needs of the class in front of you and that requires flexibility. So, that's not a problem to be honest*

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- *The project has been excellent for the teachers involved, both individually and in groups … Yes, I would be looking forward to them sharing their learning with other colleagues in the future, those who haven't been involved.*

Principals and teachers indicate that involvement in the WEAVE project has developed participants' attitudes and their pedagogical knowledge and skills. Teachers have adapted to new teaching approaches. There is staff engagement in cross-curricular school planning and resource management. The challenges of implementing WEAVE as a new learning programme are recognised but are everywhere met with successes.

Image: Courtesy of WEAVE project team

4.6 Pupils' Learning Outcomes

When the following questions were posed to teachers in focus groups about arguably the most important aspect of any teachers' TPL, how pupils benefit from the outcomes, there was no ambiguity. Teachers spoke about how WEAVE actively engages pupils in new learning experiences. It is noted that some pupils, who may experience barriers in accessing certain curricular areas, find the play and learner-centric dimensions of WEAVE to be most beneficial: Is there any evidence of positive outcomes for pupils with WEAVE – the showcase being an obvious outcome? Can I ask about pupils' behaviour, attitudes or even attainment … how do the pupils like the WEAVE project … have you noticed any effects?

- *I have a boy with additional needs in my class and he has issues around socialising. However, when we did the showcase he really stood out. He was able to bring people over to the project and explain what had been done. We were amazed because we had never seen him doing anything like that before … I have a child in my class with major additional needs and she had been involved with another class doing WEAVE with in the first cohort. She now visits another class to help them. She wouldn't have experienced success in the traditional sense before but she is absolutely chuffed with herself … I have a pupil in my class with dyslexia and some emotional needs also. I have heard from his mum that he does lots of coding at home by himself. Now, children in the class are coming to him for help.*

- *It definitely makes the children more responsible for their own learning … It is great for the children. There are a few children in my class who would not have been very confident. They would have said that they are not really good at anything but now, they are good at Lego and they really enjoy Lego. They are a lot more confident than they were before. They are good at designing the pieces that they are going to make too … I have a pupil with additional needs who does not like the attention of the class in any way. We did a Lego showcase for our neighbouring school though and he took over the showcase, explaining what was happening, without anybody asking him or telling him to do it.*

- *It is nice to see children who are not academic in other ways, leading the lessons in WEAVE groups. I have two new girls from (a different country) and they have no English. They are very able but they cannot participate in class because of their lack of English. When we do coding, they are really confident in the group. There are other girls who would struggle in Math's and English and they are flying at the WEAVE project … I think that Lego is a leveller for everybody in the classroom. My classroom is very multicultural and while English is not a barrier, all of the children come from different types of homes and different types of backgrounds. There are cultural differences but Lego is something that they all have in common. It is something that they can all be involved with and I suppose it creates an inclusiveness, where all of the children are in it together. It really develops their cooperation skills, their teamwork and in general while they are quite well able and there are no problems with behaviour, they're all quite happy when their build is completed.*

When interviewed separately in one-to-one interviews, school principals were equally enthusiastic in their comments :

- *Well, the pupils just love it and they are really engaged with it. They get excited about it. One of the teachers said that it really brings out the best in the children. They are so positive and engaged and they respond really well in how positively they talk about it … Also, they are very proud of their achievements. It has improved their presentation skills in giving oral reports … Then, there is the showcase. This is great for their self-esteem and for their self-confidence. It is great for their oral language skills overall.*

- *What I have noticed is that there is a type of maturing and I'm asking myself, "Is this because of the project?" The pupils haven't seen anything like this before and it seems to be dissolving a hard edge. I think they see their teachers differently.*

- *The learning is very children driven. I see them really explore their creativity as the teachers just give them more space. It is definitely more group-driven with pair-work and team-work. Yes, I have definitely noticed louder classrooms with more energy around lessons … I would say that the children are really excited about it. I have noticed changes in them. We are very lucky here, in that the children are very well-behaved and we have a lot of positive motivation initiatives. With WEAVE, there is a sense of just getting into the work and they are genuinely excited to do this.*

- *I visited the classes myself when they put on the local showcases and the children are very proud of their work … They love that teachers come over and ask how it all works. They are able to answer the questions and there is a great sense of pride from the point of view that they were working with other children, children in mixed classes … The classes have worked very well together and the mix is good.*

- *I would absolutely recommend it … The pupils are more confident now as a result … They've had no opportunity to learn coding beforehand so this was great … The teamwork was brilliant … So was the skill building … In the activities they had to rely on each other and not on Google or mum or dad for the answers. We live in a world like that now and it was great to see them working together getting answers from each other.*

Principals and teachers indicate that involvement in the WEAVE project has generated significant positive and unforeseen outcomes for student engagement and learning. The impact on pupils has been very positive, but it is reported as noticeably more positive on children with additional needs and on those who are integrating into the Irish system from abroad. The evidence from the study is that the WEAVE project impacts positively on pupils' behaviour, on their attitudes to learning and on their attainment and wellbeing.

4.7 Conclusion

Chapter four has presented a synopsis of evidence derived from an analysis of 12 focus groups, 9 interviews, observation data, documentary data and digital data. It has drawn from the expertise of teachers and principals involved directly with the WEAVE programme implementation. The evidence leads us to conclude that the 2021-2023 WEAVE TPL has demonstrated effectiveness across all of Guskey's (2000, 2002) five categories.

Chapter 5 An Analysis of Outcomes

5.1 Introduction

Chapter five presents an analysis of the formative elements of the EQI WEAVE evaluation. '*Data beyond talk*' (Flick, 2018) was used in the evaluation to enable the EQI researcher to become more or less part of the action during the 2023 DCU WEAVE showcase. The data gathered, both visual and verbal, provided informative perspectives on the outcomes of the 2021-2023 WEAVE programme. Engagement with school principals elicited insightful perspectives about recommendations for the sustainability of the WEAVE project. An active collegial emersion in co-constructed road mapping, assisted the evaluation process to deliver a workable model for the PDST.

5.2 Schools' Showcases

The main highlight of the annual WEAVE calendar is the WEAVE showcase event, hosted at DCU. In 2023, attendance at the showcase rose from 198 to over 650 and events were held concurrently in different parts of the St. Patrick's DCU campus, due to this increase. The schools attending the event set up exhibitions of project work, at which pupils and teachers from other participating schools had the opportunity to meet, to ask questions, to discuss and to share their experiences of coding, LEGO robotics, computational thinking and problem solving. The images and text in this section are taken from the 2023 WEAVE showcase and provide evidence of positive and energetic programme outcomes.

The 2023 showcase was opened by Prof. Anne Sinnott, Deputy President of DCU with special words of welcome given to participants by Prof. Deirdre Butler (DCU), Dr Monica Ward (DCU), Dr Yvonne Kavanagh (SETU) and Prof. Kimberly Scott (ASU). The showcase day itself was planned, organised and coordinated by the WEAVE tutor, Ms. Jennifer McGarry, and the success of the event was publicly attributed to her. During a busy energy-filled day across the DCU St. Patrick's campus, pupils showcased WEAVE project work and were engaged in a wide range of science experiments in specially arranged workshops.

Images: Courtesy of WEAVE project team


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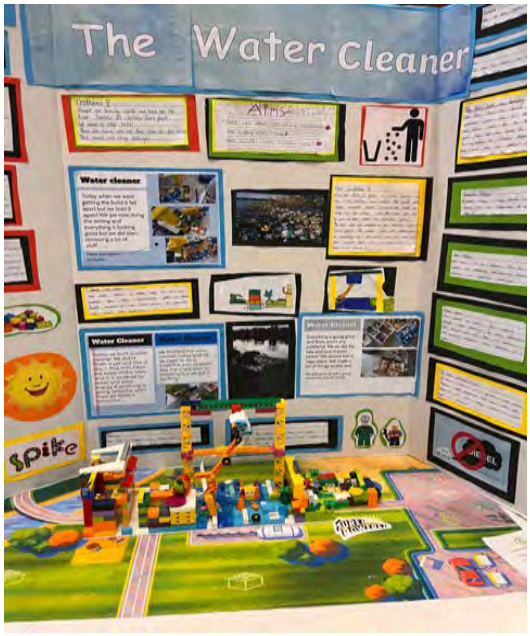
Dogs for the Rescue!


The Water Cleaner


Lego Project
Youth Bus


Our Visit Planet Co-Kart
Tuck In Veiby
education
spike
Our School Survey
Wind Energy


The Solar Funfair
LEGO
NO

The event concluded with a celebration of the project work; involving the WEAVE team, the event organisers and the staff of all of the participating schools.

Images: Courtesy of WEAVE project team

5.3 School Leadership

Fullan notes that leaders require enthusiasm, energy, hope and commitment in order to produce results and this is particularly the case in complex and in an ever-changing scenarios, such as in schools (2020, p.9). When principals in the 2021-2023 WEAVE project schools were asked about their own attitudes to WEAVE and if they would recommend it, given that it did entail change and new approaches to learning, their answers were fully supportive of the innovations involved. They were asked: As a principal leading a school that has invested in staff support for the WEAVE project, what, in a few short sentences, would be your own evaluation of it? Would you recommend it to other schools or principals .. if so, why … and if not, why not? Finally, could it be changed or improved in any way?

- *I would highly recommend it. It is a program that has brought huge engagement for the children and in a really positive way to the whole school. There have been very positive outcomes for the children in ways that we were not expecting … All of the children have a great sense of achievement and also, the staff and their learning. They have a great sense of achievement to with all of the coding and the learning that has been involved. It has had a hugely positive effect. I would encourage other schools to take it on … I know that there were a few hiccups during the year that couldn't be helped and then, there was the subbing crisis.*

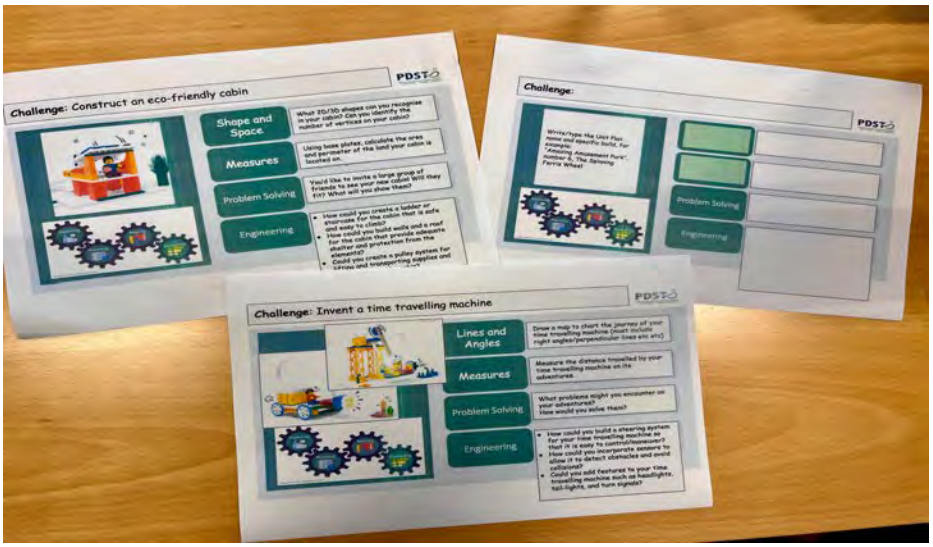
- *For me, this is a very exciting project, especially coming out of the doldrums of COVID-19. It has been great to bring this into the school … It's interesting and successful for the children and (the tutor) has been the key to this.*

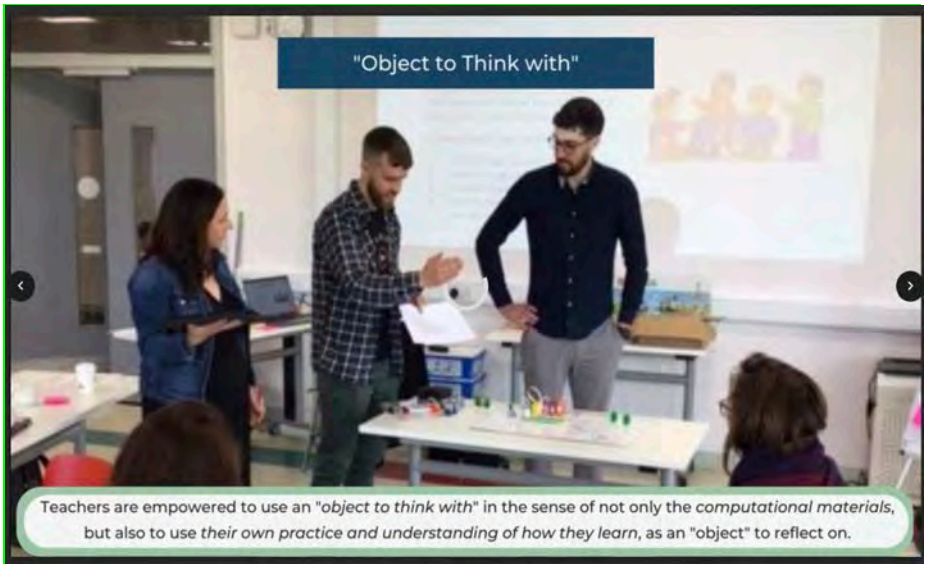
- *It is unbelievable and I really maintain that of the 80 pupils leaving this school, they will be 50% more employable than the other body of children who are not involved in the project … The boys don't even know that they have gotten all of the skills and for me it is real life learning. For me, it is the team-working aspect and the problem-solving aspect and the communication aspect that is absolutely fantastic … Oh God yes! Absolutely! 100% absolutely! If there were a way to replicated it, I think that it should be in every school. In all honesty, I really do believe that. I think that it is a necessity for children to be able to participate in this type of education because it is a new model.*

- *Bottom line, yes, I would! We have gotten so much from it. To be honest, finding four substitute teachers for one day was a headache. This was very hard last year but that is just part of it. I would definitely say 'yes, it is worth it!' … Schools would need a good bank of iPads before starting because the project will put pressure on that resource.*

- *Overall this is a fabulous project, and it provides amazing opportunities for children to learn … Would I recommend it? I would! But a school would need to be prepared, maybe with a roadmap or a time map detailing how teachers are required to deliver on the investment … The program is quite demanding but the teachers involved are happy with it and it is very worthwhile.*

The spirit of Hargreaves and O'Connor's '*Collaborative Professionalism',* that educators turn '*students into change makers with their teachers*' (2018, p.9), is core and foundational to the WEAVE project. That noted, and in spite of the daily demands imposed upon school principals due to resource management issues and staff shortages during 2021-23, all of the principals involved in the WEAVE project were highly supportive of it and of their teachers' and pupils' collaborative engagement in it. They recommended its continuation into the future. Any suggestions for change and improvement that were noted have been already incorporated into the project review and into the roadmap for sustainability.



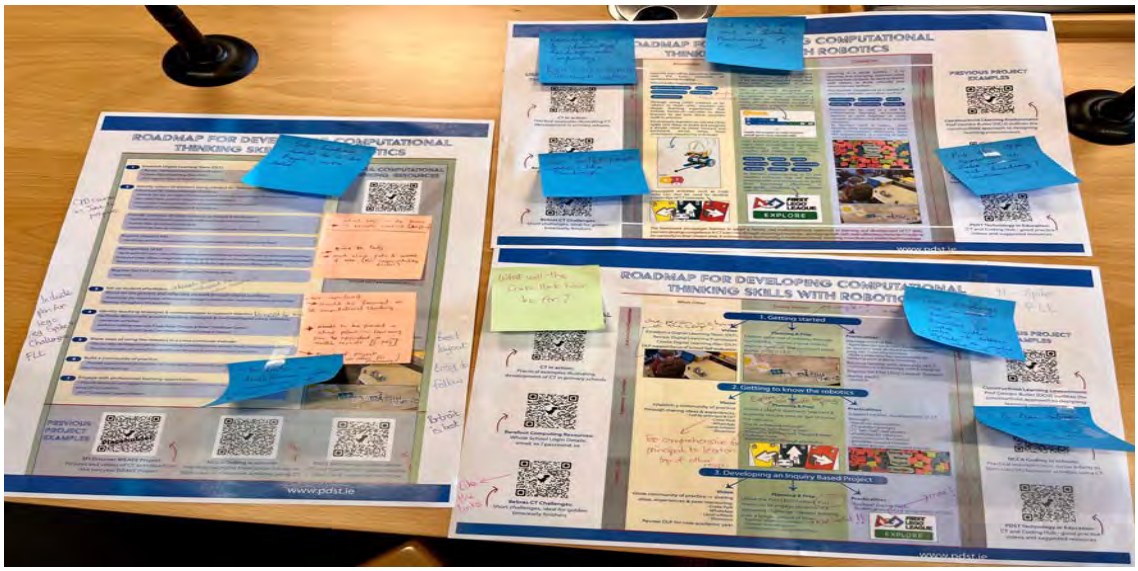


Images: Courtesy of WEAVE project team

5.4 A Roadmap for Sustainability

The core aim of the EQI formative evaluation was to offer support in co-developing a cross-curricular culturally responsive computational thinking roadmap for primary schools. This included a particular emphasis on project peer mentoring, empowering communities of practice and developing increased self-concept, self-efficacy and self-confidence in the learning processes.

It was intended that such a roadmap would inform and shape the hand-over of the WEAVE project to the PDST and ensure optimum sustainability. The PDST currently employ similar roadmaps in other curricular areas. As part of the formative evaluation process, the course tutor and the researcher collaborated to review the interim EQI reports #1 and #2, to revise course content materials and other significant information, and to design a draft framework or template document that could be offered to participating WEAVE TPL teachers for consideration. The teachers would play a significant role in discussing the merits of each template, provide revisions and reshape the outline plan at the final meetings in Dublin and



Carlow. Three versions of draft TPL roadmaps were presented to participants who worked actively in groups with the course tutor and the researcher to suggest revisions and edits. It was considered vital to the process that each group would have a hands-on real-time editing input. Post-it notes proved to be extremely successful and 6-8 practical suggestions were added to each of the drafts at each of the two meetings. Evidence of the outcomes was gathered and the various drafts roadmaps were re-edited into a second draft version.

This successfully co-developed version was presented by the WEAVE team on 19th June 2023 to the final 2022-2023 meeting of the WEAVE teachers and principals. The PDST Technology in Education team was in attendance at this meeting and also offered collaborative input. Discussions followed in groups as to how the WEAVE roadmap could assist the roll-out the project into 2023-2024 and beyond. It is planned that the final iteration of the roadmap is printed and distributed to all schools that engage in PDST supported WEAVE projects.

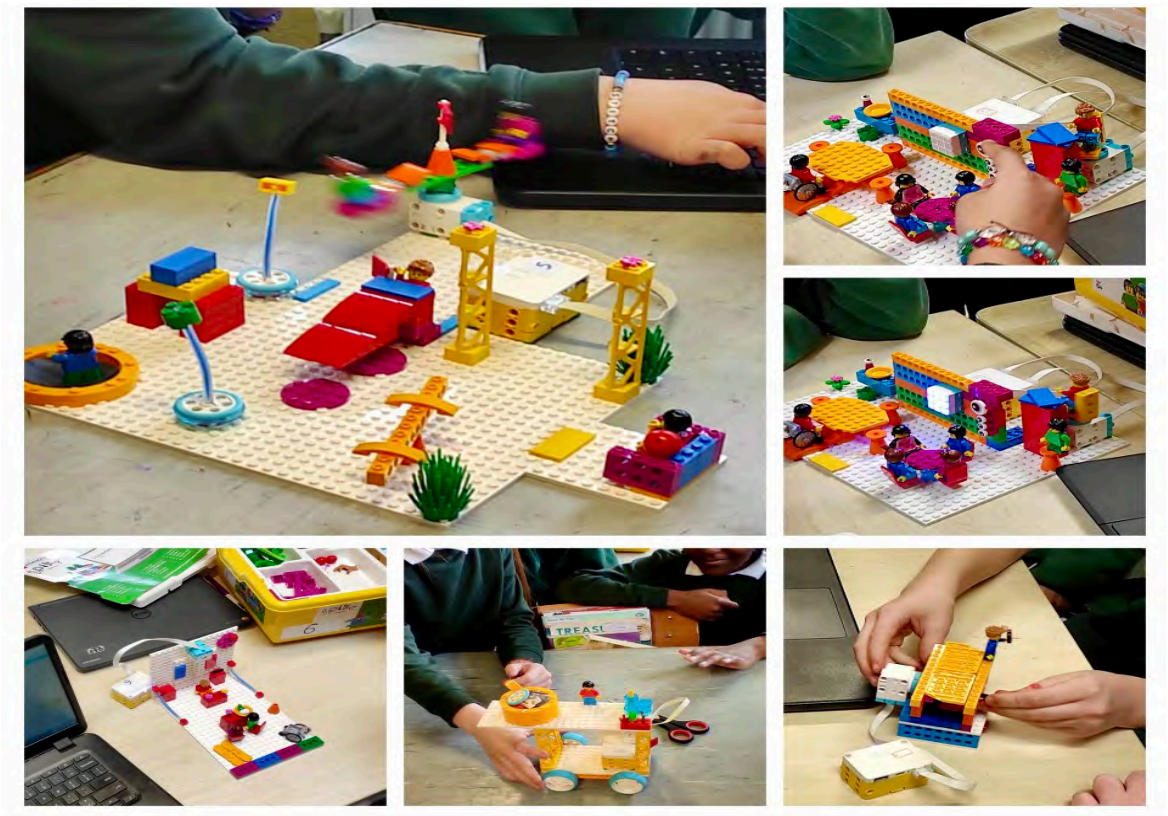
Images: Courtesy of WEAVE project team

Image: Courtesy of WEAVE project team

The final successfully co-constructed iteration of the WEAVE TPL roadmap is pictured above. It contains links for new WEAVE schools to supporting information.

5.5 Conclusion

Chapter five of the EQI/WEAVE evaluation provides significant evidence of the progress of the programme in 2022-2023. '*Data beyond talk*' (Flick, 2018) has been used in the evaluation and has enabled the EQI researcher to become more or less part of the action during the 2023 DCU/SETU WEAVE TPL sessions, during schools' showcases and during the final hand-over of the project to the PDST. The data gathered at these events are presented in this chapter and provide significant evidence of the positive outcomes of this two-year plan. The chapter also contains a section with detailed input from school leaders. Importantly and with principals' support, a collegially co-developed framework is finalised following collaborative input from digital technologies academics and tutors, from participating teachers, from EQI and from the PDST technology team.



Images: Courtesy of WEAVE project team

Chapter 6 Discussion, Recommendations and an Easy-To-Read Summary

6.1 Introduction

In chapter six we offer some concluding remarks about the challenges and opportunities facing a TPL programme for developing computational thinking skills. We acknowledge issues of curriculum overload, time management and resource management. We offer suggestions for sustainability into the future and conclude with recommendations from teachers in their own words. An 'easy-to-read' summary of the EQI WEAVE evaluation ends our report.

6.2 Challenges and Opportunities:

6.2.1 Computational Thinking and Cultural Responsiveness

The groups of teachers commencing the WEAVE TPL sessions demonstrated a limited understanding of the concepts of computational thinking and of cultural responsiveness, in comparison to teachers who had undergone WEAVE TPL training and who had embedded these learned concepts in classroom practice. The competences among members of the latter group, as evidenced in their explanations of the concepts and by their reported application to societal interactions in schools and classrooms, represents a commendable professional progression. Participants attribute much of this progression and success directly to the successful intervention of the course tutor:

- *On the days that we did have (the tutor) coming into the classroom, that was amazing.*
- *When (she) was teaching a lesson, she wasn't telling the children every little thing to do. They were discovering as they went along and it's good for a teacher to know that they don't have to be an expert in this. They just need to facilitate it and to provide the children with the materials.*
- *There were times when (she) would show us, that if something was going wrong in the class, then this is how to fix it. So, we had ideas about how to fix some of the problems and how to fit this into what we were teaching, that was really good.'*

It is recommended that the strong emphasis on the importance of computational thinking skills and the awareness of cultural responsivity be maintained and developed further, particularly with regard to the embedding of associated values within the communities of professional

practice in staffrooms among teachers and school staff, and with regard to the facilitation of effective collaborative group work in classrooms among pupils.

6.2.2 Curriculum Overload and Time Management

Curriculum overload and time management were identified as challenges to the successful implementation of the WEAVE project in classrooms. It is recommended that teachers are engaged in discussions as to how project topics may be managed and how integration using cross-curricular frameworks may be achieved:

- *The biggest challenge in our school was to find a time to meet with other teachers and to have (the tutor) come out.*
- *It's like everything else from the teacher's perspective I suppose. It's just a matter of managing time. You know yourself how much work needs to be done or how much is expected, and how much gets done. This obviously fit into things that we are supposed to be teaching. There are certain specific things that you have to teach and trying to manage overload, with curriculum overload, that is a thing.*
- *Every year there is more and more squeezed into the curriculum and I suppose it's harder to keep children focused as well. With something like this it's amazing to see how it can be integrated into other areas of the curriculum. With this project you can integrate so much.*

6.2.3 WEAVE Resources

The availability of additional supports to schools, through the WEAVE project, was widely recognised by participants as an enormous benefit. In particular, teachers mentioned the considerable investment in LEGO kits provided by the project, as well as the in-class support provided by the tutor. It is recommended that teachers in different schools are facilitated to discuss potential ways of sharing effective practice among each other as their management of the learning process evolves and improves. Groups in different schools may wish to consider on-going links and collaboration using Apps such as Google Chat, Facetime or Zoom. Such an undertaking could also assist in troubleshooting the day-to-day practicalities associated with digital technologies:

- *Having more opportunities to see it being modelled would be great and to have somebody with the skills to demonstrate the model to the teacher. Even if it was a recording of their classroom, just to get more exposure, to let teachers see how ideas could be introduced and to share ideas with other schools, especially given that we are so close to each other*

- *Another big challenge for us was having the digital equipment. We just had 15 iPads at the start in the school. That was for the entire School and it was timetabled. You would find them coming to you not charged but now we have another 15, so there are 30 in the school. Not having the equipment was a challenge.*

- *Yes, when you have somebody coming in to support you, it's always a great help. There is new technology involved and this time last year I suppose, our school wouldn't have had a lot of technology. We only had six iPads shared in a school of more than 400 pupils. Now, we are up to 31 iPads and in the large part, thanks to various grants that we are given, the WEAVE project was a huge accelerator for us. It has been fantastic for us as a staff. Our experience has been a positive experience as a staff and it has been backed up by providing resources. That really is vital and it goes for every school.*

- *Because of WEAVE we've gotten loads of new iPads and chrome books that we use now for passing around classes from scratch, coding and stuff like that. So, yes resources are a huge thing. Our school would not be economically well off and kids would not have the technology at home to do this sort of thing. For me personally, that would be the big thing, having the resources to do this sort of thing because they wouldn't have this ordinarily. They wouldn't even have the inclination to do it either so this opened their eyes to a whole new world. They wouldn't be able to go home and sit down and do scratch.*

Images: Courtesy of WEAVE project team

6.3 Progress to Date with WEAVE TPL and Sustainability into the Future

The evidence in the evaluation points to significant positive impacts from the WEAVE project on participating teachers, on pupils in their classes and on the professional communities of practice within their schools.

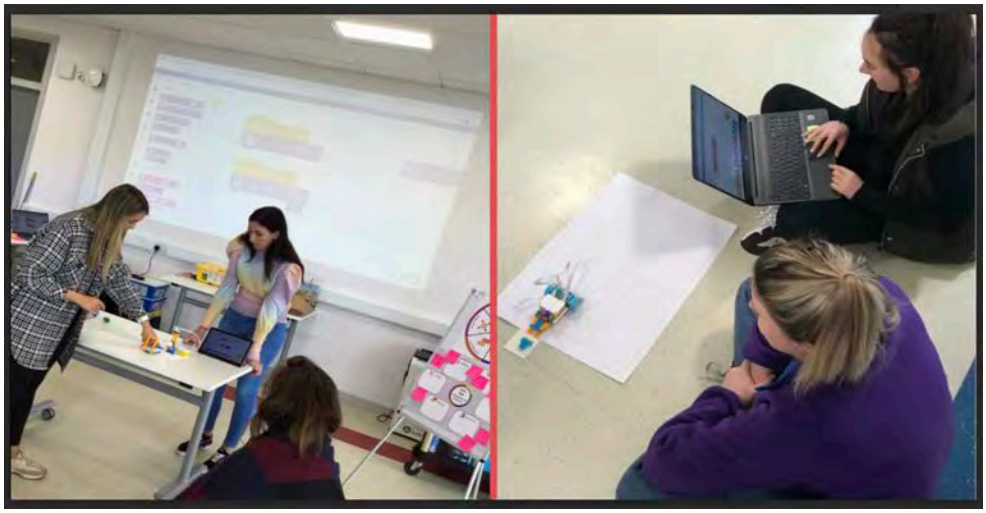
The project is a two year national level collaborative project funded by Science Foundation Ireland and is informed by the Department of Education Digital Strategy for Schools 2015 – 2020 initiative. It is expected that the findings from the work undertaken on the WEAVE Project will help inform what can be done on future models of TPL, in line with the recently published Digital Strategy for Schools to 2027, to support teachers developing computational thinking skills in a sustainable manner. The aim of co-designing enquiry-based learning experiences with a range of teachers and pupils over two years and across a number of participating schools has, according to the evidence in this evaluation, been largely successful and has benefitted significant numbers of learners, both teachers and pupils.

As a technology enhanced active learning encounter, it has grown communities of professional practice at a time, following school closures due to the pandemic, when the significance and impact of such initiatives should not be underestimated. As the term of the project comes to a close and as current expertise leaves the programme, it is important to plan purposefully for the future, to implements suitable adaptations in order to hand over the project to the PDST and to work constructively in a manner that ensures optimum sustainability into 2023-24 and beyond; particularly with new schools that have not engaged in co-created course development.

To this end, it is worth noting again that participants attributed their satisfaction and successes to a number of specific factors during the EQI evaluation:

- The effectiveness of the WEAVE TPL tutor
- The availability of material infrastructure and resources
- The support of school visits
- Showcase presentations of completed projects in their own schools and at DCU

Teachers' perspectives of current successful practice offer valuable signposting therefore to inform sustainability and future course development.



Images: Courtesy of WEAVE project team

6.4 In Their Own Words: Some Final Remarks from the Teachers Involved

The EQI evaluation extended beyond an inquiry about the aims of the WEAVE programme and beyond Guskey's (2000, 2002) critical questioning model to direct context specific questioning as to the practical usefulness of the programme, purely from the teachers' own perspectives. The following questions were posed: As a teacher, you have invested time and effort in learning about computational thinking on the WEAVE project TPL. What, in a few short sentences, would be your own evaluation of it … particularly in terms of professional learning? Has it influenced your approach to teaching in any way for example? Would you recommend this type of work, developing computational thinking, to teachers in other schools.. if so, why … and if not, why not?

- *There is a confidence in the children in coding. They are very confident at coding. They love trying things out, and experimenting and adapting. You can definitely see the progress … They are not fighting in groups anymore and they know their roles. Sometimes groups of girls might be not all that nice to each other, complaining about doing things wrong, but now they have their roles and they know what to do … We mixed up our two classes and put them together. Now, there are boys talking to other boys that they would not have spoken to before. They may have played soccer with them on yard but they would never have spoken to them to discuss something. They were out of their comfort zone a little bit and it is good practice for them. They were talking about planning and what they were going to do … As we have said already, there*

is definitely a benefit to it. But, it would be better to plan it beforehand to get more out of it. The way we did it, we were always trying to catch up. If we had it at the start of the year and could work it from September it would be much easier. That is the only thing I would say about it for next year.

- *I think that the idea of debugging and using it in a cross curricular way has gone down really well. It can be used in any subject. When children ask what went wrong and how can they fix it themselves, this is an important skill to learn. Even for me, if I were to be honest (laughs), I find myself using it. It's especially useful in teaching.*

- *I think it is great to see children developing their problem-solving skills, whether it is through coding or through managing the conflict that arises in the groups, for example when somebody knocks over your build or how to fix arguments within your group. In my class, this project has definitely helped their problem-solving skills … Everything is about critical reflection and it is up to schools to have that conversation. Computational thinking is a base point that starts with your Bee-Bots and then it moves to scratch Junior and beyond. So, it's a case of the school asking where do we start this journey and what computational thinking development do you want.*

Teachers spoke positively about the impact of computational thinking skills development in their classrooms. While both the coding and the LEGO building gave rise to some difficulties due to universal supply-chain resourcing issues in 2023, teachers remained optimistic for the project and offered constructive advice going forward. There was strong evidence of teachers' culturally responsive practices, particularly inclusive practices for children with additional learning needs and children of migrant and new-comer families to Ireland.

Images: Courtesy of WEAVE project team

6.5 An Easy-to-read Summary

It is likely that this report will fall into the hands of children at some point. It should, because children are at the heart of the project and without children, there would be no WEAVE. Some sections of this report may be difficult for children to understand (or maybe not!), so for that reason, a simple and hopefully easy to read summary of this long 100+ page report is written below.

This report was written by a researcher in a university who studied how teachers and children learned about the WEAVE project in 2022-2023. The story starts in 1997, 26 years ago and 10 years before the first iPhone was invented. Around that time, home computers first went on sale in shops and some schools and families started buying them. It was difficult to know which computers to choose and what we could actually do with them but everyone worked very hard in the years that followed and now in 2023, we almost all use computers. Most teachers now use computers, whiteboards, tablets or other technologies as part of their work every day. The part of the story that we like the best, and what we are learning about now in the WEAVE project, is how pupils use computing to learn to understand the world and to learn to solve problems; often without teacher's help.

Universities are places where fantastic ideas grow. Teachers enjoy going there to learn about fantastic ideas and about new projects, like the WEAVE project. They tell us that it's fun and interesting to learn about LEGO robotics, coding and problem solving. They tell us that when they return to school and show the pupils what they've learned, the pupils enjoy it too. They also tell us that sometime the pupils are better at WEAVE than their teachers are! They also tell us that some children, who may find some other learning hard at times, really like WEAVE and are sometimes the best in the group at it. We thought this was amazing.

We learned that pupils and teachers in other classes, the classes not doing WEAVE, cannot believe their eyes when they see the WEAVE projects in action. Teachers in staffrooms ask WEAVE teachers 'How did your class do all of that?' WEAVE teachers are so proud of their classes' work. This is brilliant. Sometimes, some WEAVE classes invite other classes and other schools around to show them their amazing WEAVE work. We've seen the photos. They're very impressive.

The teachers offered the following advice to us for any school starting WEAVE in the future. Plan ahead and try to have all of the kits ready in advance. Check them, bag them and have the pupils look after them. Pupils are excellent at doing this job. Teachers need to organise the iPads or Chromebooks in advance to ensure that there are enough to do the project. If there are not enough in the school, the Department of Education computer grant can be used to buy more.

Every teacher has a yearly plan for what pupils will learn. It may be necessary to change this plan in September to fit in the WEAVE project. Teachers should talk to the principal about this. Pupils may not be learning about the land, rivers and seas of Ireland that year, but when the yearly plan is changed to fit in the WEAVE project, pupils will learn to solve problems and write code to help them learn about things like the rivers, the land and much more in an individually meaningful way. Girls and boys will learn to think like a computer scientist and hopefully, will grow up to understand how to use computation to solve their problems, to create and to discover new questions, whether they become artists or economists, musicians or sports players and even computer scientists! Fun fact: The world needs more girls becoming computer scientists. If you're a girl reading this or hearing it for the first time, think about it. You could be that computer scientist in a few years' time!

Thank you to all of the teachers, all of the principals and all of the pupils who helped the researcher to write this report about WEAVE. Your work is amazing and so are you.

Images: Courtesy of WEAVE project team

6.6 Conclusion

In chapter six we have offered some concluding remarks about the challenges and opportunities facing a TPL programme for developing culturally responsive computational thinking skills. We have acknowledged issues of curriculum overload, time management and resource management. We have offered suggestions for programme sustainability into the future and most significantly in the final chapters, we have concluded with recommendations from teachers and principals in their own words. We ended the chapter with an 'easy-to-read' summary.

Throughout the EQI WEAVE evaluation, we have succeeded in engaging collegially with the expertise and energies of the tutor, the course organisers and the teachers involved. We would like to acknowledge the full co-operation of all parties and trust that the evaluation report is a true and valid representation of the investment in this worthwhile project to date. Given the evidence provided, it is our recommendation that all parties would continue to collaborate and to sustain the programme by developing it further in schools – particularly in schools for girls where the original aims and objectives of the enterprise may be realised more fully and where gender balance in STEM teaching and learning moves beyond an aspiration to become a reality in our school system.

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Appendices

Appendix 1

Focus group interview schedule 1:

Aim #1: To co-develop a cross-curricular culturally responsive computational thinking roadmap for primary schools.
Target: To gather data on participants' understanding of computational thinking, cultural responsiveness and cross curricular teaching and learning. To enquire about initial and on-going attitudes to the WEAVE project TPL among teachers. To enquire about the challenges and rewards for pupils, particularly in terms of learner-centric groupwork.

1. What drew you to the WEAVE course?
2. What is your experiences of it now?
3. What do you understand by the term computational thinking?
4. One of the aims of the project is to develop a culturally responsive computational thinking roadmap for primary school students?
5. What do you understand by the term culturally responsive?
6. Back to the first aim which is to co-develop a cross-curricular culturally responsive computational thinking roadmap for primary schools … can I ask about peer mentoring among teachers and pupils …
7. What do you see as the challenges and opportunities to co-develop a cross-curricular culturally responsive computational thinking roadmap?
8. What are the good sides and the awkward sides of co-development and groupwork?
9. What TPL has been provided and did you find it useful?
10. Anything else?

Appendix 2

Focus group interview schedule 2.

Aim #1: To co-develop a cross-curricular culturally responsive computational thinking roadmap for primary schools.
Target: To gather data about participants' initial and on-going reactions to the WEAVE TPL, about participants' learning, organisation and practical support for the programme, participants' use of knowledge and skills and importantly, teachers' assessments of pupils' learning outcomes. To supplement this, we added a further layer, enquiring if principals would recommend the programme to other schools and we also asked about what could be changed or improved in any way for schools taking up the programme in the future.

Interview Questions for Principals

WEAVE Evaluation - May 2023

Evaluating TPL provision using Guskey's (2000) five levels of questioning:

1. Participants' reactions
    - How did the teachers in the school respond to the idea of the WEAVE project initially?
    - What is the general reaction now in the school … among those involved … among others?
2. Participants' learning
    - What has WEAVE brought to the school in terms of new learning for teachers?
    - Has practice among teachers changed in any way due to this TPL?
3. Organisation and support
    - What resources have been involved in implementing the WEAVE project here?
    - Would it be obvious through teachers' planning or their interactions with each other, or through staff meetings that the project is receiving school support?
4. Participants' use of knowledge and skills
    - Have you seen any development or benefit to individual teachers or to groups on staff as a result of engaging in the WEAVE TPL – in terms of professional learning?
5. Pupil learning outcomes
    - Can I ask about pupils' behaviour, attitudes or even attainment … how do the pupils like the WEAVE project … have you noticed any effects?
    - Is there any evidence of this in the school in terms of outcomes – the showcase being the obvious outcome?

School leadership evaluation summary

- As a principal leading a school that has invested in staff support for the WEAVE project, what, in a few short sentences, would be your own evaluation of it?
- Would you recommend it to other schools or principals .. if so, why … and if not, why not?
- Finally, could it be changed or improved in any way?

Interview Questions for Teachers

WEAVE Evaluation – Final TPL Sessions – May 2023

Evaluating TPL provision using Guskey's (2002) five levels of questioning:

1. Participants' reactions

    - How did the teachers in your schools respond to the idea of the WEAVE project initially?

    - What is the general reaction now in the school … among those teachers who are involved … and among others?

2. Participants' learning

    - What has WEAVE brought to the school in terms of new learning for teachers?

    - Has practice among teachers changed in any way due to this TPL?

3. Organisation and support

    - What resources have been involved in implementing the WEAVE project in your school?

    - Would it be obvious through teachers' work, their planning or their interactions with each other, or through staff meetings that the project is receiving school support?

4. Participants' use of knowledge and skills

    - Have you seen any development or benefit to individual teachers or to groups on staff as a result of engaging in the WEAVE TPL – in terms of professional learning?

5. Pupil learning outcomes

    - Can I ask about pupils' behaviour, attitudes or even attainment … how do the pupils like the WEAVE project … have you noticed any effects?

    - Is there any evidence of this in the school in terms of outcomes – the showcase being the obvious outcome?

Participating teachers' evaluation summary

- As a teacher, you have invested time and effort in learning about computational thinking on the WEAVE project TPL. What, in a few short sentences, would be your own evaluation of it … particularly in terms of professional learning? Has it influenced your approach to teaching in any way for example?

- Would you recommend this type of work, developing computational thinking, to teachers in other schools.. if so, why … and if not, why not?

- We are reaching the end of the 2023 WEAVE TPL. As well as 'computational thinking' we have also learned about cultural responsiveness. We have talked about involving children in the project from marginalised backgrounds (those perhaps with no culture of educational technology in the home). We have talked about children with additional learning needs, (children with language learning needs and neurological diversity in particular), as well as children from abroad who are new to the Irish classroom. How would you evaluate the project now in terms of cultural responsiveness?

- Would you have anything further to add, to assist the evaluation of the project, from a participating teacher's perspective?


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