Robotics for Primary Schools in the 21st Century

A Case-Study of the Development and Roll Out of and In-House Training Programme

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Introduction

The fifth output from the Erasmus+ project: Robotics for Primary Schools in the 21st Century involved Piloting and Rollout of a training programme which schools, interested in introducing robotics into the curriculum, might adapt to use in their own contexts. The training would therefore be designed to take place in 'twilight' sessions at the end of the school day, and provided by members of the school staff.

Project partners had already shared their experiences of piloting resources and activities in primary classrooms, and the development of the training programme drew on their experiences.

Here we tell the story of what happened when the project schools from the UK collaborated to develop a training programme to support staff in their own school to develop confidence and experiences in using Robotics in their teaching.

Background to Case Study

Three primary schools took part in the Piloting and Rollout of training programme which formed These were St Andrew's School (Buckland Monachorum), Ermington and Ugborough Primary Schools. All three schools are in semi-rural locations and serve communities with a range of socio-economic backgrounds. Approximately 450 children across the three schools were involved in the project from Early Years Foundation Stage (EYFS: 4 to 5 year olds), Key Stage 1 (KS1: 5 to 7 year olds) and Key Stage 2 (KS2: 7-11 year olds).

Before project started

Across the three UK schools there was a limited understanding of robotics and programming, with a very small number of staff having a good or growing understanding and interest in the topic and its content, whilst most others were technologically and pedagogically challenged as to where robotics would or could fit into the National Curriculum. Within these schools there had been some previous understanding and use of coding programs such as Scratch and Kodu; however, this was not widespread and it was not necessarily obvious (for staff) how these programmes could provide the skills or relevance for use of the resources that currently existed with the schools at that time. All schools had simple floor robots such as Bee-Bots; however, these were mainly confined to Foundation and KS1 and had been used sporadically.

However, in the previous 12 months prior to the start of the project, two out of the three UK schools had purchased Lego WeDo. This construction set is a primary education resource developed for younger primary school students as an introduction to control technology and programming using robotics. Some members of staff had received training, and this had led to a spike in Lego usage with children, with a couple of staff engaging with WeDo and creatively using it within the curriculum. This had mainly been reserved for lower KS2 and delivered as a collapsed curriculum Lego WeDo project week, following the Lego WeDo plans that had been provided.

There was no specific designated place for robotics within our curriculum and any robotics activities, such as Bee-Bots and WeDo especially, had perhaps been more project-based and cross-curricular in nature, but ad hoc nonetheless. Robotics would not have been found within our school medium- or long-term plans.

Prior to the first school training session, which took place in January 2016, staff were surveyed on their knowledge, dispositions and attitudes to robotics. Whilst generally keen to participate in the project, they typically reported low to medium confidence to teach robotics and coding. Most saw a positive if uncertain role for robotics for the futures of their students and many expressed a desire and need for training and suitable equipment.

Getting Started

Choosing Resources

At their first Robo21C meeting in September 2015, the UK schools decided to purchase Blue-Bots (proprietary floor robots), Lego WeDo and Lego Mindstorms. It is worth noting that Ermington and Ugborough already had some limited experience of Lego WeDo, as they had previously bought the non-Bluetooth version, having been involved in a very informal Lego project with the local Ivybridge Academic Council (consisting of approximately 10-12 primary schools).

By the end of 2015 all UK project schools had the appropriate equipment to support the initial provision of robotics teaching across the main key stages. The Blue-Bots, floor robots, were, whilst not exclusively, seen as an ideal introduction for KS1, with WeDo as the next progressive step for Lower KS2 before finally accessing Mindstorms in Upper KS2 (children aged 9, 10 and 11).

Appendix A provides a curriculum progression map for the key skills and suggested equipment across the key stages.

Initial training

Half a day's training was held for teaching staff and student teachers at the start of January 2016, and this aimed to:

- Introduce the aims and objectives of the Robo21 project.
- To capture and record existing attitudes/experiences and confidence towards teaching robotics.
- To provide a non-threatening and enjoyable hands-on session, where teachers got to play around with the full range of equipment and to gain a greater understanding of the possibilities for using it.

Three main workshop groups (WeDo, Mindstorms and Blue-Bots) were set up with the proposition that staff could select to participate in 1-2 sessions, directed per their interest or need, to gain confidence in a certain area or technology.

Several key teachers had been allocated /co-opted to informally help run and support the break out groups, as they had a suitable level of skill and interest to successfully do so.

The three sessions were set up as follows:

The Blue-Bots group got to practise simple hands-on programming commands in moving the floor robots around the classroom and they then moved to greater complexity by getting four of the floor robots to carry out a dance/synchronised pattern.

The WeDo groups used mainly pre-assembled Hungry Alligator designs and programmed them to carry out simple movements using the programming application on wired computers, such as opening and closing their jaws etc. Within this they were shown the basic principles of coding using the menu provided from the WeDo applications.

The Mindstorms group and the wider teaching staff had very limited experience of Mindstorms and this session was aimed at providing an opportunity for basic construction and familiarisation of the main components, including the EV3 block. The desired outcome was the assembly of one of the most basic model designs. Any programming, which was extremely limited, was carried through the EV3 brick controls.

Developing Familiarity

The period from January –July 2016 was positioned and communicated to staff as the phase where the expectation was that most staff would, in a less formalised and structured manner, provide opportunities for children to gain experience with the new equipment. There was no specific prerequisite for structured teaching or lesson plans to be provided (or monitored against) and it was a way to get children and staff to build their experience and confidence with the new equipment and robotics generally. We also tried to encourage the

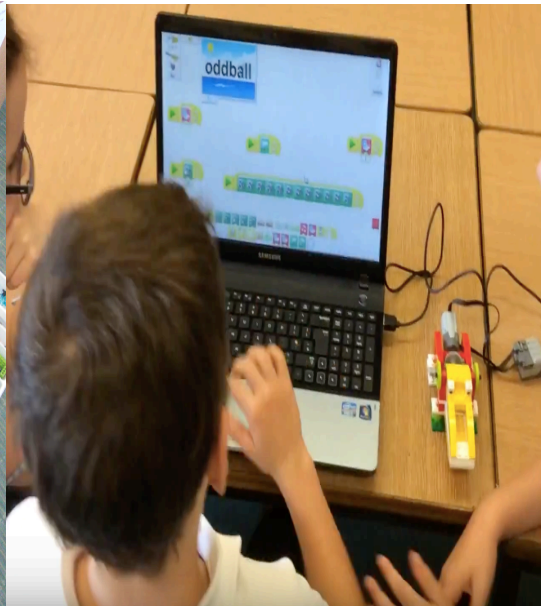
view, and possible reality, that whilst at this point many teachers lacked confidence and or experience with robotics, we should embrace children's natural enthusiasm and excitement in the project. They wanted to get their hands on the new equipment and we should give them the opportunity to do so and shouldn't be scared to relinquish some element of control to them as independent/self-directed explorers/learners. This was certainly more of a potential opportunity at upper KS2 as children already had some previous experience of WeDo and coding, and a small number had trial experience of Mindstorms. Indeed, some children in KS2 took the lead in teaching other pupils how to use the equipment and we started to see the opportunities for pupils as teachers.

What did this period provide?

It led to many children gaining initial and enhanced experiences with the new technology through mainly game-based learning (see Appendix A - Curriculum Progression Map ROBO21C and Project Output 2: A Training Framework for ROBO21C: https://drive.google.com/open?id=1p0sv5). This was often in mixed ability groupings and provided great opportunities for developing the key competencies of team working, creativity and collaboration.

One example of curriculum creativity could be seen with a nod to Strictly Come Dancing, with children being encouraged to come up with their own individual or synchronised dance movements through the manual coding of the Blue-Bots.

Some teachers ran a collapsed curriculum for a week, in which the lower KS2 children got to experience Lego WeDo for project-based learning. These were based on a variety of the WeDo models going on a journey, such as the WeDo aeroplane flying to the rainforests of Brazil. This also provided creative writing opportunities.



This period was characterized by many of the less confident teachers dipping their toes into the "teaching" of robotics, whilst some of the more confident teachers started to provide

greater opportunities for the equipment to be used within their teaching of a variety of subject areas, such as maths, design and technology.

During the September to December period we held our first children's Robotics/Maths day, which was hosted by St Andrew's. Six children drawn from lower KS2 were selected from each of the three schools. The main objective was for children to gain increased confidence and experience of WeDo. As previously mentioned, some Ermington children had already had experience of WeDo prior to the Robo21C project and they were tasked, with teacher support, to teach other children, who had very limited or no experience of WeDo, how to use the equipment. This followed the concept of using children to act as teachers and aimed to widen robotics skills and experience across the three schools.

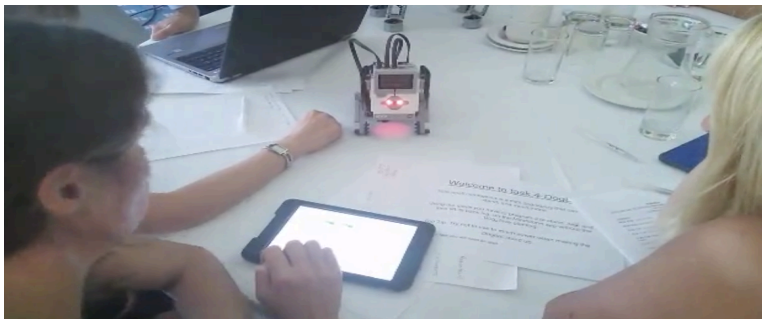
Purchase of Additional Equipment.

It is also worth noting that at the end of June 2016 the UK schools had identified that they needed more equipment, prior to the September Training Session Additional Blue-Bots, WeDo and Mindstorms were purchased, as we wanted to remove any potential barriers to widening use and teaching of robotics as part of the Robo21C project.
The March mobility to Spain had furthermore identified a potential gap in children's skills development at foundation/KS1, in respect to using hands-on concrete manipulatives to build those fine motor skills. Mr. Learnie (Lego Learn to Learn sets) were subsequently purchased to help address this.

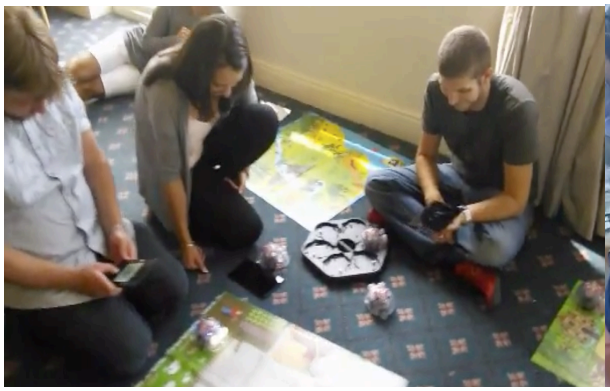
Appendix B provides a product overview of Mr. Learnie and summary of potential curriculum applications.

September 2016

All three UK schools involved in the project met on the first day of the new academic year for whole school training on robotics. All teaching staff including teaching assistants participated in the training on the day.



This broadly marked the transition point from a more informal and ad hoc use and teaching of robotics to a more systematic and curriculum-based approach. Video recordings captured a flavour of the day and evidenced the type of activities that were planned and delivered.




Video 3: You can view a video narrative of the day here
https://drive.google.com/open?id=0B9oWKFTSzotcRWtWUkdsdWVkWlU
Appendix C1 provides an overview agenda of the day including the aims and objectives and session timings and Appendices C2 and C3 examples of Challenge cards

Reflections on training and requirements for next steps.

The whole-day training session was broadly very successful in meeting the objectives previously outlined and it was extremely valuable to have a whole day focus with staff who were fresh and full of optimism from their summer holidays. Participants were generally very positive in respect to the project and seemed genuinely keen to up level their skills in respect to teaching of robotics. New equipment was introduced and best practice shared, with staff committing to put more structured focus into the teaching of this subject.
We had some technical issues with the Wi-Fi (wireless network) dropping out, which slightly compromised the coding session and caused some frustration during some of the workshop carousel. This led us to make the decision that any coding/programming where at all possible would be undertaken with wired leads at the next training session (Jan 2017).

Video 4 https://drive.google.com/open?id=0B2tSVPA7n8A5aU5aNm04OWJ3Vms
and 5 https://drive.google.com/open?id=0B2tSVPA7n8A5OWYtVW5iVmdhUHM
capture teaching assistants' perspectives on the training.

First Lego League

Having observed at first hand, during the visit to schools in Lithuania and Denmark, the potential value that this competition brought in respect of many of the key competencies outlined in 'A Training Framework for ROBO21C', it seemed the obvious decision to enter three teams. All three UK schools ran after-school robotics clubs to support and prepare the teams for the competition, which took place in December 2016. The three UK schools were competing against, amongst others, sixth form pupils and, because of prior learning and knowledge, they performed on a par or above age-related expectations.

Teams of 10 were selected from Years 5 and 6 and they were tasked with quite complex programming tasks involving the Mindstorms robots. This gave us the opportunity, focus and impetus for children and supporting teachers to extend their programming skills in a relatively tight timescale. It also has enabled us to help several children develop quite advanced skills, confidence and ability to share the gospel of robotics and programming. It became likely that these children would be used to help support other children within the schools and potentially peer-teach. In addition to this, they would also probably be part of the group of children involved in the multiplier event. On the day, there would be workshops run by children, which would aim to teach adults some of the key skills required to implement a robotics programme within their schools. Sharing their raw enthusiasm would be crucial to this aim and interestingly, when asked if they could imagine running such sessions, many children expressed unbridled confidence in their ability to do so.

Appendix D provides a QR code linking to the First Lego League website, while a selection of children's feedback on participation of the First Leg in reproduced in Appendix E.

January 2017

Another in-service training session bringing all three schools together was held after school in January 2017. After four months since the last training session, we wanted to capture some of the changes in practice that we had seen and additionally had identified the following areas as key aims.

Aims and objectives for the Training session:

- To recognise and celebrate the progress that had been made by teachers and children in the project since September.
- To share best practice, with a focus on those teachers who had more recently started to embed robotics within their teaching and to get those who hadn't previously presented to the wider group to contribute.
- To allow time to reflect on how we were doing against plans that had previously been made and to get everyone to commit to identifying individual/class next steps.
- To provide further teaching of coding skills, as this needed to be addressed to allow teachers to become more confident and able to explicitly and efficiently model these skills to children.

A detailed agenda and objectives for this session can be found in Appendix F, with a visual illustration of progress provided by the Road Map Ahead in Appendix G.

Reflections on January 2017 training session.

It provided a good opportunity to recognise that progress had been made in the previous four months including:

- Increase in timetabled allocation for robotics teaching.
- Equipment being used more widely and successfully across all key stages.
- A further Increase in confidence, belief and enthusiasm in ability to teach robotics.
- Widened experience of seeing children engaged and enjoying opportunities that the project had given. When children were seen to be really enjoying themselves, then staff came alive talking about it, and the possibilities that it brought.
- It gave time to staff to consider their next steps and their commitment to use more of the equipment and to change their teaching according to their place on the road map.
- It successfully positioned the need for evidencing teaching and learning through robotics and the fact that we are over half way through our own project, with the multiplier event less than six months away.
- It identified that at KS2 there is a need to move to more distinct modelling and explicit teaching of those key skills of programming and coding using the Mindstorms and WeDo computer programmes (programming for a purpose rather than just seeing what the equipment can do).

Areas for improvement were identified to plan for the focus of the next session in April 2017. We reflected that:

- After school training is not nearly as productive as training during in-service training days, as staff are already tired after a busy day.
- 2 hours for training is not a lot of time and we tried to cram too much into the agenda. We should be more realistic about what we can achieve.
- A greater proportion of time should be allocated to hands-on skills training to develop staff coding and programming skills. This should be the focus of training in April.
- We should look to use other ways to share best practice from the project and not rely on in-service training as the vehicle to do this. This could be achieved by allocating regular update time in staff meetings.

April 2017

Most of the April session was spent in separate key stage groups. A large proportion of the time for KS2 was focussed on further developing teachers' confidence and ability in teaching robotics through the medium of Mindstorms. The session (see timetable) was in many ways quite play-based, with teachers using programming to get their robots to meet a variety of challenges. We focussed on key programming skills using the main programming block – Move Tank. It was almost universally felt that significant gains in confidence and capability were obtained by the participants and that they are now in a much stronger position to model, teach and inspire children's use of robotics using Mindstorms. Less was more in respect to meeting training objectives, with the objectives far tighter and more specific. An appropriate amount of time was provided to facilitate the session, whereas the previous session was somewhat time compromised.

The KS1 session was less practical and more discussion-based. The individuals shared ideas from their own experiences within the classroom in respect to primarily using Blue-Bots and Bee-Bots. Outputs included a variety of resources created and the mapping out of possible wider cross curricular opportunities for the use of robotics technology in the younger age group within the school.

A detailed agenda for this final session can be found in Appendix H. An example of the Prediction Cards used in the KS2 session have been reproduced in Appendix I.

Reflections on the training package as a whole

A summary of themes and their relationship to 21st century skills which have emerged across the project complied by Jan Georgeson can be found in Appendix J.

I don't think our schools differ too much in comparison with other schools in the area, with respect to computing/ICT staff capability and confidence. Whilst the training package was tailored according to our circumstances, it could easily be adapted for other schools. Having staff with coding, robotics and programming experience was helpful; however, training could have been provided by outside agencies or through use of computing Specialist Teachers. Having key stakeholders (mainly teachers) within the school who were positive about robotics and who had a good level of capability undoubtedly helped. What was arguably more important, which I believe would be consistent across almost all schools, was the large reservoir of enthusiasm, engagement and joy for robotics that the children as learners demonstrated. Tapping into this uninhibited enthusiasm was vital to the success of our programme.

If we were to run the training again for our staff, I believe we would choose to retain the period which was referred to as the informal/ad hoc phase, when staff were given licence to 'play' and work off-curriculum. However, we would introduce more formalized training earlier in the project. Building key coding and programming skills for staff to enable the explicit teaching and modelling of the key skills is critical. We would also try to plan 'twilight' sessions after school as in-house 'clinics' for sharing issues and trouble-shooting problems. We have learned that, if new skills are to be achieved, teachers need the space, time and energy that can be provided in full-day sessions.

In a relatively short space of time we have successfully introduced and started to embed robotics within our schools and the wider creative curriculum. We have staff who are now

far clearer on the role of robotics and have much higher levels of confidence in their own teaching ability. We have seen many children thrilled and engaged through the project and abundantly demonstrating those **21st-century skills,** such as collaboration, digital literacy, critical thinking, and problem-solving that will be crucial to help them thrive in today's uncertain world.

Having children confident and capable enough to act as ambassadors for the project and being able to share what it has meant for them to an adult audience, speaks volumes and perhaps can be crystalized by a few of the children's own reflections.

"Robotics is awesome and there are so many wicked outcomes."

"I have learnt that we all have different strengths and weaknesses and my strength is coding!"

"Now I can program and build different robots, which I would imagine I would never be able to do."

The third year of the project provided our schools with a chance to further develop and embed a culture of robotics, delivering a legacy which confirms that investing in robotics within the school curriculum is so worthwhile for staff and pupils alike. Did it take time, effort and focus? Well, yes of course, but as we know, arguably anything worthwhile takes time, patience and perseverance!

Appendix A: Curriculum Progression Map: Robotics skills

	EYFS	KS1	Lower KS2	Upper KS2
All stages promote 21st century skills: teamwork, collaboration, digital literacy, communication, creativity				
Key Skills Supporting Programming	Physical manipulation Following instructions Solving simple step problems (e.g. get from A to B)	Precise, unambiguous instructions Create and debug simple programs Predict behaviour using logical reasoning (e.g. if I follow these instructions where will I get to?)	Following algorithms Use sequence selection and repetition Solve problems by decomposing into simple parts	Following and generating algorithms Debugging Programming, monitoring and controlling products Use variables of input and output
Resources	(possible use of Lego Learn to Learn) Standard Lego Bee-Bots	Bee-Bots/Blue-Bots Lego learn to Learn	(Lego WeDo) Blue-Bots	Lego Mindstorms
Problem solving opportunities/ Cross-curricular links (suggested ideas)	Create the model shown in the pictures Follow the instructions e.g. F F, R,F where do I get to? Recreate simple photo from Lego e.g. recreate this fire engine from Lego	Maths e.g. simple number line to calculate addition and subtraction e.g. 1+7-4+2-3= Sequencing e.g. literacy story cards, moths, days of the week (program Blue-Bot to visit each in turn) Literacy: write instruction text on how to use Blue-Bots Solve simple problems e.g. get from A to B without using forward of right command. Lego learn to learn curriculum pack	Maths e.g. measuring using Blue-Bots to progress to program the Blue-Bot to complete a maze- Each step = 15cm so how far has it travelled (multiplication) Blue-Bot strictly come dancing (plan on paper and create a sequence for 2 Blue-Bots) to be judged Lego WeDo: comes with curriculum plans and links Digital literacy- create and film videos of making/ instructions of how to make Create a house and calculate area and perimeter Take a picture of a machine and try to recreate in Lego e.g. fire engine, windmill	Familiarisation with equipment, how to program and create Robot wars/challenges: create a robot to fulfil the requirements (competitive elements) e.g. must complete obstacle course, must turn when reaches an obstacle, must talk etc. Children to plan and facilitate robotics lessons with small groups using equipment- student led sessions Stop in time to avoid hitting Lego people
Key Vocabulary	Forward, back, left, right, stop, start Instructions	Program, sequence,	Algorithms, loop, repeat, sequence, debug, decomposing	Algorithm Input, output, variables

Appendix B: QR code for Mr. Learnie

providing a product overview of Mr. Learnie and summary of potential curriculum application.

Appendix C1: Agenda **for Training Day –September 2016**

09.00-09.30 - Tea and coffee
9.30-10.00
Introduction to set the scene as to where we are in the project, including successes and challenges so far, and being clear about the aims and objectives of the project. Possibly we should focus on the key message that we are trying to deliver 21st century skills through Robo21.
21st century skills: teamwork, collaboration, critical thinking, digital literacy, communication
This session could provide an opportunity to look at possible challenges, time constraints and barriers.

10.00-10.30 –Curriculum skills/progression mapping.
Mark to introduce
Phase sections of progression mapping to be covered by relevant staff
Session objectives are to provide a clear outline of the computing/robotics skills and competencies progression from Foundation through to Year 6. This will also map out potentially how you would expect children to move from one resource to another for example BlueBots to WeDo to Mindstorm etc.

11.00-12.00 Training sessions (didactic) with explicit links made to the previous session. Objective that all teachers to understand/be able to teach the key skills that we believe children need to have from a computing side to capitalize on the resources that are available to them. This would be differentiated potentially according to key stage experience and requirements.

Key Skills	Physical manipulation Following instructions	Precise, unambiguous instructions Create and debug simple programs Predict behaviour using logical reasoning (e.g. if I	Following algorithms Use sequence selection and repetition	Following and generating algorithms Debugging Programming, monitoring and

	Solving simple step problems (e.g. get from A to B)	follow these instructions where will I get to?)	Solve problems by decomposing into simple parts	controlling products Use variables of input and output

Guest Speaker to run input on coding

12.00.13.00- Lunch.

13.00-13.45
Carousel of activities to start off the afternoon, with groups to undertake task activity challenges with the robotics equipment that support demonstration of 21st century skills.
Learn to Learn - build Mr Learnie
Blue-Bots - challenges using the mats and the app
WeDo- challenge cards
Mindstorms- challenges

13.45 -15.00- Action Planning

introduce the aims and objectives of the session and to share newly produced medium-term planning template for the outputs to be captured on.

Objective for the afternoon session is to link back to the progression mapping session from earlier and to start to plan how each year group/key stage can fit robotics into the curriculum in a creative and structured way. We discussed setting an objective that all teachers will commit to teach 8-10(?) robotics/sessions involving robotics over the autumn term.

Teaching assistants to come up with possible activities that they can run with groups of children, using the template provided

15.00-15.30 share outputs from the sessions. What have we committed to do and how will we make sure we deliver on it? How can we overcome any barriers previously raised?

15.30 Final wrap up session and thanks.

Appendix C2: Blue-Bot Challenge card

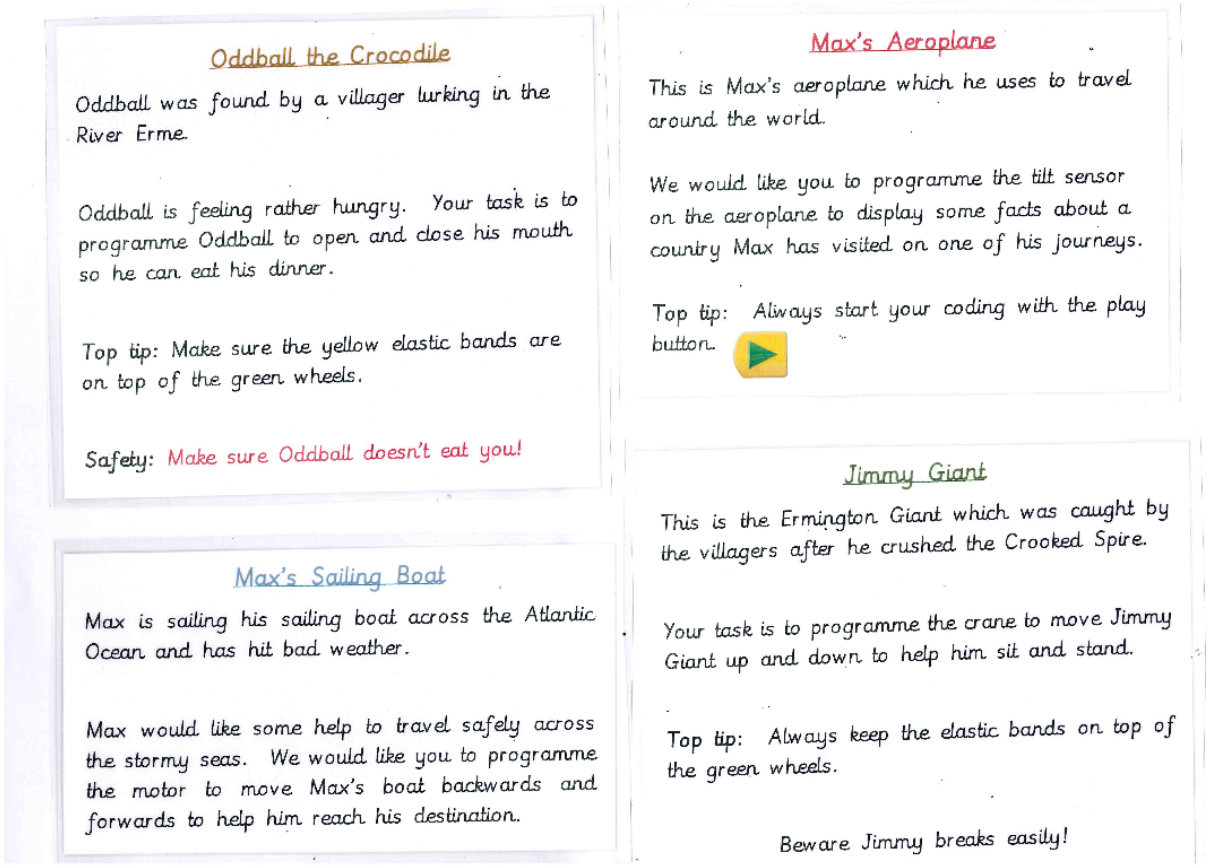
Robotics for Primary Schools in the 21st Century

Bluebot Challenge 1

Get from the start position to the finish position WITHOUT using the forward button

What is the fewest possible number of moves you can do it in?

Appendix C3: WeDo Challenge Cards



Oddball the Crocodile

Oddball was found by a villager lurking in the River Erme.

Oddball is feeling rather hungry. Your task is to programme Oddball to open and close his mouth so he can eat his dinner.

Top tip: Make sure the yellow elastic bands are on top of the green wheels.

Safety: Make sure Oddball doesn't eat you!

Max's Aeroplane

This is Max's aeroplane which he uses to travel around the world.

We would like you to programme the tilt sensor on the aeroplane to display some facts about a country Max has visited on one of his journeys.

Top tip: Always start your coding with the play button.

Max's Sailing Boat

Max is sailing his sailing boat across the Atlantic Ocean and has hit bad weather.

Max would like some help to travel safely across the stormy seas. We would like you to programme the motor to move Max's boat backwards and forwards to help him reach his destination.

Jimmy Giant

This is the Ermington Giant which was caught by the villagers after he crushed the Crooked Spire.

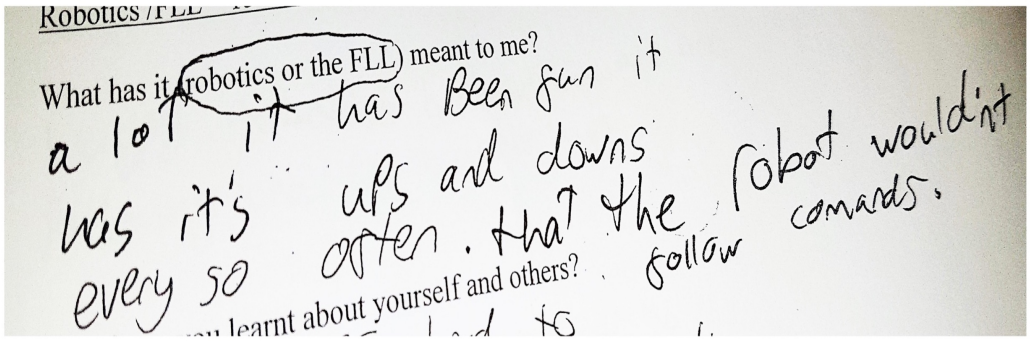
Your task is to programme the crane to move Jimmy Giant up and down to help him sit and stand.

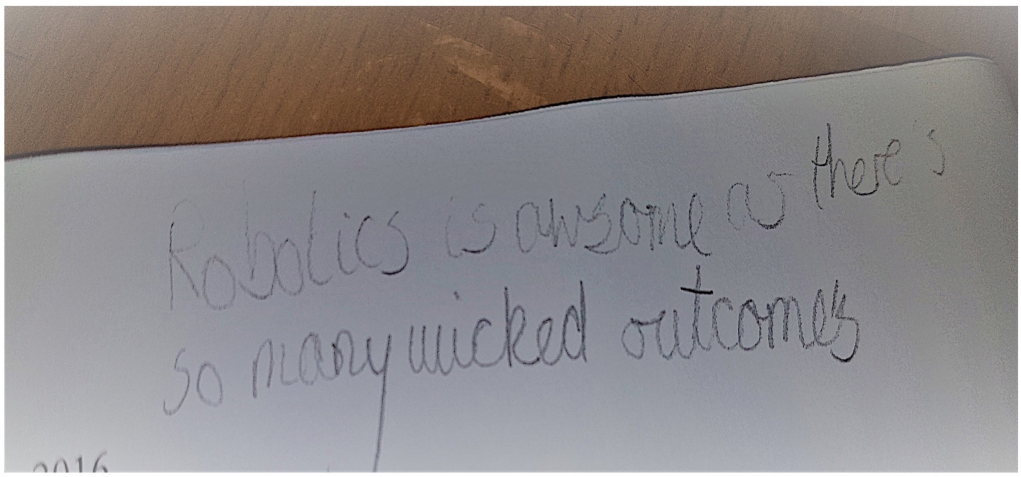
Top tip: Always keep the elastic bands on top of the green wheels.

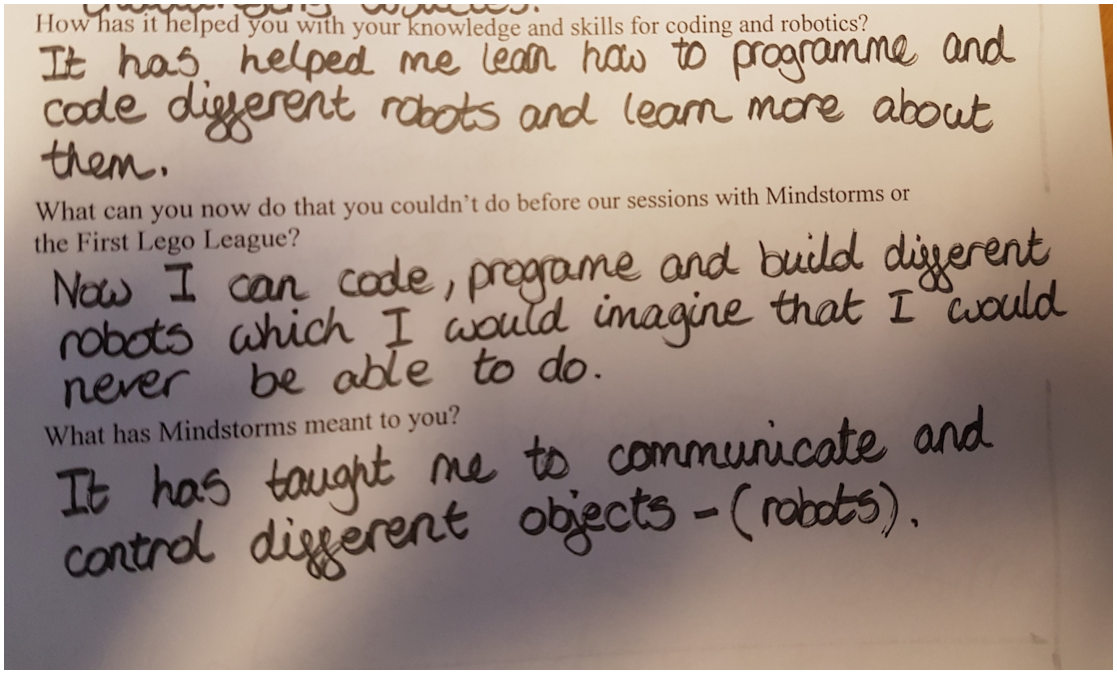
Beware Jimmy breaks easily!

Appendix D: QR code for First Lego League

Appendix E: Examples of children's feedback on the First Lego League.



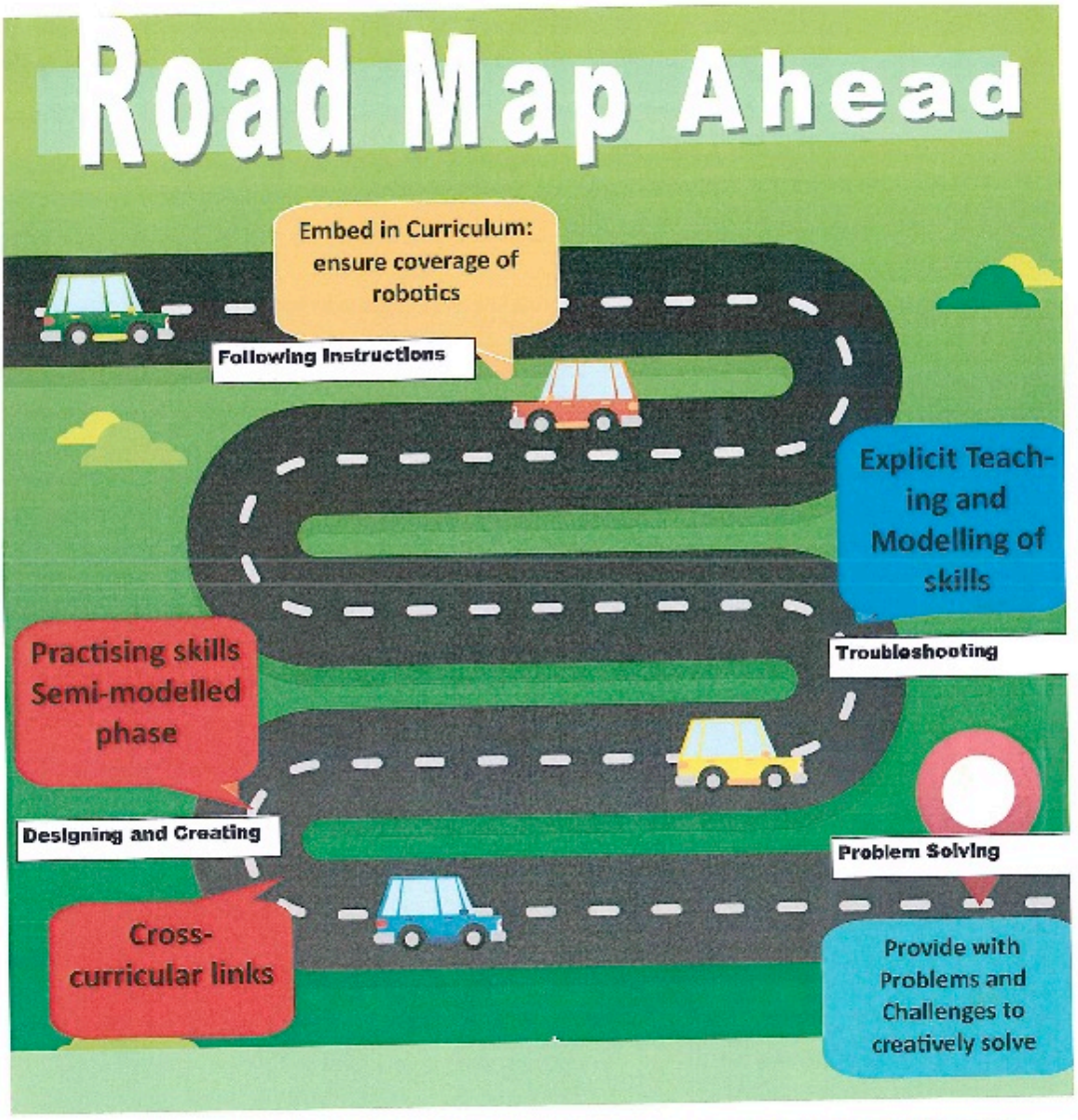




Appendix F: Agenda for Training in January 2017

Intro to session (hello and welcome)	2 min
Videos - Training and TAs	5 mins
Aims and objectives for today What is today about? • Recognising Progress we have made (teachers and children) • Reflecting on how we are doing against plans • Identifying our next steps • Building our skills	2 mins
Dad's Army clip (Don't Panic). Introduce next session. I'm stuck, don't panic.	1 min
Session: -recognising we need more explicit modelling and teaching of coding skills - a gap in teachers' knowledge and understanding of Key Skills in coding e.g. looping, repeats. This session highlights the mistakes/problems/challenges children are likely to need to overcome. We may need to alter our practice now to provide children with skills they need to become more fluent and efficient with their skills. (like solving a maths problem by using the most efficient method). show common mistakes. Staff to "show and have a go"- model inefficiency and fix it. Self-select equipment by KS or by need.	30 mins
Thank you and introduce next session- outlining our road map ahead.	1 min
Road Map ahead. Different stages of Robotics Journey Couple of minutes to think where are you on the road map and note down what your next steps need to be to get further along the map. Share where you are and what you are committing to do in KS teams. What are the gaps/barriers to achieving this? How might you overcome them? What will you have achieved by Easter? Simple sheet- write down 2 things you are committing to doing. (Robotics New Year's Resolutions)	10 mins
Our journey with the project. Looking ahead towards the end of the year. NOT just about robotics, 21st century skills- life skills! 4 Cs- creativity, communication, critical thinking, collaboration • In next 6 months we need to capture and share what we do- evidence base. Videos, photos, interviews, evaluations • Multiplier event in June (explain and show poster)- child led sessions • 3rd year of project • First Lego League	5-10 mins
Pictures and or videos for end.	

Appendix G: Roadmap ahead



My Robotics New Year's Resolutions:

1.

2.

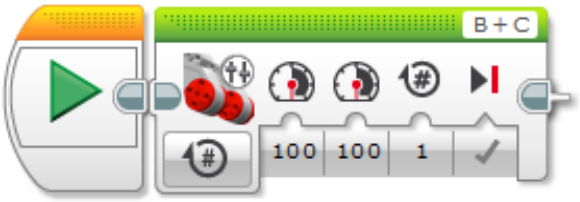
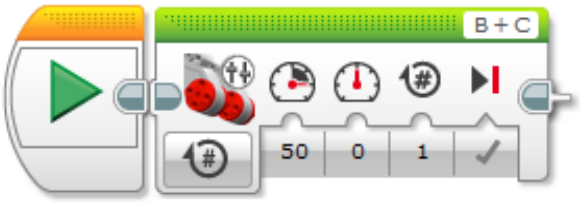
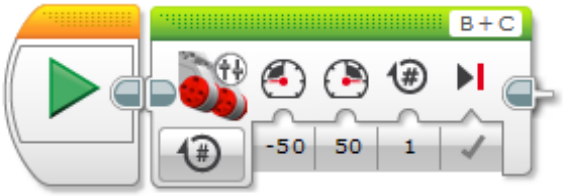
Appendix H: Agenda for training, April 2017

4pm	Tour of the school	
4.20	Start of session Welcome: Brief overview of the sessions, rationale behind them KS1 staff to decide where they want to participate. KS2 Aims and objectives – Everyone should be able to: -familiarisation of software -move forward controlled by seconds or rotation for a specified distance - program using the Mindstorms software - turn left and right 90 degrees, curved right and left - troubleshooting and problem solving KS1: aims and objectives - updates and new ideas from European partners - cross-curricular links - resources and ideas	Mark
4.30	Show program. Move tank. Show what it looks like and explain what it does. 50 and 50 tell robot to go straight you will use on for seconds/degrees/rotations. Move 1m (using metre stick) Who can get the closest without running it over? Complete activity	Joan
4.45	Test robots and reflect on how did you do it- what was the best method- trial and error or could you be more precise? - did you think about how far it would go for a set number of seconds? - Did you measure 1 rotation of the wheel? - How did you need to change your programming?	Mark
4.50	Next challenge what if the Lego person was 10cm away?? Change programs and re-test.	Mark

4.55	Retest and feedback- what did you do?	Mark
5.00	Predict what will happen if you change these values What if they're both 100? (faster) What if one is 50 and one is 0? (turn) What if one is -50 and +50 (spin) Fill in in shee?? How else can you change it? Test out and feedback.	Joan
5.10	This is one way to move the steering. Show move steering- how does this work? How do I get it to turn now? Explain that both blocks do the same thing so its personal preference. Choose whether to use move steering or move tank for next task. Navigate the maze – Mr Hayes. Or dog walker task from First Lego League mat.	Joan
5.40	**Plenary:** Set up a few that are wrong- why aren't they working?? e.g. wrong ports specified. - one wire not pushed in properly	Joan
5.45	**Reflection at the end- what have you learnt?**	Mark

Appendix I: Prediction card.

Take a look at the programming below. Predict what it will make the robot do.
Then program the robot and see what it actually does.

Programming	Prediction	Actual Result
		
		
		

Appendix J: Emerging themes

Emerging themes (and tensions) June 2017 from interviews and observations in class and at training events in Devon Schools:

Theme	Examples	Relationship to 21st century skills
Distributing expertise	Teacher 'lends' child 'experts' to other teachers. It is quicker to ask an expert (teacher or child) than learn yourself by trial and error – but does this mean you are missing out on important learning?	Collaboration
Finding a language	Collaboration requires a shared language: children can't ask each other for pieces or discuss debugging if they are not using the same words for objects, operations or processes. Teachers spend time teaching vocabulary of coding	Communication Collaboration
Resources and progression	Robotics resources need to be part of continuous provision for younger children. Younger children talk wistfully about resources used in older classes. Teachers identify need for resource to bridge gap in children's thinking: e.g. between Blue bots (on-robot programming) vs. WeDo (remote coding)	Creativity Criticality
Diversity/meeting different needs	Opportunities for children to try different roles in teams; learn about own strengths & weaknesses. Teachers sometimes surprised by which children enjoy robotics and/or turn out to be 'coding stars'.	Criticality
Relational turn	Younger children make own models (gallery of labelled identical My Learnies) & treat finished model as visible evidence of personal achievement Older children can describe the successful completion of an operation as a (group) achievement (sometimes evidenced by video)	Collaboration
instructions	Children need to experience following instructions precisely (to be effective and efficient coders). Children need to break away from building and coding from instructions to solve real problems	Creativity
Practical problems	Practical problems with a simple (but unknown) solution can hold up whole session. Fear of not knowing how to solve practical problems undermines teachers' confidence in teaching coding and discourages 'risky' teaching, so reduces opportunities for creativity & criticality.	Criticality Creativity

Jan Georgeson