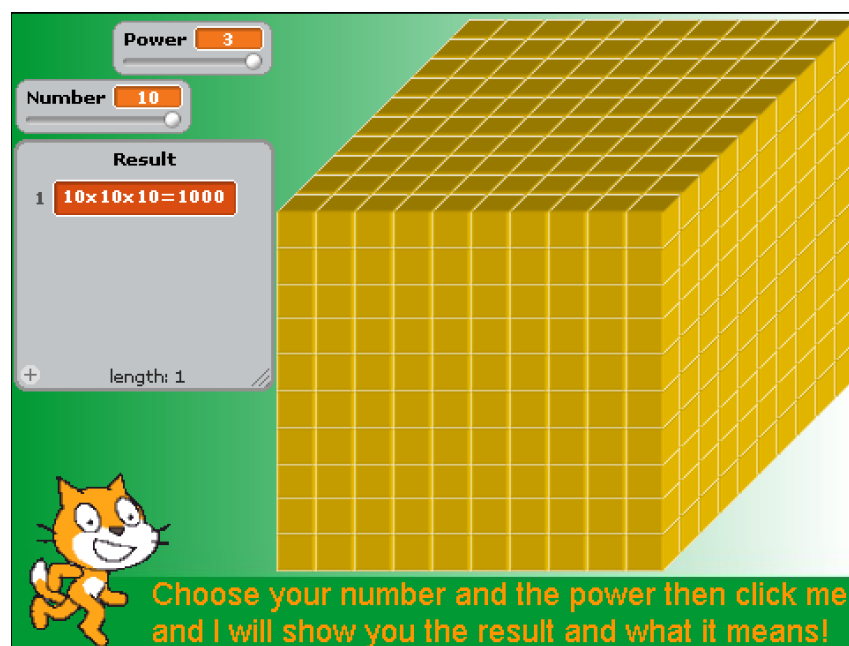


# An Investigation into the Use of Scratch to Teach KS3 Mathematics



*A dissertation submitted as a part of the requirements of the Maths and  
Science Bachelors Education Degree from St Marys Teaching College Belfast*

I would like to take this opportunity to thank all those people that helped me with this study. Karen Randall for her participation, the Scratch users I was in contact with. Particular recognition goes to, Gerry Trainor, who has guided me through this project from the beginning. Thank you.

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## **Introduction**

*"Scratch is a visual, block based programming language designed to facilitate media manipulation for novice programmers."*

*([www.media.mit.edu/~mres/papers/sigcse-08.pdf](http://www.media.mit.edu/~mres/papers/sigcse-08.pdf))*

It is a new and innovative programme that allows children to learn how to program and create multimedia games and applications with ease. It is described on the Scratch website as

*"a programming language that makes it easy to create your own interactive stories, animations, games, music, and art -- and share your creations on the web."*

*([http://info.Scratch.mit.edu/About\\_Scratch](http://info.Scratch.mit.edu/About_Scratch))*

The name was derived from the scratching technique used by hip-hop disc jockeys that spin vinyl records back and forth with their hands to mix music clips together in creative ways. This is similar to what can be achieved with Scratch, mixing media in different ways to create something new. The program was launched in 2007 and

*"has become a vibrant online community, with members sharing more than 1 million projects. Each day members of the worldwide Scratch community (mostly ages eight to sixteen) upload roughly fifteen hundred new Scratch projects to the Web site—on average, a new project every minute. The collection of projects is incredibly diverse: interactive newsletters, science simulations, virtual tours, animated tutorials, and many others."*

*(<http://onlinelibrary.wiley.com/doi/10.1002/yd.377/pdf>)*

Scratch is designed to develop programming skills and concepts for those with little or no computer programming experience so they could create their own interactive games, stories animations and simulations as well as share them with other Scratch users.

Scratch was created by the Massachusetts Institute of Technology (MIT) Media Laboratory. This organisation focuses on,

*"the study, invention and creative use of digital technologies to enhance the ways that people think, express and communicate ideas, and explore scientific frontiers."*

*(<http://media.mit.edu/about/faq#what>)*

Students can have great fun with Scratch, creating fun games and animations while learning and developing thinking skills. It is easy to use, students can program their Scratch projects by simply snapping together graphical blocks, without any of the obscure punctuation and syntax of traditional programming languages. In this way, Scratch makes programming accessible and more appealing to a much broader audience, so the program is more simplistic, appealing and relevant to young programmers but still being able to challenge even the most experienced programmers.

*"We wanted to develop an approach to programming that would appeal to people who hadn't previously imagined themselves as programmers. We wanted to make it easy for everyone of all ages, backgrounds and interests to program their own interactive stories, games, animations and simulations."*

*(<http://media.mit.edu/~mres/scratch/scratch-cacm.pdf>)*

There are over 1.5 million Scratch projects on the website, with thousands that teach some mathematics or use mathematics in some substantial way. Scratch is been used by math teachers all over the world and is promoted on the Northern Ireland ICT accreditation website as a tool for exploring programming. There is also a team of experienced Scratch users and educators that are working to create more Scratch projects that can be used to teach math and science.

The study will involve researching how Scratch develops mathematical thinking skills and how it can be used to teach key stage three mathematics, beginning with examining the current literature on the program, projects, features, websites and resources available. The study will then investigate how Scratch can be used in key stage three maths lessons. This will require evaluating personal experiences of using Scratch, the ways it can be used and interviewing experienced Scratch educators. The questions that I will base the study on are as follows;

### Research questions

*How does Scratch promote mathematical thinking skills?*

*What ways can Scratch be used to teach key stage three mathematics?*

## **Literature Review**

### **Overview**

Scratch is a new and innovative program that is fun and easy to use. It has exciting potential to help pupils develop computer programming skills and thinking skills. The program can be used in many different ways, with the different subjects and areas of the key stage three curriculum. It is designed and laid out in a way that it will capture the attention and interest of the children. When Scratch is opened it will display a blank project with a cartoon cat, in this blank project the cat is the 'sprite'. A sprite is an object in Scratch which can move, there can be more than one. Sprites can be drawn, taken from the sprites folder or imported from my documents. The back ground or 'stage' of the sprite is fixed can also be drawn, taken from the samples or imported. This is an appealing aspect of the program, as students can have great fun adding and creating sprites and backgrounds. The blocks for motion, looks, sound, pen, control, sensing, operators, variables can drag and move into the script area. To create a script you simply snap together graphical blocks, just as you would for magnetic Lego Blocks. These blocks replace the often complicated and tedious procedure of typing in instructions in older programs such as LOGO. The blocks can only be connected in a way that makes sense, if the script does not make sense the program will not allow the blocks to stick e.g. motion and operator blocks cannot connect correctly. This method is more suitable and appealing for children with little or no programming experience.

### **Scratch and LOGO**

Scratch is not the first programming resource aimed at novice programmers. It builds on the ideas and concept of previous programs such as LOGO.

*"LOGO is a high-level programming language used mainly for educational purposes, with graphical commands that are easy to use."*

*(<http://www.computing-dictionary.com/definition/LOGO-1.html>)*

Seymour Papert, credited as the inventor of LOGO (1980) and co-founder of the MIT lab which created Scratch presented the constructivist learning required with LOGO as,

*"the cornerstone for rethinking approaches to education and learning."*

*(<http://web.media.mit.edu/~mres/papers/CHI-programming-panel.pdf>)*

LOGO requires specific instructions to be typed in to create actions e.g. the movements of the turtle. Scratch substitutes the ‘*type code*’ associated with LOGO with a ‘*drag and drop*’ approach.

*“Scratch is inspired by previous work on LOGO and squeak Etoys but aims to be simpler and more intuitive.”*

*(<http://info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Programming-with-Scratch.pdf>)*

This approach is inspired by Lego Blocks, a toy company specialising in block building and the fifth largest toy manufacturing company in the world. Scratch documented this interest in Lego on the website, stating they were,

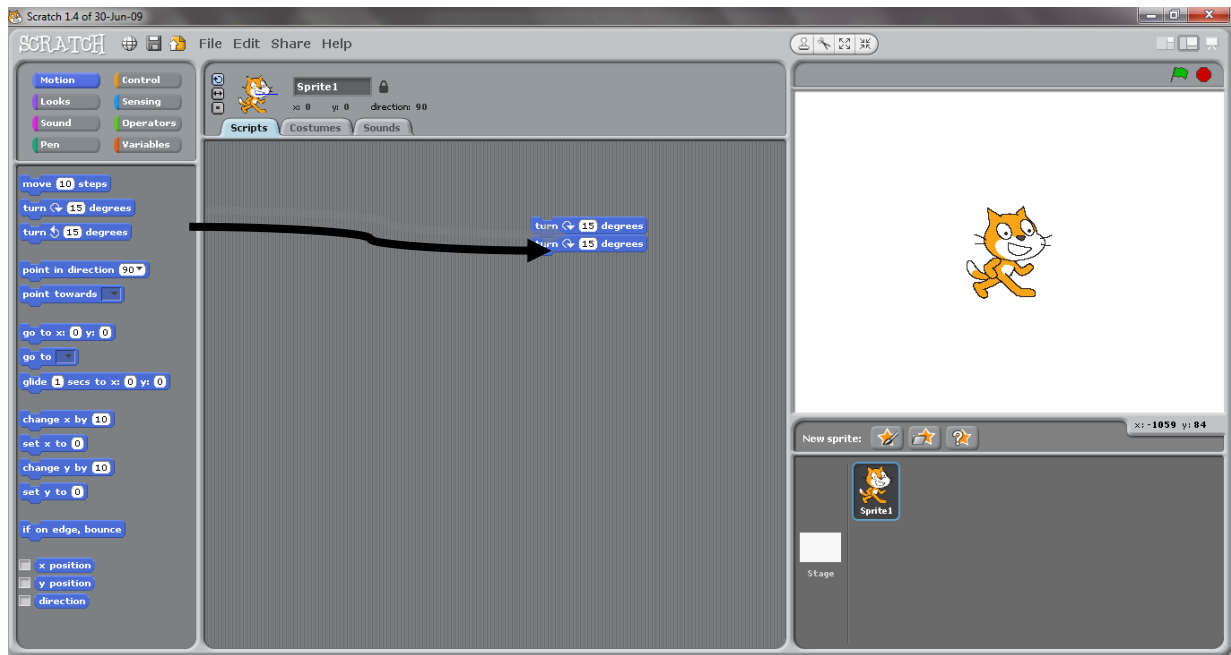
*“intrigued and inspired by the way children play and build with Lego bricks.”*

*(<http://media.mit.edu/~mres/scratch/scratch-cacm.pdf>)*



## Scratch Appearance

The following illustrates the aesthetically pleasing and simplistic look of the program and how it may appeal to young Scratch users. The arrow indicates how the two motion blocks i.e. 'turn 15 degrees', can be dragged from the left and connected together like Lego Blocks in the script area.



*"Scratch users learn mathematical and computational ideas that are built into the Scratch experience. As students create programs in Scratch, they learn core computational concepts such as iteration and conditionals. They also gain an understanding of important mathematical concepts such as coordinates, variables and random numbers."*

*(<http://info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Learning-with-Scratch.pdf>)*

## Fundamental Mathematics of Scratch

Creating any project with Scratch involves the use of many different mathematical operations. Firstly, positioning the sprite in a specific position requires knowledge of two dimensional coordinates. The origin is in the middle of the 'stage' and the coordinates of both 'x' and 'y' to move a sprite can be positive or negative. With motion commands, inserting values can control the magnitude and direction of the sprites movement, e.g. negative x value will move the sprite horizontally left. This helps the

development of coordinate geometry, the students must make the connection that values for x correspond to the horizontal movement of the sprite and the values for y corresponds to the vertical movements.

*"Math is a natural fit with endless possibilities when teaching with Scratch. Time, percentages, and variables barely scratch the surface of the concepts that can be taught through this program. One can even turn the 'Background' into a giant Coordinate Plane to help demonstration motion along the X and Y Axes."*

*(<http://Scratched.media.mit.edu/resources/lesson-ideas-middle-school-classrooms>)*

The angle of the sprite movement can be adjusted by inserting values for degrees into the turn command, the same way it was needed for LOGO. The students knowledge of angles is important for the sprite to move in the direction required. Pupils must be able to understand anticlockwise and clockwise turns and how the values of degrees correspond to the direction of the movement.

Using Scratch develops mathematics and computational thinking skills. It requires logical thinking to combine the scripts of a project to work correctly. A project may contain more than one sprite and hence more than one script, including sounds, movement variables etc. This requires clear logical thinking for the scripts to work together and for the project to work as intended.

### **Scratch and Problem Solving**

The process of creating Scratch projects involves problem solving skills. Often when making a Scratch project, the intended action of the sprite is not achieved as the result of an error in the script. To solve the problem requires clear and logical thinking and helps develop the students problem solving skills. The students are required to assess the problem, evaluate how it has occurred and then modify the script to resolve the error. These problem solving skills are important aspects of mathematics and essential for everyday life. The Northern Ireland Curriculum promotes the development of these skills in education. The curriculum overview states that,

*"there is emphasis on information management skills and on thinking skills, problem solving and creativity."*

[www.bbc.co.uk/northernireland/schools/pdf/NIschools\\_curriculumOverview.pdf](http://www.bbc.co.uk/northernireland/schools/pdf/NIschools_curriculumOverview.pdf)

## **Getting Started with Scratch**

There are a range of resources on the Scratch website for helping people get started with Scratch, video tutorials, step by step instructions and also Scratch cards. These Scratch cards are designed to help provide,

*“a quick way to learn the Scratch code. The front of the card shows what you can do; the back shows how to do it.”*

[http://info.Scratch.mit.edu/support/Scratch\\_cards](http://info.Scratch.mit.edu/support/Scratch_cards)



Crook (2009) in a study on the embedding of Scratch in the classroom writes about getting started with Scratch and states that,

*“Scratch is easily learnt by an adult in a couple of hours and children from the age of seven can be productive from the very first lesson.”*

<http://scratched.media.mit.edu/sites/default/files/Scratch%20in%20the%20Classroom-10.pdf>

## **Scratch Help Function**

There are many documents and tutorial videos available to help people learn how to use Scratch, as well as the help function. This help function is a useful aid for using the program, right clicking any of the commands can direct you to a help menu and explain what the chosen command does and how it can be used. The help menu is well illustrated and the language is clear, concise and appropriate for even the young key stage three children. When a project is created it can be added to the Scratch website.

*"Scratch projects can also be shared on the Scratch website the same way YouTube videos can be shared and photos on Flickr."*

*(<http://info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Creating-with-Scratch.pdf>)*

## **Sharing Scratch Projects**

Sharing projects allows Scratch programmers to display their creations on the internet for everyone to see and download. Uploading Scratch projects to the Scratch website is very simple to do. Simply clicking the share tab on the program, add tags and descriptions and it will then be automatically directed to your Scratch profile page. The Scratch projects can be assessed by all other Scratch users, after creating a username on the website, sharing the resources help users gain ideas by browsing through projects on the website. Uploading a project is a great way for pupils to get feedback from other Scratch users all over the world, receiving comments on their projects and other Scratch users can choose to 'love' the project by clicking 'love' link below the project when uploaded. This can add some competitive fun to creating and uploading projects and can be encouraging for the pupils if they receive a comment or 'love'. Uploading projects is a great way for a teacher using Scratch to have all the projects made by the pupils uploaded together in the one area, so they can assess, evaluate and also illustrate the projects on the class interactive whiteboard. Uploading the projects is more convenient for the teacher to show particular solutions on the interactive whiteboard. It can also encourage pupils to share sprites and project solutions so their classmates can see them. If the projects are all uploaded on Scratch they can be grouped in the one gallery, the teacher can illustrate the progress of other students and how the backgrounds or scripts can be shared by simply downloading and from the website.

*"If you like one of the characters, images or scripts in another project, simply download the project and use the parts of it in your own Scratch project."*

*(<http://info.scratch.mit.edu/sites/infocratch.media.mit.edu/docs/Creating-with-Scratch.pdf>)*

### **Remixing with Scratch**

A project which has been modified and shared is known as a remix. Remixes are always under the Creative Commons Attribution-Share Alike License and the original creator receives a message when one of their projects has been remixed. Some users create projects specifically to be remixed or modified e.g. projects requiring the addition of colouring or sounds to be added. Pupils can also work at the same project at home or in class to solve a bug or error by downloading it and remixing it. This is a fun and competitive way for students to think logically and use problem solving skills to identify the problem on a project and solve it. There are many similar ideas for this on the ScratchEd website.

### **ScratchEd**

ScratchEd is a website that was created in July 2009 for people that use Scratch to educate. ScratchEd is for,

*"a wide variety of educators have been supporting Scratch creators, in both formal and informal learning environments: a teacher who wants to share stories about Scratch and cross-curricular integration; a researcher who wants feedback on materials developed for exploring Scratch as participatory literacy; a parent who wants advice on how to introduce Scratch at a local all-girls high school; a museum program director who wants to connect with other museums who have introduced Scratch."*

*(<http://Scratched.media.mit.edu/about>)*

By signing up to the website you can avail of the stories, resources, discussions and contacts of the website. The resources uploaded are separated into different categories and subjects. They can help educators learn how to get started on Scratch, share resources including tutorial videos, projects, and documentation, lesson plans and Scratch based units.

Stories
Resources
Discussions
Members

Resources Home
Search Resources
Explore Keywords

## Search Resources: Mathematics

Click a term to refine your current search.

<b>Age</b> 10-12 (9) 13-15 (9) 16-18 (7) Any (6) 18+ (4) 7-9 (3) < 6 (1)	<b>Content type</b> Activities and Projects (11) Lessons Plans (8) Assessment and Evaluation (6) Teaching and Learning Strategies (5) Scratch Projects (4) Curriculum Standards (3) Homework (3) Unit Plans (3) Labs (2) Presentations and Lecture Notes (2) Video (2) Readings (1)	<b>Curricular Area</b> Computer Science (7) Arts/Music (2) Science and Technology (2) Any (2) Language Arts (1) Social Studies (1)
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On ScratchEd there are a number of documents posted on teaching ideas and lesson plans for the different subjects. There are also links to different galleries where projects are grouped according to their nature. These are very useful for an educator using Scratch, as they contain useful teaching ideas, advice and resources that can be easily found and accessed. Karen Randall is an experienced Scratch user who has created many math based projects and has taught using Scratch in an elementary school. Karen posted a very useful document on ways to use Scratch to teach maths. This is just one example of the many helpful resources that are available on ScratchEd to assist budding Scratch educators. The document has three main ideas, creating a basic project for drawing different polygons, a project using more advanced coordinate geometry to draw geometric shapes and then using this to apply transformations and symmetries. The document is very useful for helping maths teachers integrate Scratch into post-primary teaching to teach shape.

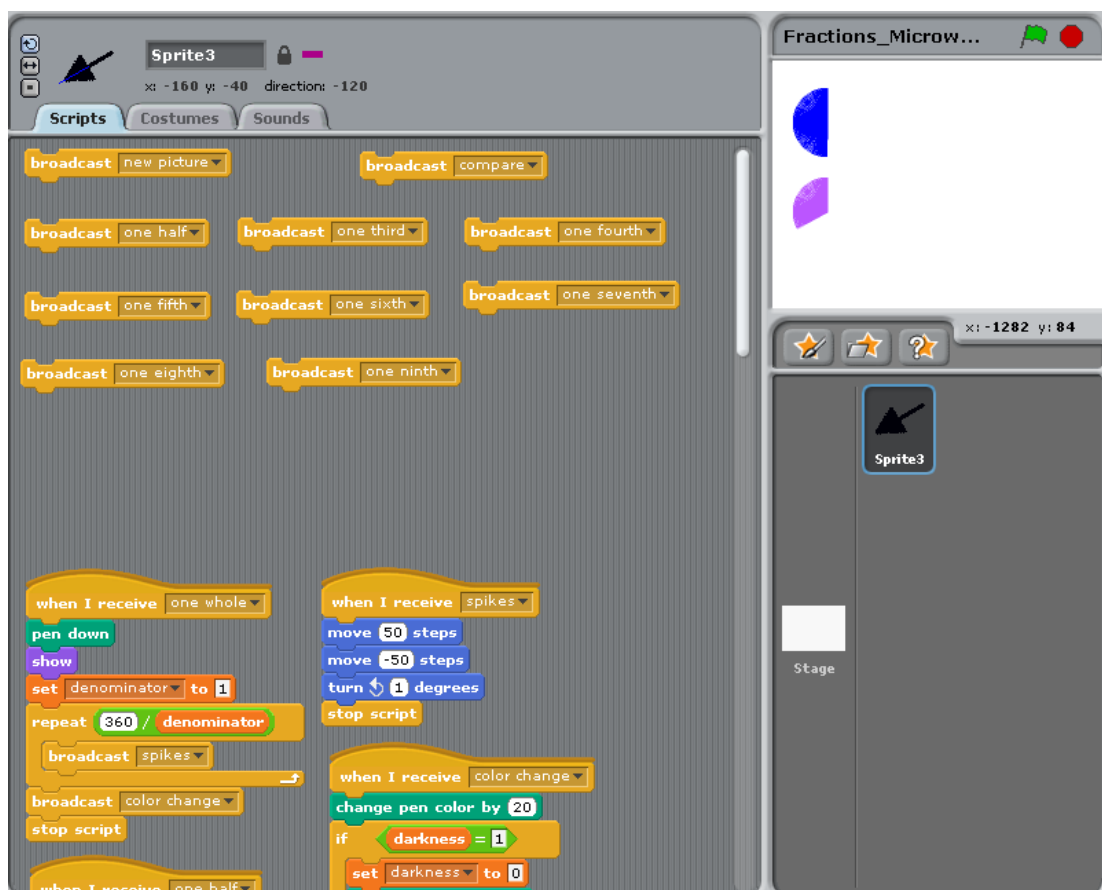
<http://scratched.media.mit.edu/resources/geometry-lessons-scratch>

## Show and Tell Videos

ScratchEd has a number of *show and tell* videos uploaded in the ScratchEd resources, these *show and tell* videos are of Scratch educators from all over the world talking about their experiences using Scratch. The Scratch educator shares ideas they have and the projects they or their students have created using Scratch. These educators are often then asked questions on their teaching experience using Scratch from member of the MIT team or other Scratch educators. The videos are very helpful for ideas and teaching methods to teach with Scratch and give a useful insight into the experiences of other Scratch educators.

## ScratchEd Math Resources

Kathryn Perry talked on a show and tell video about her project called *fractions microworld*. The project is designed as a teaching aid to teach the concept of fractions.



If you click on 'broadcast one half' it will draw one half of a full circle, clicking on 'compare' and 'broadcast one third' will draw a third of a full circle in a separate area. If

the compare button was not pressed the third would be drawn attached to the half. This is a helpful resource for illustrating fractions using ICT and animations. Kathryn has also designed a worksheet for this project that is uploaded on the ScratchEd website. For the first example  $7/4$ , the pupils must recognise that they have to click  $1/4$  seven times on Scratch and then using this visual representation to write down the mixed number value.


Name: \_\_\_\_\_

### Improper Fractions and Mixed Numbers

Scratch Logo for 5th Grade Classes  
K. Perry, 01/2010, GCSD

Program Scratch to show you pictures of each of the improper fractions below. Then convert to mixed numbers.

<p>EXAMPLE A: <b><math>7/4</math></b></p> <p>In Scratch: Click on _____ times</p> <div style="display: flex; align-items: center; justify-content: center;"> <math>\frac{7}{4} =</math> <div style="border-bottom: 1px solid black; width: 100px; margin-left: 10px;"></div> </div> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> <span>improper fraction</span> <span>mixed number</span> </div>	<p>EXAMPLE B: <b><math>14/8</math></b></p> <p>In Scratch: Click on _____ times</p> <div style="display: flex; align-items: center; justify-content: center;"> <math>\frac{14}{8} =</math> <div style="border-bottom: 1px solid black; width: 100px; margin-left: 10px;"></div> </div> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> <span>improper fraction</span> <span>mixed number</span> </div>
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This resource could be used in a key stage three maths lesson to teach pupils about proper and improper fractions and mixed numbers. The project and the worksheet can be downloaded from

<http://scratched.media.mit.edu/resources/fractions-microworld>

The Super School Team has also been creating classroom ready resources to teach using Scratch.

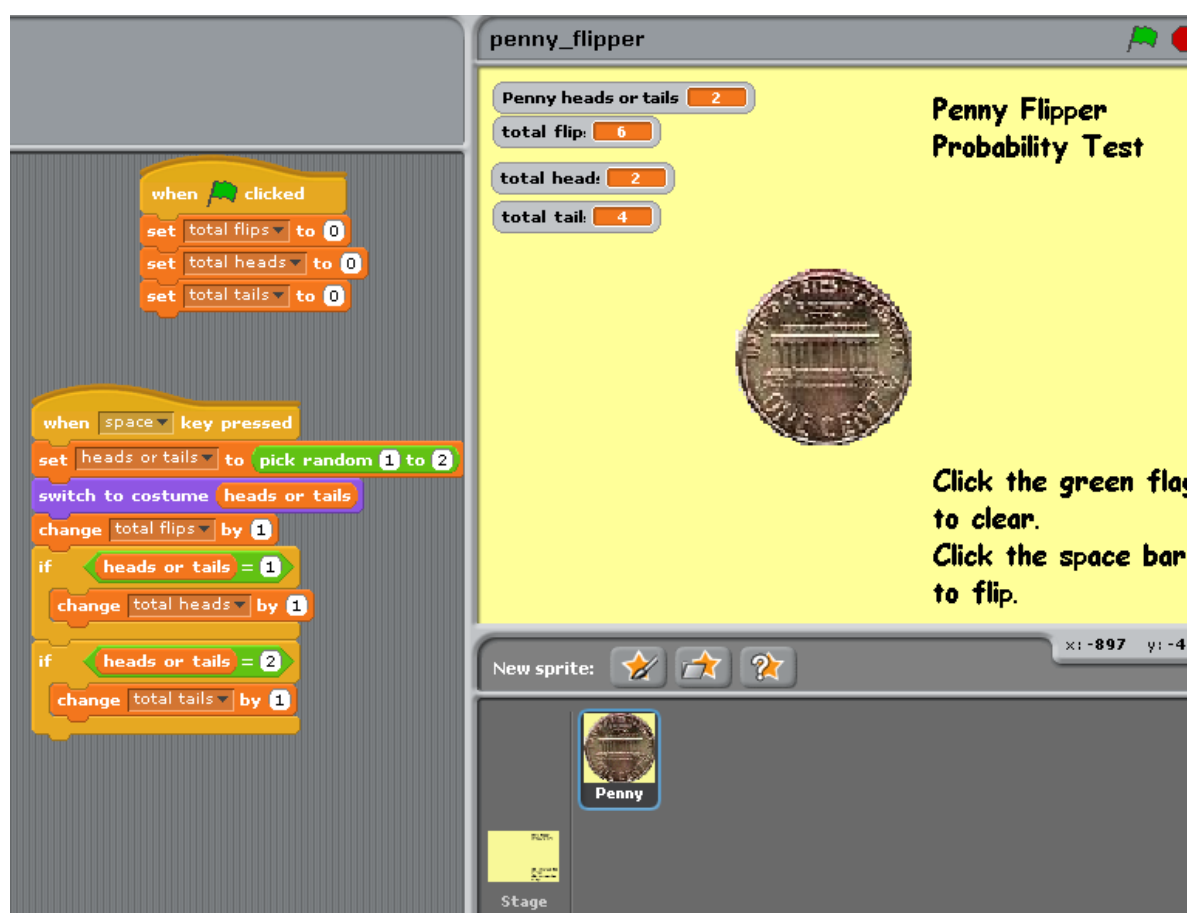
*"The Super School Team work together to come up with a large number of classroom ready activities and games and a convenient classifying method"*

<http://scratched.media.mit.edu/resources/scratch-math-and-science-classes>

Behrouz Aghevli is the founder of the Super School Team and welcomes other Scratch educators with the same idea. The team has created many maths based projects that are available from the Scratch website. These projects are useful teaching aids that can be used to teach many different areas in math and science.



Scratch can be used to teach pupils on all areas of mathematics. The Scratch website has many examples of how Scratch can be used to teach probability. There are various examples covering different aspects and levels of probability. The project called '*Penny flipper*' is a project created by Karen Randell (Room209), the project uses the random number generator function of Scratch to show the probability of flipping a coin. It allows the coin to be flipped thousands of times to show the probability of getting heads or tails. '*Penny flipper*' can show a realistic and visually interesting demonstration of a large number of trials in a short period of time. It could be used as teaching resource for Key Stage 3 Mathematics to show that the probability will not always be exactly 0.5 but the more trials the closer the probability will be to 0.5.



The project titled '*probability*' by '*jboyler*' is a probability project designed for students

*"to illustrate that larger sample sizes lead to more accurate results when determining the experimental probability of an event."*

*([www.scratch.mit.edu/projects/jboyer/346863](http://www.scratch.mit.edu/projects/jboyer/346863))*

The screenshot displays a Scratch project titled "bag probability". The stage features a black bag icon, a text box with the question "There are 8 chips in the bag. Can you figure out how many green chips there are?", and two buttons labeled "Draw" and "Guess". Above the text, four monitors show the counts for "Red Chips Drawn", "Total Chips Drawn", "Yellow Chips Drawn", and "Green Chips Drawn", all currently at 0.

The code on the left is organized into four event-driven blocks:

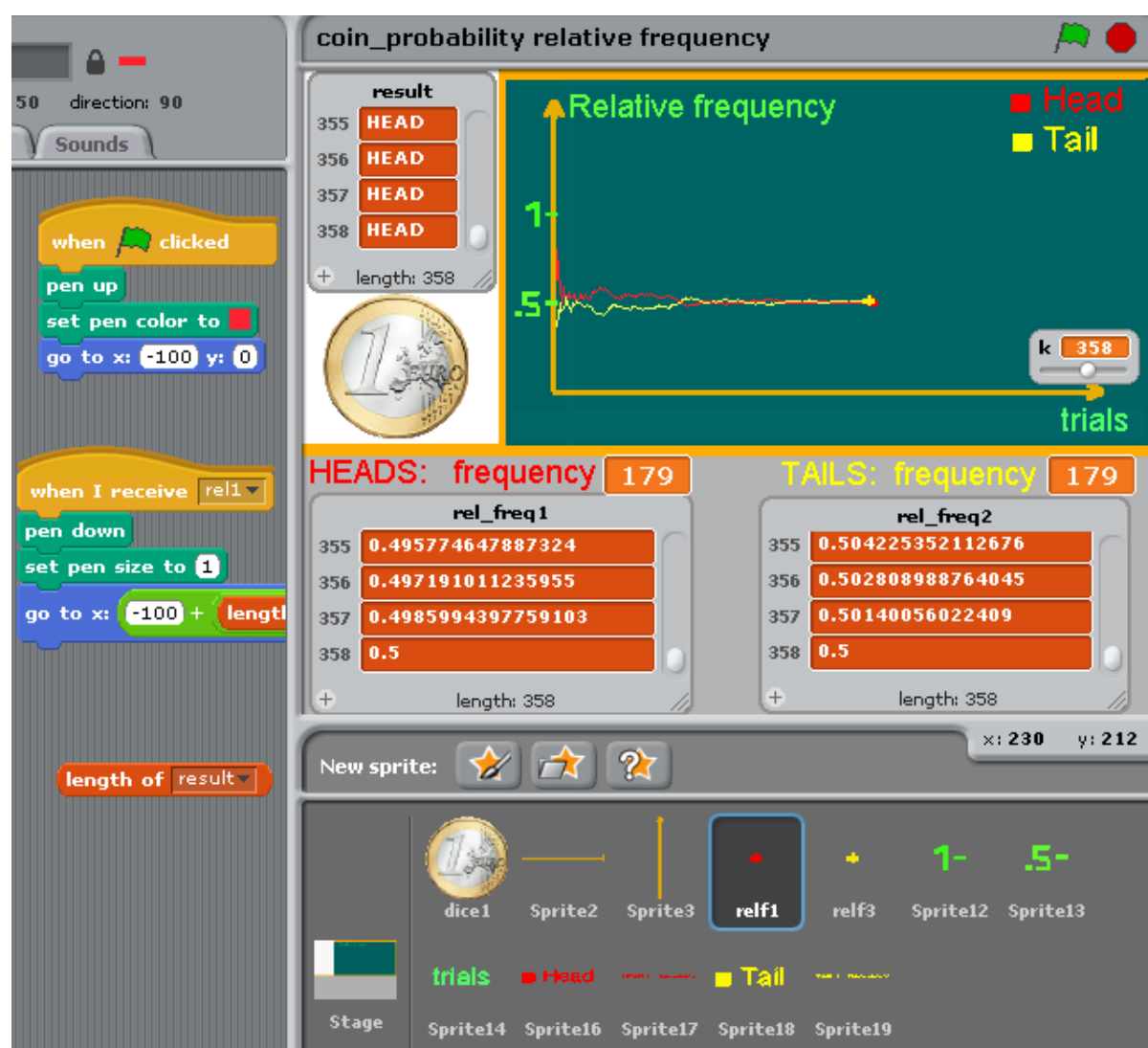
- when Sprite1 clicked:** broadcasts "Wrong", then plays a note (48 for 1 beats).
- when I receive Wrong:** hides the sprite.
- when I receive start:** hides the sprite.
- when I receive All hide:** shows the sprite.
- when I receive Win:** hides the sprite.

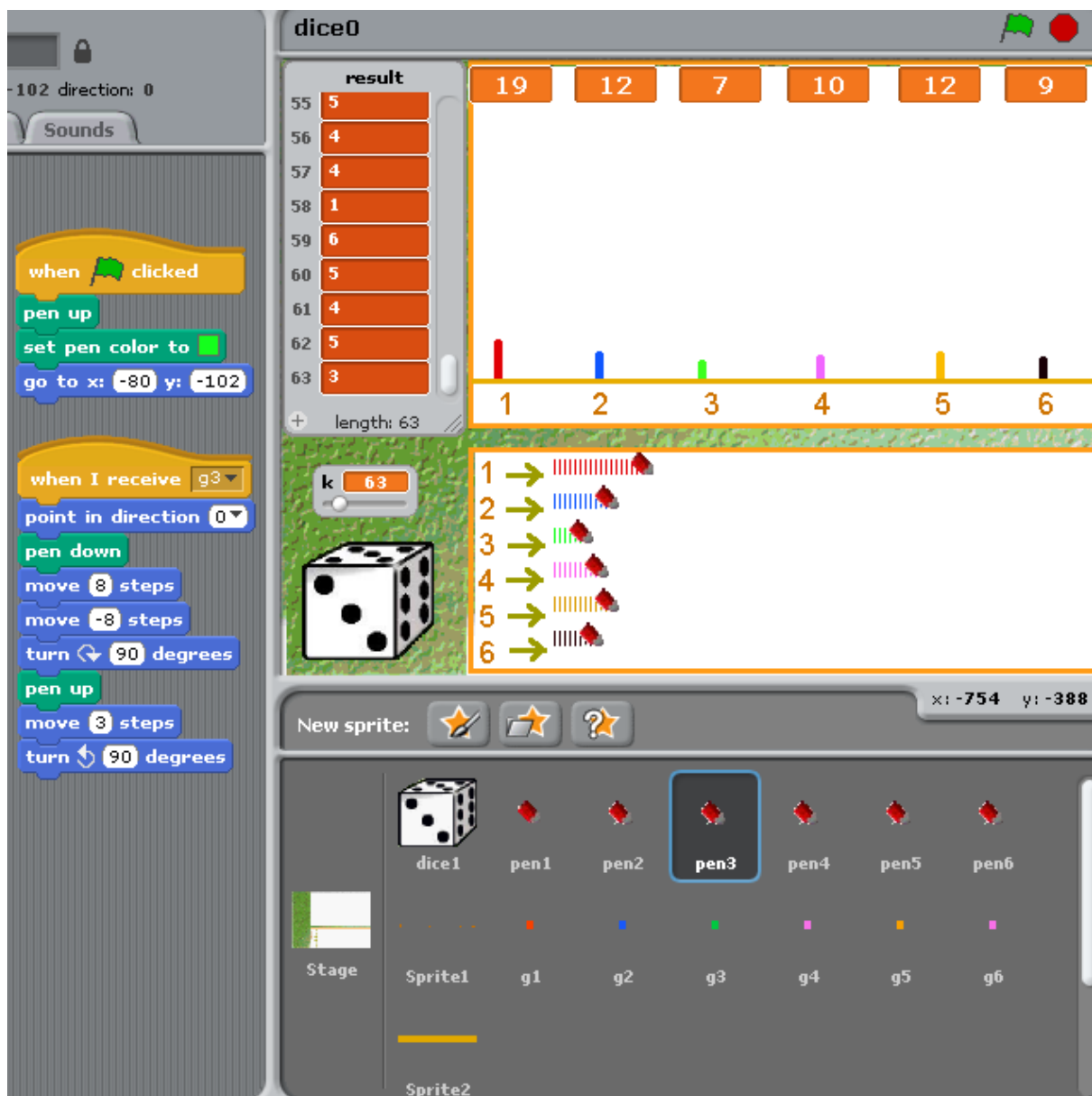
The bottom of the interface shows the "New sprite:" area with three icons (star, folder, question mark) and a coordinate display (x: 102, y: 156). Below this is a grid of 10 green circular buttons labeled "1" through "0", each associated with a sprite name (Sprite1 to Sprite10). The "1" button is currently selected. A "Bag" icon is also visible in the bottom left of the grid area.

*"I think that Scratch is a great program to have students use as well (as it was designed for) because it requires them to use logic and gives immediate feedback on mistakes. I think ideally I would have students create a program for their classmates to use on a topic that we are studying because that would require much greater understanding of the material than using a teacher created program".*

1 4 7 8 3 0 6 1

The Scratch user 'Dapontes' created two probability projects called "coin probability relative frequency" and "dice0". These projects display the probabilities of coin flipping and of throwing a dice. The two projects demonstrate that more trials show more accurate results in a very different way. The projects are visually very interesting and have also graphs to illustrate the results. Pupils would enjoy this interactive demonstration of probability and it would be a useful resource to teach children key stage three probability.





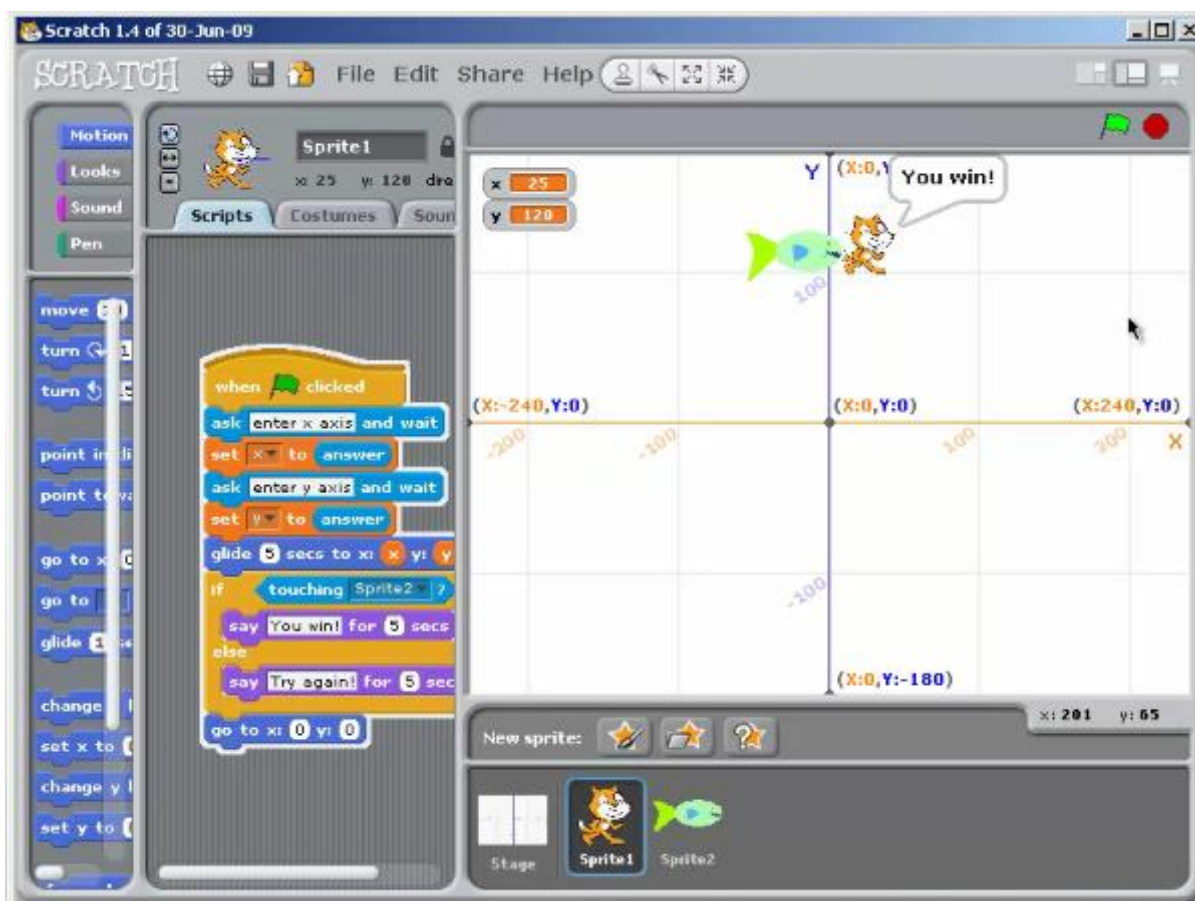
The Scratch user 'Paddle2see' created a roulette table project. This project could be used to teach probability to key stage three students in an interesting and appealing way. The pupils would also enjoy this interactive and animated resource and could discuss the probability of obtaining e.g. a red odd number, out of the thirty six numbers.



Psdbenj is a Scratch user that uploaded a seven minute video tutorial on the ScratchEd website on creating a coordinate game.

[www.screencast.com/users/psdbenj/folders/Default/media/9c3867b4-434b-4341-996b-112da9dcbe41](http://www.screencast.com/users/psdbenj/folders/Default/media/9c3867b4-434b-4341-996b-112da9dcbe41)

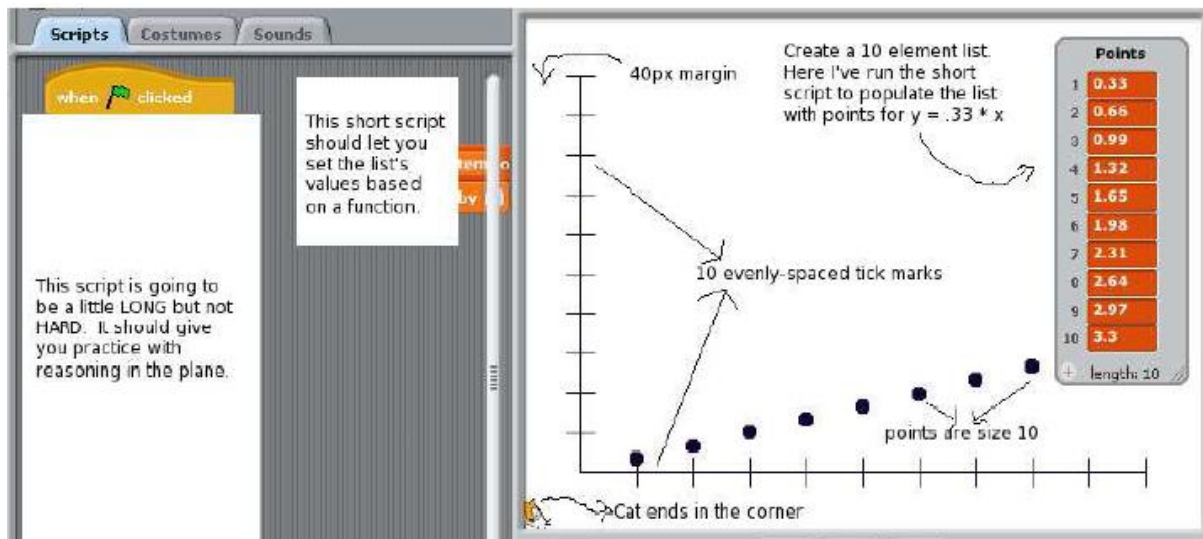
The video consists of the Scratch user creating the project and talking, exactly step by step, about how they are doing it.



The game would be a great resource to teach coordinates to key stage three pupils in a fun way using ICT. The idea of the game is for the cat to catch the fish, the fish will move to a random point on the x y coordinate plane and then find the correct coordinate values for the cat to catch the fish. If the cat catches the fish the cat says '*well done*' if the cat doesn't catch the fish it says '*try again*' and the cat returns to the starting position. This game is fun and appealing for the students, it involves estimating coordinates and the difficulty level can be easily changed by shrinking or enlarging the sprites. This game is a simple idea which the pupils could create very easily themselves using the tutorial video, or it could be used as a teaching aid to teach key stage students about coordinates.



There is also a document in ScratchEd maths resources, titled '*Assignment: Graphing with Scratch*' this is a Scratch assignment involving drawing a set of axis and plotting ten points of a function. The assignment would be beneficial for teaching GCSE functions and graphs. It is well detailed and has a list of project requirements including the size of the axis, thickness of lines etc and will require drawing a graph as illustrated below. The assignment has a rubric which is marked out of twenty with two marks for creativity. Giving only two marks for creativity for this maths assignment will help ensure the pupils focus on the mathematics rather than the design.



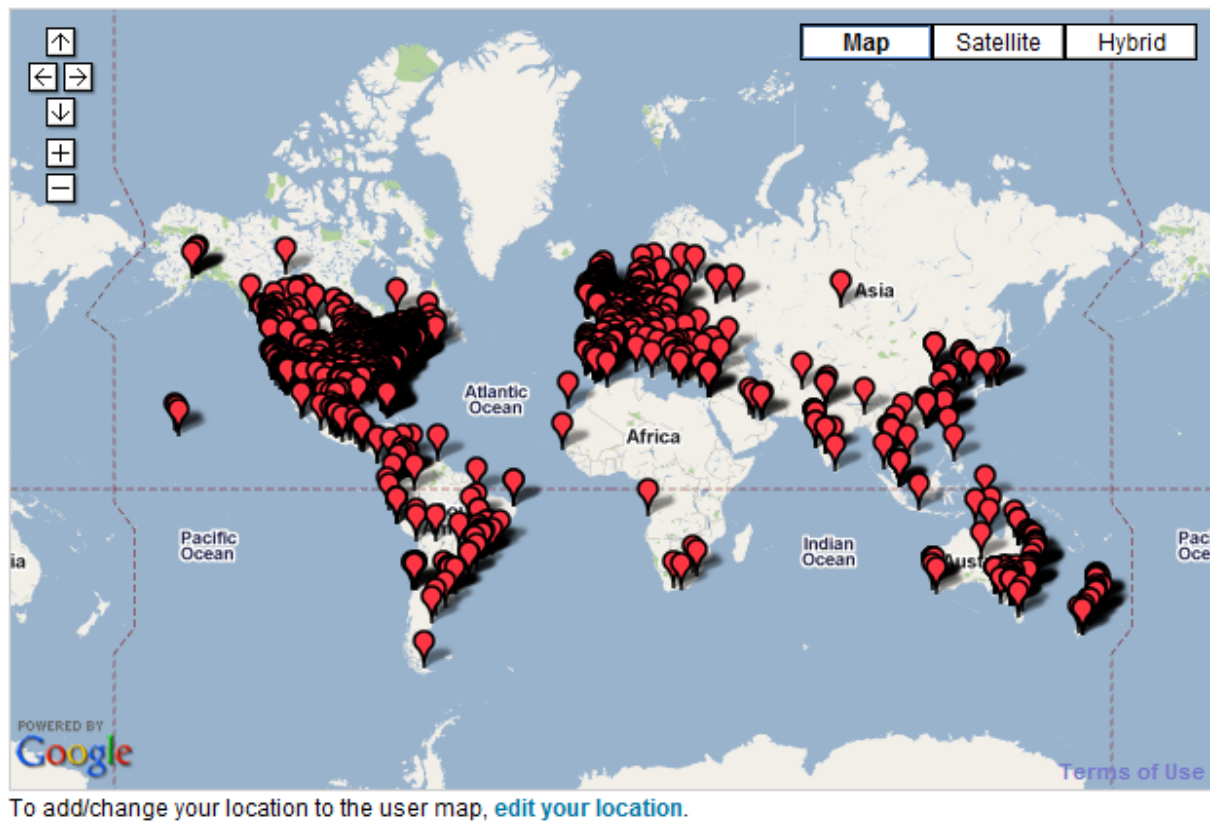
### ScratchEd Discussion Forum

The ScratchEd website has a discussion forum where other ScratchEd users can communicate with each other. The discussion forum is a way for Scratch users around the world to communicate and share ideas. The forum includes discussions titled, news and announcements, events, Scratch educator meet ups, teaching with Scratch, and researching Scratch etc. The forum is very active and helpful for contacting Scratch users and getting help with any difficulties using the program e.g. a Scratch user had a query about how to change the background when two sprites touch, Karen Brennan, a member the Scratch team created a basic project on this and sent it to the user. This is just one example of the great support network that is provided by members of the Scratch team and other Scratch users on the ScratchEd website.

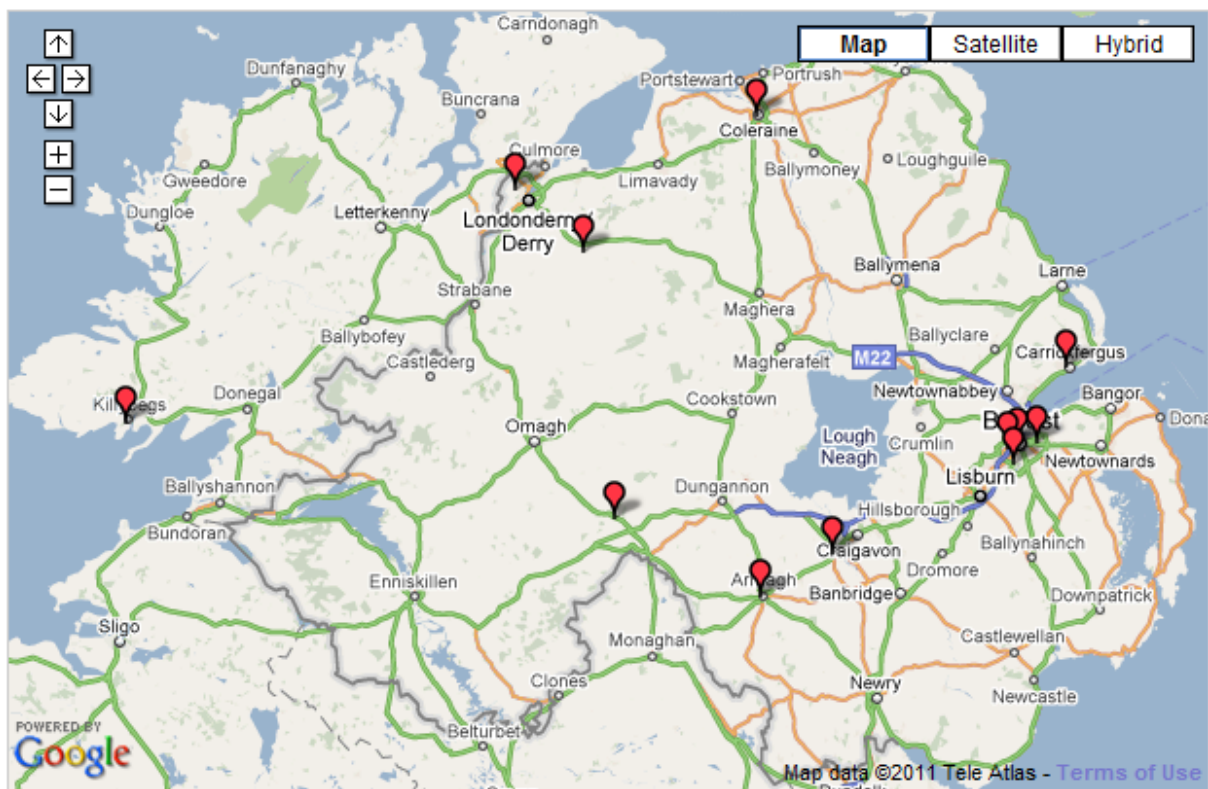
### Scratch Members

Scratch members is one of the main tabs in the ScratchEd website. This marks the locations of the Scratch users around the world with a red flag on the map. The image clearly shows the popularity of Scratch and the world wide network of ScratchEd users that are signed up.





The members maps allows you to zoom in on your own location, this allows you to see where Scratch is been used locally. By clicking on the red flag you can also enter their ScratchEd profile and send a comment. This shows the general post code area of the user, their projects and the information that was posted publicly on ScratchEd, no personal information about the ScratchEd user is given. The member's map is a useful application to get in contact with people locally that use Scratch, to develop a network of local contacts, communicate about Scratch with people that may be using it in a similar way and share feedback and ideas.



To add/change your location to the user map, [edit your location](#).

The Scratch members map is a way to develop and expand the Scratch community so users can help each other and work together to explore the vast capabilities of the program. Scratch Day is another way to speak with Scratch users to share ideas and experiences.

### **Scratch Day**

*"Scratch Day is a worldwide network of gatherings, where people come together to meet other Scratchers, share projects and experiences, and learn more about Scratch. There are currently 47 events in 24 countries."*

*(<http://day.scratch.mit.edu>)*

There has been a Scratch Day in Dublin every year since 2009, organised by Stephen Howell a lecturer in computer Science in the institute of Technology in Tallaght Dublin. Scratch Day is a great idea to bring people together to demonstrate their ideas and to show people that are new to Scratch the range of capabilities.

*You can plan many different types of activities for Scratch Day. For example, you could organize hands-on workshops to introduce newcomers to Scratch, exhibitions to showcase projects by local Scratchers, sessions where educators share Scratch experiences, informal gatherings where Scratchers can share ideas."*

*( <http://day.scratch.mit.edu>)*

There are a number of short promotional videos available on the Scratch and the ScratchEd website showing previous Scratch days and explaining the purpose of the day. Scratch Day would be a great event for pupils and teachers, to have fun with Scratch, organise fun activities and collaborate with other pupils locally that are using Scratch. Pupils would also be given an opportunity to showcase their Scratch projects and see the vast range of projects that are created with Scratch. A Scratch Day in Northern Ireland would also be useful for teachers to see how Scratch can be integrated into the Northern Ireland Curriculum.

### **Teaching with Scratch**

Stamati Crook (2009) carried out a study into embedding Scratch into the UK curriculum.

*[www.scratched.media.mit.edu/resources/embedding-scratch-classroom](http://www.scratched.media.mit.edu/resources/embedding-scratch-classroom)*

Crook examines the teaching with Scratch to twenty three children aged between seven and eight that worked together to create projects. The study found that the pupils really enjoyed the lesson and looked forward to using Scratch every week. Initially some of the pupils complained that other pairs were copying work until the teacher explained that sharing knowledge of programming techniques was a part of the process. Crook found that,

*"Both boys and girls liked Scratch although boys were more drawn to creating games. Some of the pupils preferred the creative process of drawing and creating sprites and had to be encouraged to get on with the task of programming, but all completed their tasks."*

*(<http://scratched.media.mit.edu/sites/default/files/Scratch%20in%20the%20Classroom-10.pdf>)*

Teachers are required to spend considerable effort preparing Scratch based lessons plans and also to ensure that they had the programming knowledge to keep up with the more advanced young programmers who were working on their projects at home. The study by Cook (2009) also found the interest of the other school teachers to be low and that it seemed unlikely that the other teachers in the school were willing to adopt Scratch in the immediate future. However,

*"Teachers and educational establishments need access to the resources and training required to give teachers the experience and confidence to incorporate Scratch into their lessons plans into ICT and other topics of the curriculum."*

*([www.scratched.media.mit.edu/sites/default/files/Scratch%20in%20the%20Classroom-10.pdf](http://www.scratched.media.mit.edu/sites/default/files/Scratch%20in%20the%20Classroom-10.pdf))*

## **Methodology**

### **Methods of Research**

Cohen et al (2007) refers to the three methods of research, qualitative, quantitative and action research. In the research I chose qualitative and action research as the preferred methods. Qualitative research involves processes such as interviews and observations, where the information is spoken, written or observed, while action research involves learning by doing. For this study action research involved, creating Scratch projects and using Scratch in key stage three maths lessons. The qualitative research methods of observing the Scratch forums, evaluating Scratch projects uploaded on Scratch website and interviewing experienced Scratch users.

### **Interviews**

*"The interview is a flexible tool for data collection, enabling multi-sensory channels to be used: verbal, non verbal, spoken and heard. The order of the interview can still be controlled while still giving space for spontaneity."*

*(Cohen et al, 2007, p.349)*

There are several types of interviews that may be used in research, structured interviews, semi-structured interviews and unstructured interviews. I chose to use

semi-structured interviews as I had a clear list of issues to be addressed and questions to be answered.

*“With the semi-structured interview the interviewer is prepared to be flexible on terms of the order in which the topics are considered.”*

*(Denscombe, 2007 P 176)*

The semi-structured interviews were carried out over *Skype* with experienced Scratch users in various different countries around the world. A list of questions was typed up and emailed to the interviewees a few days in advance [Appendix A]. This was so they would have a better idea of the types of questions that would be asked and have time to prepare a full and detailed response.

### **Teaching Experience of Scratch**

The research of this study also included the implementation of Scratch as a teaching aid in teaching key stage three mathematics. This was permitted by the senior staff of the school and involved teaching angles and shape properties to year 8 pupils. Scratch was used in three forty minutes lessons educating pupils with no previous experience of the program. The study required creating maths based Scratch projects analysing the process, ease of use and reflecting on the math thinking skills involved as well as how it can be used to teach key stage three mathematics.

### **Signing up to Scratch**

In the study research I was required to sign up to Scratch and ScratchEd, analysing maths based projects already created, reading documentation, participating in the Scratch forums and generally contributing to the Scratch online community. The focus is on reflecting on the all round features available to a Scratch user regarding development of maths thinking skills.

### **Questionnaires**

Questionnaires were not used as a part of the study for a number of reasons. Firstly there was an increased possibility of having a low response rate and secondly, there are a limited number of suitable contacts locally that could have benefited the study by completing questionnaires.

## **Results**

### **Overview**

The study will now look at the information gathered in the research about Scratch and how it can be used with key stage three students to develop mathematical thinking skills. This will involve examining these projects uploaded by other Scratch users and evaluating the maths involved in creating maths based projects.

Karen Randall (*room209*) is an experienced Scratch user and has experience in using Scratch to teach mathematics in an elementary school. Karen states that,

*"Scratch is full of potential for using the maths we were studying to solve interesting problems."*

*(<http://ScratchEd.media.mit.edu/stories/Scratch-pre-algebra-class>)*

### **Creating with Scratch**

Creating with Scratch firstly involves coming up with a concept and idea before creating the project. The user can create a template or prototype to begin with and experiment with it. The project can then be shared with other Scratch users on the website where comments, feedback and ideas can be left to develop it further, or again downloading it or modifying it themselves. This can also be a useful exercise in the classroom, students can collaborate ideas and work together to create group projects. The students could first decide on an idea or concept idea, each person in the group could be given a different role e.g. creating background (stage). They can all be given a basic prototype and they can individually develop it by adding their own ideas and media. Sharing resources can also be a great way to get to know other Scratch users that are creating similar projects.

*"The Web site has become a bustling online community. Members are constantly asking questions, giving advice, and modifying one another's projects."*

*([www.web.media.mit.edu/~mres/papers/Learning-Leading-final.pdf](http://www.web.media.mit.edu/~mres/papers/Learning-Leading-final.pdf))*

## **Scratch Community**

The Scratch Community is friendly, cooperative and expanding all the time. When looking at the Scratch forum, comments on projects and speaking with experienced Scratch users I was very impressed at how enthusiastic and helpful the Scratch users were. Scratch users are keen to share their new and innovative ways to use the program and a number of other teachers that had seen and heard about Scratch in the school I carried out my research were very eager to learn more about it. These teachers felt the program had a lot of potential in education and asked me to explain the program and demonstrate its capabilities.

*"People interact with digital media all the time, few are able to create their own games, animations or simulations. It's as if they can read but can't write."*

*(<http://web.media.mit.edu/~mres/papers/Scratch-CACM-final.pdf>)*

## **Fluency with Scratch**

Creating projects with Scratch helps novice programmers develop a deeper level of fluency with digital technology, this means not only knowing how to work with computers but how to write with them. There are many resources and programs available today, many varieties of interactive media's but few that are suitable for novice programmers to create with.

*"These programs are one way street: You can only browse and click what others have created; you can't design and create your own."*

*([www.info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Creating-with-Scratch.pdf](http://www.info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Creating-with-Scratch.pdf))*

Computers and technology are becoming increasingly popular in today's society, in education, recreation, work and socially. Learning to program will enable Scratch users to understand the workings of the technologies that they encounter in everyday life and develop the skills required to create them. Scratch makes combining interactive creations easier for inexperienced programmers. It will give the users an opportunity to express themselves creatively in creating interactive projects and to think clearly and logically to create them.



As stated by Mitchel Resnick, Professor of Learning Research at the MIT Media Lab and head of the Scratch development team.

*“Our feeling is that it’s especially important for young people to have the opportunity to design, create and express themselves with new interactive media technologies — not just to view these things, but to create them and interact with them. We think it should be open to as many people as possible, and we’re interested in finding ways for people to design and share interactive media on all types of platforms.”*

*(<http://web.mit.edu/newsoffice/2010/3q-resnick-scratch-0428.html>)*

### **Teaching with Scratch**

Scratch can be used in many different ways to teach key stage three mathematics. In my experience of using Scratch in a secondary school with a year 8 maths lesson I focused on the topics of angles and shapes. I firstly gave a demonstration of the features of Scratch and showed some examples of Scratch projects. The pupils were very excited about working with the program as it was very appealing to them. I then set the pupils a simple task to draw a basic polygon. Most of the pupils worked well and drew the shapes as instructed. This involved using their previous knowledge of angles and properties of polygons. There are also a number of ‘*show and tell*’ videos available on ScratchEd to help new Scratch users become familiar with the program this could have also been used to demonstrate the features to the pupils.

In an interview with Karen Randall, Karen mentioned that there are some pupils that can work and discover things for themselves on the program and others that need more assistance and guidance. I also found this to be the case. Some pupils will take to the program very well, thinking for themselves, solving problems. Others will need more guidance and support, e.g. asking for help when they are having problems with the script. The pupils should be encouraged to think for themselves to solve errors in the script, it will help the pupils to understand the logic and sequencing of the program. Encouraging the pupils to sign up to Scratch and use Scratch at home, even if it is experimenting, would leave it much easier to start using it in lessons as they will be more familiar with how to use the features and do the basics.



*"There is a buzz in the room when the kids get going on Scratch projects. Students set design goals for their projects and problem-solve to fix program bugs. They collaborate, cooperate, and co-teach. They appreciate the power that Scratch gives them to create their own versions of games and animations."*

*(<http://web.media.mit.edu/~mres/papers/Learning-Leading-final.pdf>)*

### Scratch Assignments and Presentations

Scratch has potential to be the innovative and interactive replacement for the traditional assignments and presentations that students complete in school.

*"In classrooms, students have begun to use Scratch to create reports and presentations—replacing traditional PowerPoint presentations with content that is far more dynamic and interactive."*

*([www.web.media.mit.edu/~mres/papers/Learning-Leading-final.pdf](http://www.web.media.mit.edu/~mres/papers/Learning-Leading-final.pdf))*

### Scratch as a Unit

Pupils could create Scratch games as a unit. There are many great examples and pre-designed units available on the Scratch website and on Scratch Ed that are effective in developing mathematical thinking skills of key stage three pupils. Patrick Woessner designed a six day unit for 7th grade students to create a game with a grading rubric included. There are a few similar units including the greenfoot programming unit.

*[www.Scratched.media.mit.edu/stories/using-picoboards-and-Scratch-students-alternate-input-devices](http://www.Scratched.media.mit.edu/stories/using-picoboards-and-Scratch-students-alternate-input-devices).*

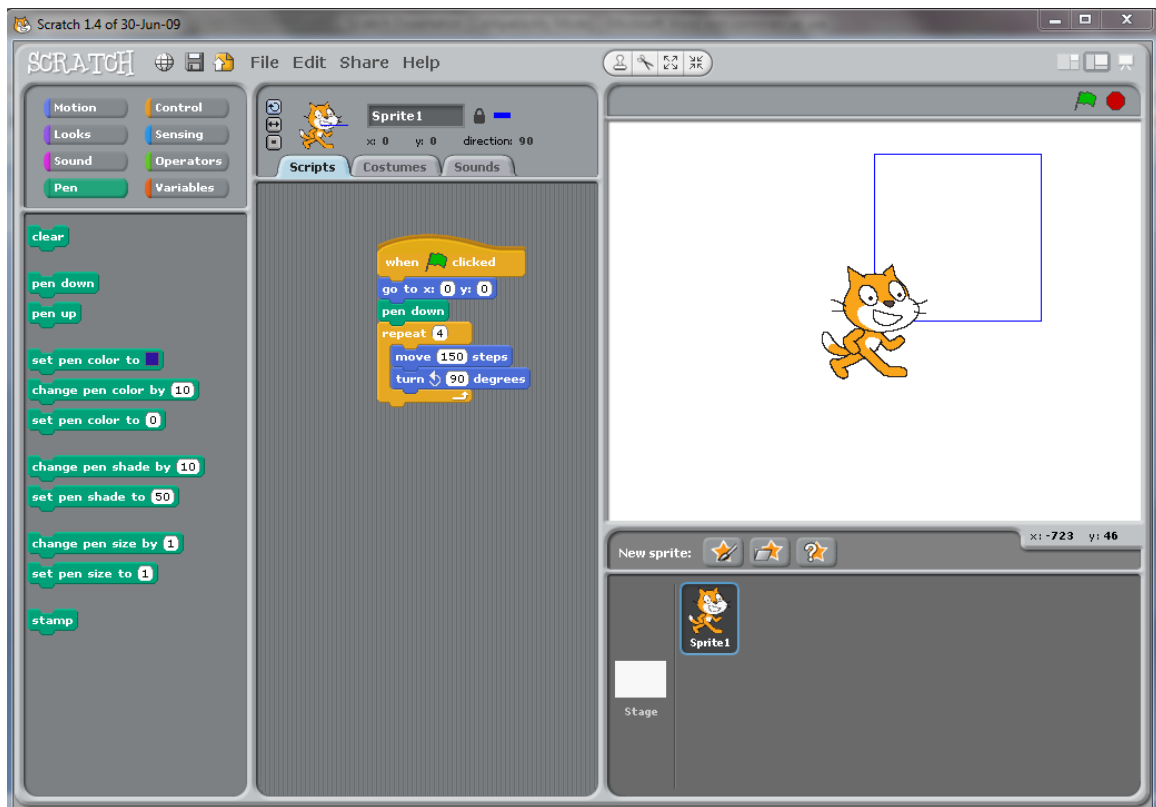
This unit gives step by step 'phases' to create one of the traditional asteroid games. This method is more interactive and would be a welcomed change from the traditional PowerPoint's and assignments.

*"In order to do things like map a slider control to drive a sprite around the screen or a paddle in game or a rocket ship flying around the screen and shooting asteroids, students need to be able to use variables and describe processes like turning, moving, changing direction and increasing or decreasing momentum, drawing a circle using trig functions and so on. The motivation for mastering these concepts is to enable making a better game or story or scenario."*

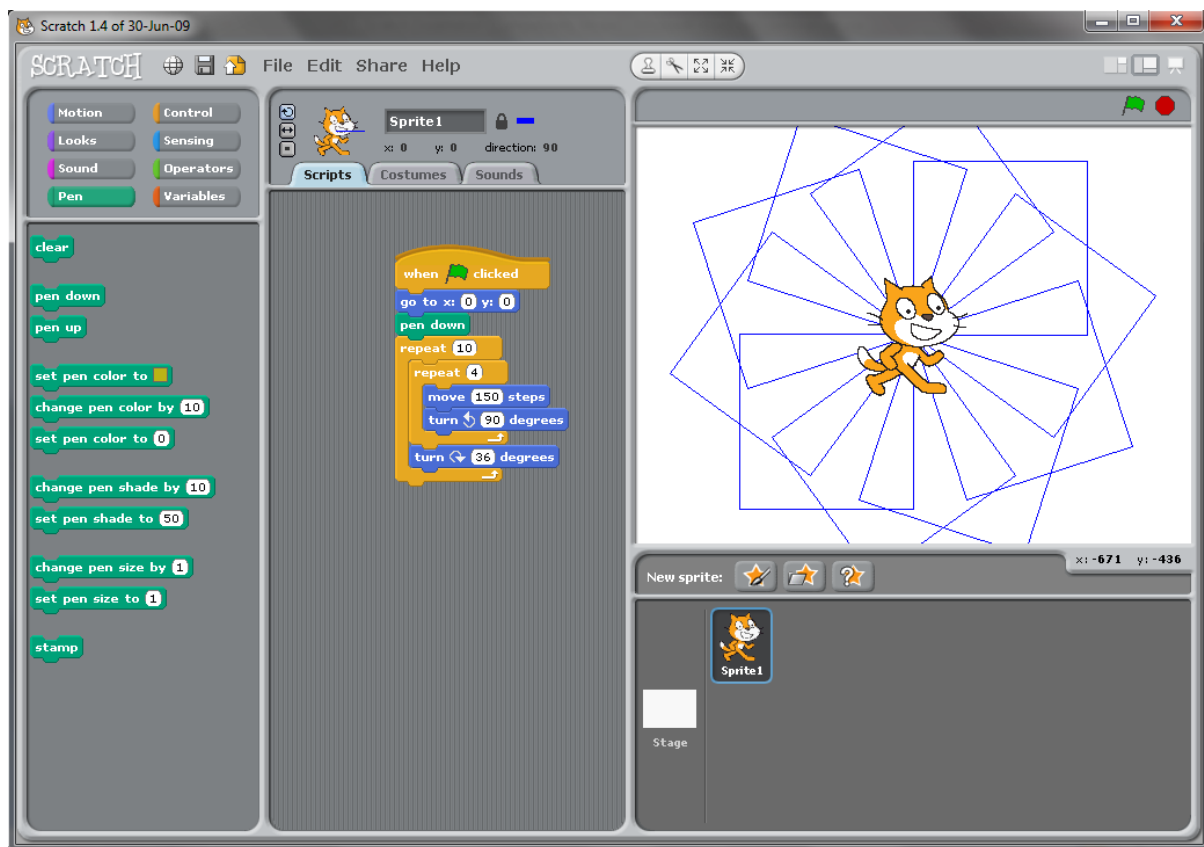
*([www.Scratched.media.mit.edu/sites/default/files/Scratch2Greenfoot01.pdf](http://www.Scratched.media.mit.edu/sites/default/files/Scratch2Greenfoot01.pdf))*

## Shape and Angles

Scratch can be used to teach students about shapes and angles. For a student to draw a simple shape on Scratch, such as a square, begins with choosing a starting coordinate. The student must then decide on the dimensions of the squares and angles of the turns to draw a complete shape. This requires the mathematical knowledge of the shape to be in place, the size of the angles and the relationship of the length and breadth. If the first attempt to draw the shape was not successful the student must use their problem solving skills to correct the error, e.g. if the shape was too small, alter the values appropriately to draw it at a better scale. Students can also use the repeat function of Scratch to draw the shape and to shorten the script. They then must think about how many repeats it will take to complete the shape.



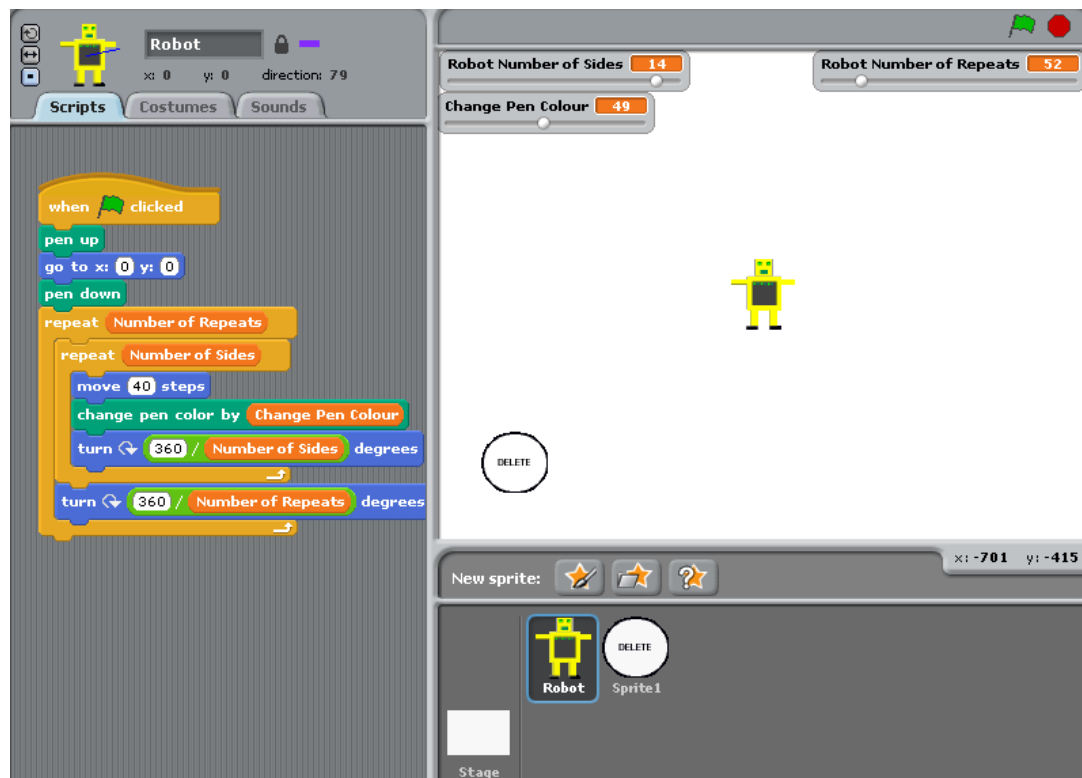
The pupils can then use this basic shape to create more fun and elaborate shapes and patterns, simply by adding to the script.



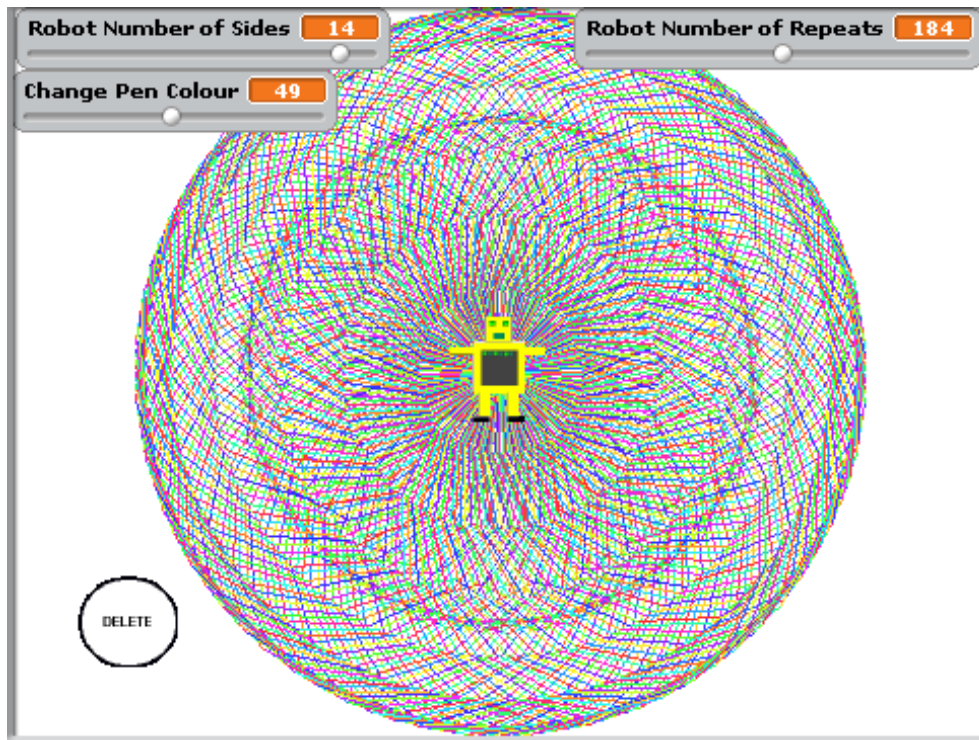
This pattern above is created from using the repeat function of the original square and involves further mathematical thinking. By commanding the sprite to turn clockwise 36 degrees, how many repetitions will be needed to bring the sprite back to the starting point again? The students must then use their knowledge of angles to work out a complete circle is 360 degrees so moving 36 degrees 10 times will bring the sprite back to the starting point, the origin. This would be a fun way to help pupils understand the angles and sides of the different polygons. Pupils can then experiment with different shapes and then use their knowledge of the polygon and angles in a full turn to create different patterns. This basic concept can be expanded and developed depending on the working level the pupils. The students can add different sprites and backgrounds, patterns containing different colours and also with more than one type of shape. They can also construct images using different polygons i.e. house or car etc.

The variables function on Scratch can be used to create shapes and patterns. When the pupils have knowledge of how to draw polygons and create these patterns they can

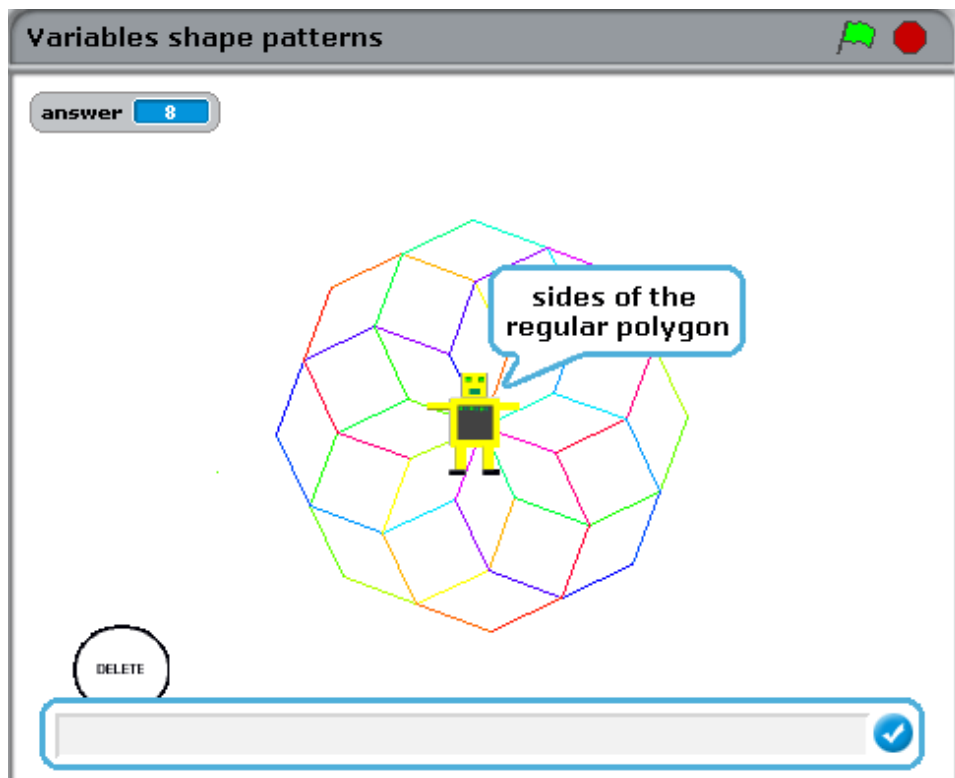
design a project with variables to change the values for the number of sides, number of repeats of the pattern and colour change.



The project which I created contains variables for the number of sides of the shape, number of repeats and also to change the colour of the pen to make it visually appealing. I set the variable displays to sliders so they can be dragged to change the values. This way it is easier to create more patterns and also combine the patterns to create some interesting affects e.g.



Creating the project involved a significant amount of mathematical thinking. The original shape was created by moving 40 steps and turning clockwise at an angle of  $360^\circ$  divided by the number of sides. The “*number of repeats*” variable was created by turning the shape clockwise with an angle of  $360^\circ$  divided by the number of repeats using the divider operator and the colour changes after every 40 steps moved when drawing the shape. This project can also be created using the ask command e.g.



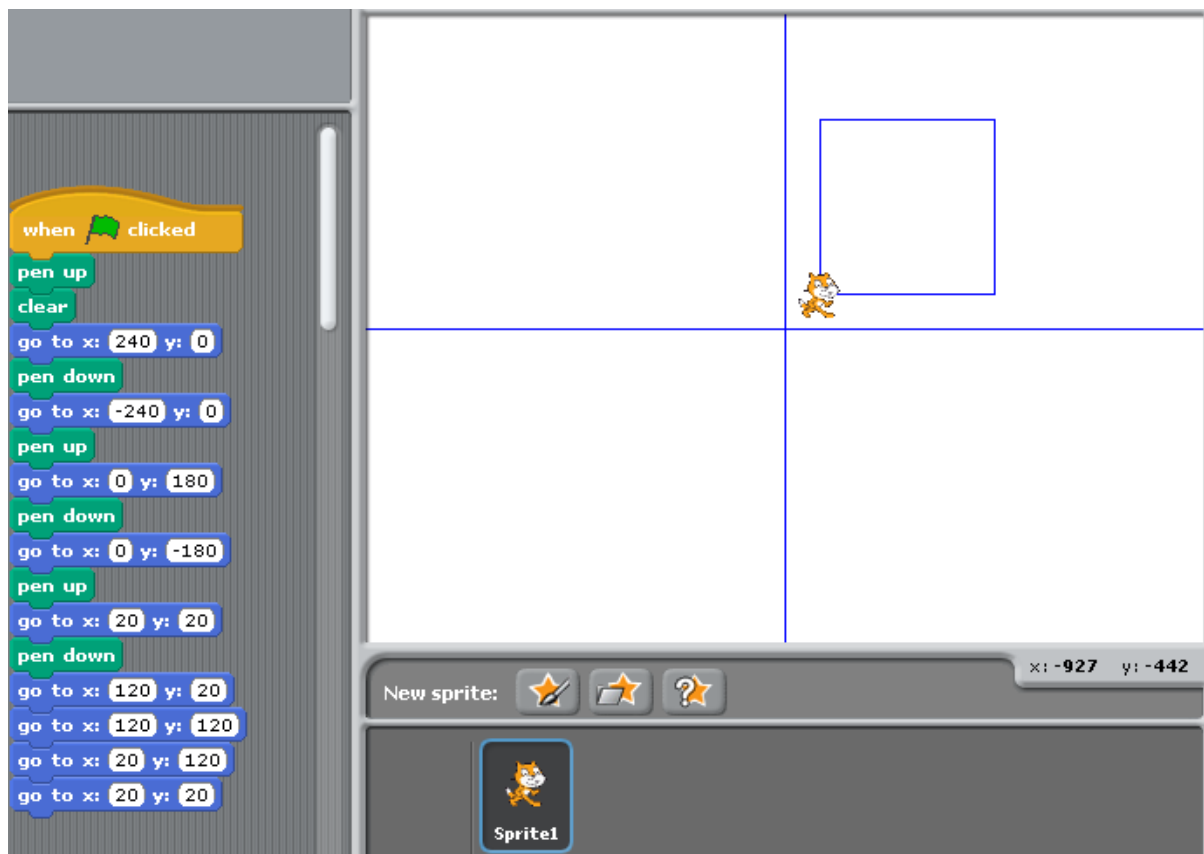
This idea of drawing shapes is a fun and interactive way to teach shape and angles at key stage three linking ICT and Maths. Creating the project with variables involves basic algebra. The pupils could first discuss and discover the formula for the internal angles of a regular polygon and then combine this with their knowledge of writing with Scratch to create the script with variables.

### Translations, Reflections and Transformations

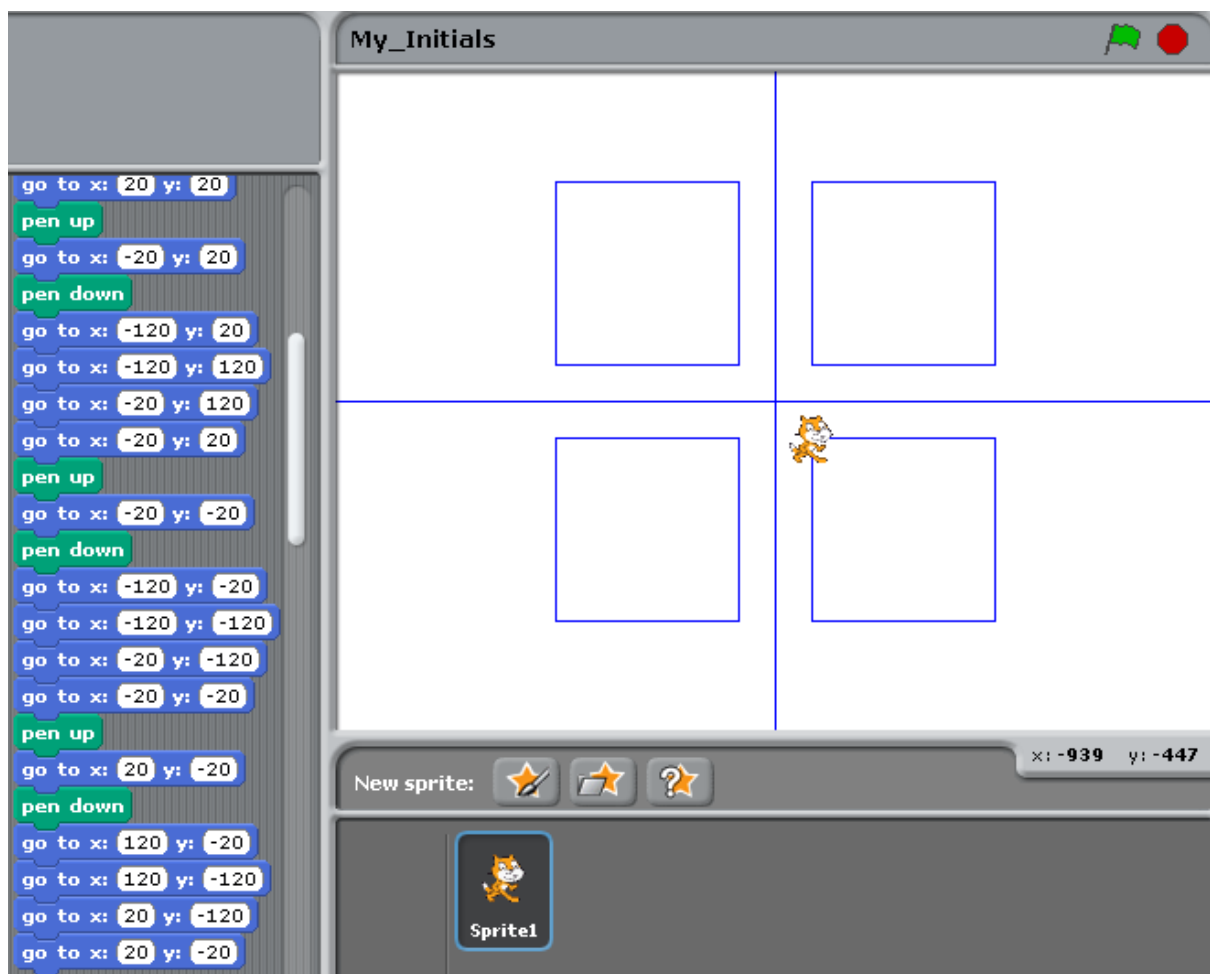
Scratch can also be useful to illustrate translations, reflections and transformations similar to Karen Randall's *'My Initials'* project,

[www.Scratch.mit.edu/projects/room209/321638](http://www.Scratch.mit.edu/projects/room209/321638).

From drawing a basic shape in the first quadrant and a basic x and y axis, students can then illustrate the symmetries of the shape in the remaining quadrants. This develops the pupil's knowledge of various aspects of mathematics including symmetry, coordinates and arithmetic of positive and negative numbers. The students must draw the image in the first quadrant using the *'pen down'* operation and their knowledge of coordinates.



The next step is to calculate the coordinate points in the next quadrants. The starting coordinates and the shape itself can be changed depending on the ability of the class. In this basic example I started with a square at (20, 20) but this can be more challenging by starting with a more complicated shape and beginning from a starting point where the x and y coordinates are different. When drawing the reflections the students are required to use their mathematical thinking skills to calculate the coordinate points of the shape in the remaining quadrants.



## Enlargement

Scratch can also be used to illustrate transformation and enlargements. I found a resource titled '*Ally's scale factor project*' on the Scratch website.

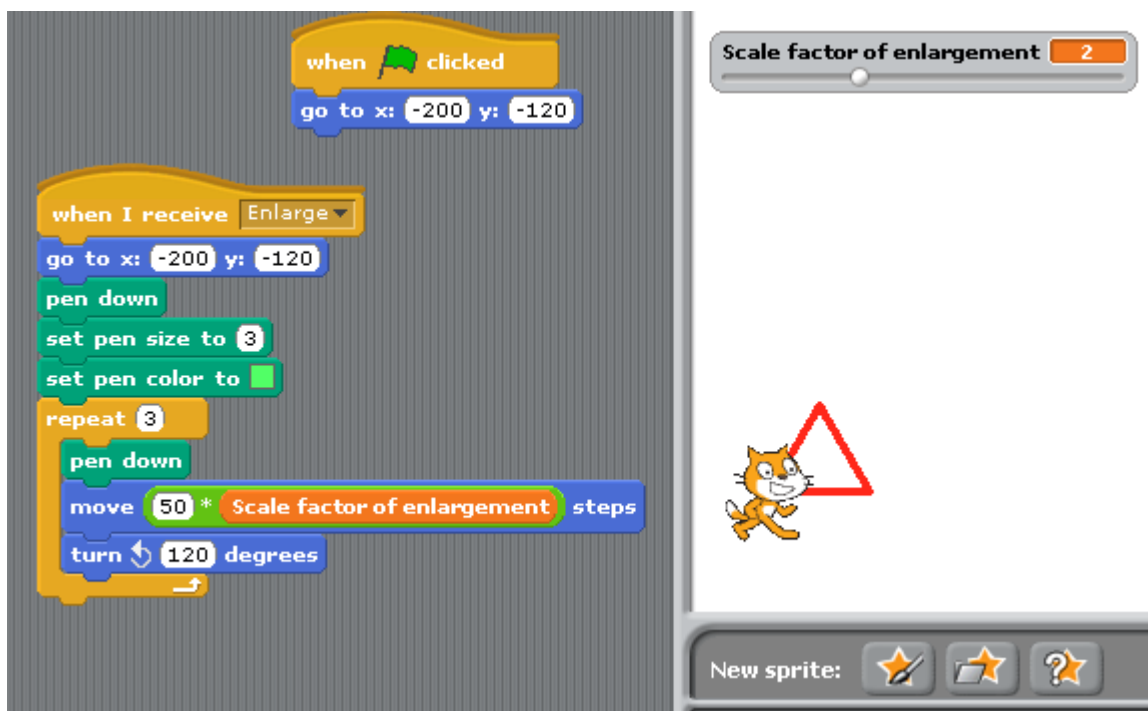
[www.Scratch.mit.edu/projects/ExpoSchool/867742](http://www.Scratch.mit.edu/projects/ExpoSchool/867742)

I used the idea of this project to create a resource on enlargement. I downloaded the project to learn how it was created and then went and created a remix. This resource can be used in two ways, the pupils can create the Scratch project, or it can be used as a teaching aid in the classroom.



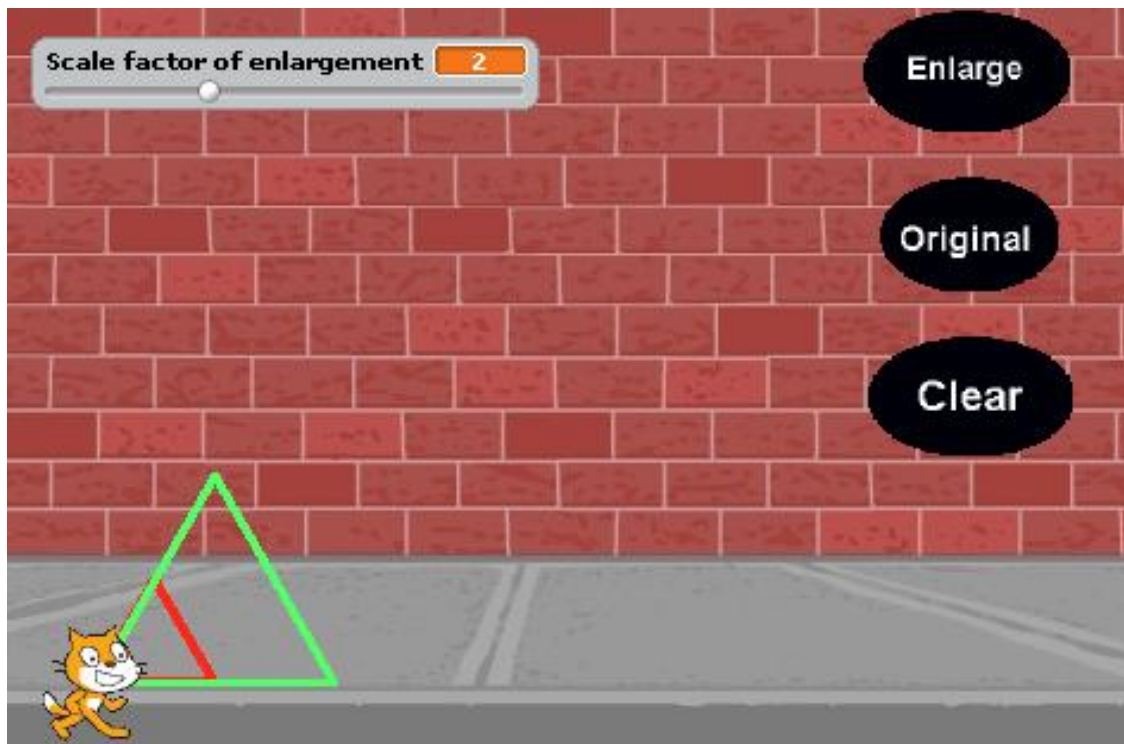


The first step of creating the resource is to decide on the original shape. In this case I have chosen an equilateral triangle. I changed the thickness of the line and colour so it would be easier to distinguish. The next step is to create an enlargement sprite.



To create the enlargement sprite I simply duplicated the original sprite script and modified the colour and added a variable slider. To add the variable slider I dragged the multiplication operator and inserted the scale factor variable into the multiplication.

For students to complete the step in creating the project they must understand that with enlargement it is the length of the sides of the original multiplied by a scale of enlargement, the angles remain unchanged. I clicked on the '*scale factor of enlargement*' image on the stage to display a slider and then set the limit to six, as it was the largest that would fit on the stage. I then created other sprites to link the scripts and changed the background of the stage so it would look more appealing for students.



Linking the original and enlargement scripts to their respective buttons requires clear and logical thinking of how the script should run and how to use the control operations. The project should run so that at the beginning the original and enlargement sprites begin at the same point and only move when the appropriate buttons are pressed. Adding the control buttons to the project may result in errors, however mathematical and computational skills are then required to identify the problem, evaluate and resolve it so it would run smoothly. The project can be used for illustrating enlargement to a class in an appealing and interactive way, using the interactive whiteboard or data projector. The project clearly illustrates that with the enlargement scale of two, each side of the triangle has doubled.

## Project Feedback

I uploaded this project onto the Scratch website and another Scratch user commented on it saying;

*"Nice job! I am thinking of doing something similar but for teaching elementary logic :) I think it might be useful (for people using this to learn on their own) to add that when e.g. the scale factor says '2', the triangle produced is actually 4 times larger. So although each side has been enlarged by scale factor 2, as it is a two-dimensional shape, the actual triangle produced is scaled up by 4 (the area of 'scale factor 2' triangle is 4 times larger than 'original' triangle)."*

*([www.Scratch.mit.edu/projects/steveo\\_101/1564783](http://www.Scratch.mit.edu/projects/steveo_101/1564783))*

This feedback was encouraging and gave me the idea to enhance my project to show how doubling the scale factor increases the area of the shape four times. It is also a small example of, what I found to be, a very cooperative, helpful and encouraging Scratch community of users. I have been in contact with a number of other Scratch users and I was amazed at the enthusiasm and willingness to help that I received. It is also clear to see when browsing the projects the positive and often helpful comments that are posted and the friends that are made between Scratch users all over the world.

## Games with Scratch

From teaching key stage three mathematics it is clear that students enjoy these maths based games. Many of these games are available on websites such as [www.mathsplayground.com](http://www.mathsplayground.com) and [www.woodlands-junior.kent.sch.uk/maths](http://www.woodlands-junior.kent.sch.uk/maths), and from observations on school experience, are being used by pupils during free time. These games are fun and entertaining for the pupils and all involve mathematical elements and thinking skills. If students created similar games themselves using Scratch they would be developing their maths and computational thinking skills and at the same time be interesting and fun activities for the pupils. Students would be motivated to improve and develop their games further, e.g. making it more advanced or interactive and in order to do this they must develop the mathematics to add variables, operators and sensors.

As stated by Daniel Green, a senior systems engineer for Sun Microsystems / Oracle Corporation in response to an email,

*“Math underlies most computer games and having the students create their own games using Scratch as a tool encourages them to better understand the related math concepts”*

## **Conclusion**

The literature and investigation in this study examined how Scratch can be used to teach key stage three mathematics. The study was aimed to consider the following research questions:

*How does Scratch promote mathematical thinking skills?*

*What ways can Scratch be used to teach key stage three mathematics?*

## **Mathematical Thinking Skills Creating with Scratch**

The research found that there is a great deal of mathematics involved when creating Scratch projects. Creating even the most basic project or sprite movement involves knowledge of different areas of mathematics and requires some form of mathematical thinking. Scratch provides a fun way for pupils to develop these skills and gives them an opportunity to create their own games, projects and animations. There may also be some competitiveness between students when creating projects to produce the best project or receive more ‘loves’ on the Scratch website, this will help encourage the pupils to improve and develop their Scratch project and as a result advance on their Scratch skills. Therefore it was found during the research that Scratch does develop mathematical thinking skills and the appeal of the program provides underlying incentive for pupils to improve their projects and consequently their mathematical thinking skills.

## **Scratch and the Northern Ireland Curriculum**

The Northern Ireland Curriculum promotes these thinking skills and,

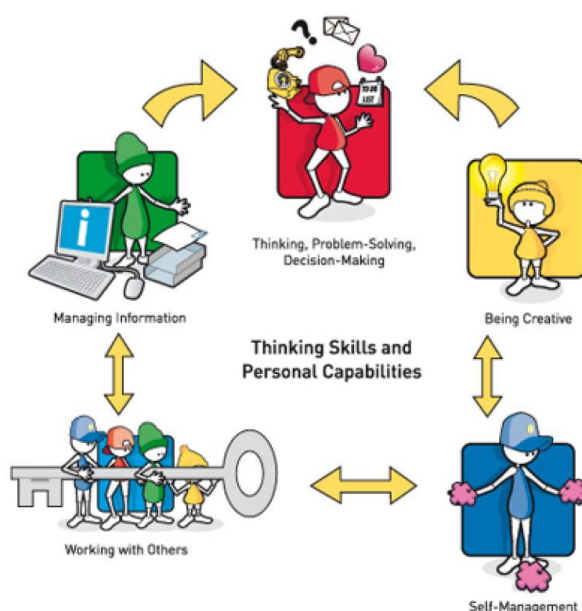
*“the creative use of technology to enhance mathematical understanding by demonstrating creative thinking in their approach to solving mathematical problems and using practical skills using technology.”*

*([http://www.nicurriculum.org.uk/docs/key\\_stage\\_3/statutory\\_requirements/ks3\\_mathematics\\_new.pdf](http://www.nicurriculum.org.uk/docs/key_stage_3/statutory_requirements/ks3_mathematics_new.pdf))*

Scratch is the ideal tool to facilitate this type of learning in the classroom. It involves the creative use of technology to develop problem solving skills and ICT skills. These skills, promoted by the Northern Ireland Curriculum and developed by Scratch, help pupils to go beyond the attainment of knowledge so they can,

*“search for meaning, apply ideas, analyse patterns and relationships, create and design something new and monitor and evaluate their progress”.*

Scratch can be used in many different ways in the classroom and has the potential to cover all five areas of the thinking skills and personal capabilities stated in the curriculum.



[http://www.nicurriculum.org.uk/docs/key\\_stage\\_3/non\\_statutory/ks3\\_mathematics\\_ns\\_guidance.pdf](http://www.nicurriculum.org.uk/docs/key_stage_3/non_statutory/ks3_mathematics_ns_guidance.pdf)

In the study I have researched the different ways to teach mathematics with Scratch e.g. part of a unit, lesson resource, an alternative method of presentations and animations, storytelling with animations, problem solving by remixing projects, collaborative projects etc.

### **Teacher Views of Scratch**

The research has revealed that many of the younger teachers are keen to learn more about Scratch and are willing to incorporate it into their teaching. In the research

school a number of teachers observed some lessons that I taught with Scratch and others heard I was using the program and wanted me to talk them through its capabilities. These teachers recognised the potential Scratch has in education and were enthusiastic to learn about it. However, I also found that some of the other teachers were unaware of Scratch and its potential or felt it required too much effort learning the program and spending the extra time planning the lessons. All teachers of mathematics would benefit from receiving training in how to use Scratch and integrate it into the Northern Ireland Curriculum. The teachers will learn how to use it and see the vast range of resources available. It may also be an idea to have Scratch integrated into the student teacher course so that newly qualified teachers are familiar with the program and will be more confident to teach with it.

Scratch is an innovative teaching resource that helps develop important thinking skills that are promoted by the Northern Ireland Curriculum. Creating a Scratch project involves mathematical thinking, problem solving, sequencing and logical thinking, it also requires more complex thinking skills the more the competence to improve projects. Key stage three pupils are enthusiastic about using Scratch and are motivated to improve their thinking skills in order to enhance their Scratch projects. There are also a vast range of resources and Scratch projects designed by educators to teach various different aspects of mathematics. These Scratch resources are constantly growing and are readily available to anyone.



## **Websites**

### **Scratch Website links**

[\*\(www.day.scratch.mit.edu\)\*](http://www.day.scratch.mit.edu)

[\*\(www.info.scratch.mit.edu/About\\_Scratch\).\*](http://www.info.scratch.mit.edu/About_Scratch)

[\*\(www.info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Creating-with-Scratch.pdf\)\*](http://www.info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Creating-with-Scratch.pdf)

[\*\(www.info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Learning-with-Scratch.pdf\)\*](http://www.info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Learning-with-Scratch.pdf)

[\*\(www.info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Programming-with-Scratch.pdf\)\*](http://www.info.scratch.mit.edu/sites/infoscratch.media.mit.edu/docs/Programming-with-Scratch.pdf)

[\*\(www.info.scratch.mit.edu/support/Scratch\\_cards\)\*](http://www.info.scratch.mit.edu/support/Scratch_cards)

### **Mitchel Resnick Papers**

[\*\(www.media.mit.edu/~mres/papers/sigcse-08.pdf\)\*](http://www.media.mit.edu/~mres/papers/sigcse-08.pdf)

[\*\(www.media.mit.edu/~mres/scratch/scratch-cacm.pdf\)\*](http://www.media.mit.edu/~mres/scratch/scratch-cacm.pdf)

[\*\(www.media.mit.edu/~mres/scratch/scratch-cacm.pdf\)\*](http://www.media.mit.edu/~mres/scratch/scratch-cacm.pdf)

[\*\(www.media.mit.edu/about/faq#what\)\*](http://www.media.mit.edu/about/faq#what)

[\*\(http://web.media.mit.edu/~mres/papers/CHI-programming-panel.pdf\).\*](http://web.media.mit.edu/~mres/papers/CHI-programming-panel.pdf)

[\*\(http://web.media.mit.edu/~mres/papers/Learning-Leading-final.pdf\)\*](http://web.media.mit.edu/~mres/papers/Learning-Leading-final.pdf)

[\*\(http://web.media.mit.edu/~mres/papers/Scratch-CACM-final.pdf\)\*](http://web.media.mit.edu/~mres/papers/Scratch-CACM-final.pdf)

[\*\(http://web.mit.edu/newsoffice/2010/3q-resnick-scratch-0428.html\)\*](http://web.mit.edu/newsoffice/2010/3q-resnick-scratch-0428.html)

### **Scratch Projects**

[\*\(http://Scratch.mit.edu/projects/ExpoSchool/867742\)\*](http://Scratch.mit.edu/projects/ExpoSchool/867742)

[\*\(http://scratch.mit.edu/projects/jboyer/346863\)\*](http://scratch.mit.edu/projects/jboyer/346863)

[\*\(http://Scratch.mit.edu/projects/room209/321638.\*](http://Scratch.mit.edu/projects/room209/321638)



[http://Scratch.mit.edu/projects/steveo\\_101/1564783](http://Scratch.mit.edu/projects/steveo_101/1564783)

## **ScratchEd**

<http://Scratched.media.mit.edu/about>

<http://scratched.media.mit.edu/resources/embedding-scratch-classroom>

<http://scratched.media.mit.edu/resources/fractions-microworld>

<http://scratched.media.mit.edu/resources/geometry-lessons-scratch>

<http://Scratched.media.mit.edu/resources/lesson-ideas-middle-school-classrooms>

<http://scratched.media.mit.edu/resources/scratch-math-and-science-classes>

<http://scratched.media.mit.edu/sites/default/files/Scratch%20in%20the%20Classroom-10.pdf>

<http://Scratched.media.mit.edu/sites/default/files/Scratch2Greenfoot01.pdf>

<http://ScratchEd.media.mit.edu/stories/Scratch-pre-algebra-class>

<http://Scratched.media.mit.edu/stories/using-picoboard-and-Scratch-students-alternate-input-devices>

## **Other Websites**

[www.screencast.com/users/psdbenj/folders/Default/media/9c3867b4-434b-4341-996b-112da9dcbe41](http://www.screencast.com/users/psdbenj/folders/Default/media/9c3867b4-434b-4341-996b-112da9dcbe41)

[www.bbc.co.uk/northernireland/schools/pdf/NISchools\\_curriculumOverview.pdf](http://www.bbc.co.uk/northernireland/schools/pdf/NISchools_curriculumOverview.pdf)

[www.mathsnet.net/logo.html](http://www.mathsnet.net/logo.html)

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**COHEN, L, MANION, L AND MORRISON K (2007) RESEARCH METHODS IN EDUCATION; LONDON, SAGE PUBLICATIONS**

**MUIJS, D (2004) DOING QUANTITATIVE RESEARCH IN EDUCATION WITH SPSS; LONDON, SAGE**

## **Appendix A**

### **Email sent to Karen Randal before the interview**

Introduction-who you are, what you do?

Which age group do you teach?

What do you teach with scratch – programming, aspects of Maths or Science, logical thinking etc?

Is your approach teacher-led or pupil-led?

What types of projects do the pupils create?

Do they work individually, in pairs or bigger groups?

The student's response with Scratch-Do they enjoy it? Find it easy to use?

Do you feel Scratch can develop mathematical thinking skills? how?

What benefits do the pupils get from using the program – more creativity, confidence, enjoyment, collaboration?

What benefits do you see as a teacher that motivates you to continue using Scratch?

Has your teaching changed as a result?