



CALMAST



Waterford Institute of Technology
INSTITIÚID TEICNEOLAÍOCHTA PHORT LÁIRGE

STEMreach Problem Solving



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SANOFI

STEMreach Problem Solving – a handbook for industry partners, teachers and students

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About Calmast

Calmast is Waterford Institute of Technology's STEM Engagement Centre. Calmast was founded in 2003 and runs several festival and a myriad of activities in all areas of STEM, engaging more than 30,000 participants annually in the region.

The guiding spirit is "STEM for all" with particular efforts to ensure inclusion regardless of gender, socio-economic background, ability or location. In addition, Maths Ireland was founded and is run by Calmast engages over 400,000 in Ireland and Northern Ireland through Maths Week in October.

About STEMreach

STEMreach is a major STEM (science, technology, engineering, maths) initiative by Calmast. The initiative was developed to provide sustained engagement through partnership in the South-East in Ireland. STEMreach connects higher education, industry, governmental and non-governmental bodies with primary and post-primary schools and wider society and is designed to benefit educational attainment, economy and culture in the region.

STEMreach is an effective way of engaging learners with all areas of STEM. Based on peer learning, younger pupils learn from and with older students. Starting with a pilot in 2017, STEMreach was well received by teachers and students. The Calmast led initiative has quickly grown to include many different programmes with several thousand students and pupils involved annually. Each programme runs for a period of six weeks. In this time, TY (transition year) students research a particular topic in STEM. Guided by their teachers, industry partners and WIT staff, they learn about science communication and develop lesson plans and activities for 1st year students and/or primary pupils before working with their younger peers. Together, the TY students and the younger pupils further explore various STEM subjects including the STEMreach Problem Solving programme. Implemented in 2018, the STEMreach Problem Solving Programme was found to strongly encourage a positive attitude towards maths, to increase the participants' confidence in their own abilities and to develop their problem solving skills while also promoting creativity and supporting personal development.

Contact

Website: www.calmast.ie

Email: calmast@wit.ie

Phone: 051 302492

Share your story with us on social media

Twitter: @CalmastWIT

Instagram: @CalmastWIT

Facebook: @CalmastSTEMHub

#SouthEastSTEM

#STEMreach

What is Problem Solving?

Problem Solving is defined as “the process of finding solutions to difficult or complex issues”. In a more mathematical sense problem solving is “the ability to analyse mathematical situations; to plan, monitor and evaluate solutions; to apply strategies; and to demonstrate creativity and self-reliance in using mathematics” (Irish Primary School Curriculum Mathematics 1999, p.8).

Problem Solving is not only limited to solving equations or finding the solutions to mathematical questions. Problem Solving is much more – we all solve problems on a daily basis when going shopping or deciding what to wear. Sometimes we might not even be aware of it.

Why Problem Solving?

We all come across various problems on a daily basis. We encounter problems at school, not only in a maths class but in all classes from languages to social studies to sciences. We use our problem solving skills at work where each job challenges us with range of problems, tasks and decisions on a daily basis. Of course we also have to find strategies to tackle all kinds of problems in our everyday life.

Problem solving skills make us feel more comfortable when facing a new challenge. Developing our problem solving skills means improving our strategic thinking, it helps us to find appropriate strategies and enables us to think of different ways to solve a problem. Such skills can be learned and improved through constantly challenging ourselves. The immediate feeling of success when having solved a problem is extremely rewarding. We become more confident and are encouraged us to practise and tackle increasingly complex challenges.

Working on a solution to a problem in a team is usually more effective: you support each other, you share ideas, you build on each other’s ideas and you are more likely to find a fast and simple strategy to solve the problem you’re facing. This makes the project more fun and finding a solution together is a very motivating (but also challenging) experience that adds to everyone’s personal development.

Each problem may be solved by a unique strategy – but more often than not several approaches can help to find a solution and many strategies can be applied to more than just one single problem. By practising and becoming more skilled in discovering these, we strengthen our strategic thinking. We also develop what is called lateral thinking: it becomes easier for us to see then problem in a different light, thus being able to solve it in a more creative way and using strategies that we may not have associated with a particular problem in the first place. We learn how to transfer problem solving strategies and by doing so become confident in new situations.

Strategies that are often applied to solve problems are:

- Trial and error
- Change your point of view
- Work backwards
- Find intermediate points, work step by step
- Eliminate what’s impossible
- Work with simplifications
- Look for patterns, symmetry
- Make a list or prepare a table of data
- Draw a picture
- Make a physical model

This list is by no means exhaustive but can be a starting point.

For industry partners: STEMreach Problem Solving with TY students

Calmast developed the STEMreach initiative to link industry and education. The initiative lives with the strong involvement of industry partners in the region who support Calmast's activities and also contribute to STEMreach with volunteer mentors. As the South-East STEM Hub, Calmast coordinates an extensive network of industry, schools, governmental and non-governmental bodies interested in the promotion of STEM.

Industry involvement

Volunteer mentors from STEMreach industry partner have first-hand experience regarding the application of problem solving in a large variety of jobs. This is of great value to STEMreach and contributes significantly to the problem solving programme. A crucial part of STEMreach is linking schools, higher education and industry so that students become aware of the study options in the regions and the career opportunities available to them in the South-East. This is facilitated by volunteer mentors from local industry partners visiting schools.

The visit ideally also kicks off the problem solving programme at the secondary school. During the visit, industry volunteers cover the following topics:

- What is problem solving?
- Why are problem solving skills so important?
- How can problem solving skills be developed?

Under these headings, students should become familiar with the idea of problem solving and the many different applications of problem solving in everyday life, personal and professional. This is where the experience of industry volunteers is an invaluable contribution: they chat about their own career, how problem solving skills helps them in their job and all the different areas in their company where problem solving is applied. It is important to encourage a positive attitude towards maths/problem solving in the students, to nurture a 'can do' approach in an informal setting and to inspire them to develop strategies to solve maths problems and puzzles.

In addition, industry partners are invited to attend the final puzzle fair at which first year students or primary pupils learn about problem solving strategies under the guidance of their older peers.

Positive experience

Everyone, presenters and volunteers, students, pupils and teachers, should feel comfortable while participating in STEMreach Problem Solving programme. For this reason, please ensure that you and also the TY students have a positive experience and enjoy working on this programme. The teacher will be in charge of keeping order in the classroom. Please turn to the teacher if you are faced with a concerning situation. Please do not link with students or pupils outside the classroom or on social media. Please avoid situations where you are on your own with a student or pupil.

It is important that you also make the TY students aware of this. They will have to ensure that the younger pupils have a positive experience and develop a positive attitude towards problem solving. On the day of the puzzle fair the teacher will be in charge of the classroom and the TY students can turn to their teacher whenever they feel uncomfortable or overwhelmed with a situation. They should not link with the younger pupils on social media or outside the classroom and never be alone with any of their younger peers.

For secondary school teachers: Bringing STEMreach Problem Solving into the classroom

In recent years, problem solving has become a more and more important skill and has also found its place in the curriculum: Ireland's Literacy & Numeracy Strategy states the need to "ensure that the curriculum contains additional guidance for teachers on approaches to teaching and learning advocated in areas such as estimation, shape and space, measures, the use of co-operative group learning and problem-solving approaches" (Literacy & Numeracy Strategy 2011, p. 56).

Yet teachers at primary and secondary schools expressed a concern in encouraging problem solving in the classroom. This led to the development of the STEMreach Problem Solving programme in 2017. Evaluation showed that 52% of the TY students who participated felt more confident in problem solving after having taken part in the programme. In addition, 48% believed their communication skills had improved. The programme also has a considerable impact on the younger pupils: 89% of the primary pupils who participated in the programme felt their problem solving abilities had improved.

This demonstrates that STEMreach not only supports the development of problem solving skills but also contributes to the development of communication and social skills through peer learning and team work. STEMreach strengthens the participants' confidence in their own abilities and in themselves. Creativity, imagination and taking initiative are encouraged too.

STEMreach further provides a way to include informal STEM learning in the curriculum as recommended by the Department of Education and Skills and contributes to the overall aim of making Ireland the best in Europe in STEM education by 2026 (DES Policy Statement 2016).

The programme

All STEMreach programmes are designed to be run by the TY students with only minimal support from their teachers. The school will have to ensure that enough time is available to work on the programme.

The secondary teachers accompany the progress of the programme and, together with Calmast, coordinate the timeline and key dates:

- 1 double period Introduction by Calmast and/or industry partner
- 8-10 double periods to solve given puzzles, develop problem solving strategies, discuss approach to communicate strategies to younger pupils, create physical models
- 2-4 double periods to practise with each other and develop puzzles further if needed
- Puzzle Fair with younger pupils (involvement of industry partner optional)

The puzzles

A number of puzzles are included in this handbook. There are no solutions – the TY students will have to work out the solution to each problem and present the strategy they have used to find the solution. In case of questions we are happy to help of course and can provide solutions if needed.

As each puzzle is different and also because everyone's perception of an easy or difficult puzzle varies, we recommend asking each TY student to try at least three different puzzles before settling on the one that they want to make a physical model of. It is essential that the TY students have a thorough understanding of the puzzle they select. They need to be able to explain the strategy or strategies that lead to the correct solution and to be aware of the most likely sources of error. They should also consider an easier as well as a harder version of the same puzzle. This will enable them to adjust the level of difficulty according to the abilities of the younger pupils on the day of the puzzle fair.

Evaluation

The success of STEMreach strongly relies on communication between all partners and continuous feedback. It is important to evaluate the impact STEMreach Problem Solving has on all involved. For this reason, Calmast has developed a series of pre- and post-surveys.

The secondary teacher as Calmast's main point of contact will ensure that all participants complete the surveys. Hard copies of are included in this handbook.

We are, however, very conscious of the impact of printing on the environment and ask you to complete the online survey if possible. The links to the survey will be provided by Calmast. Please email calmast@wit.ie if you have not received the links one week prior to starting the programme.

Photo & video consent

We at Calmast love to see the fantastic puzzles that the students create and the excitement on the day! Please share your story in pictures or videos with us on social media or email them to us –not only of the day of the puzzle fair but also of the days or weeks leading up to it.

We would also like to take pictures and videos of what is happening and we want to share them with everyone through our all our channels.

Please complete the photo/video consent form included in this handbook. An online version is available and the link will be provided by Calmast. Please email calmast@wit.ie if you have not received the link one week prior to starting the programme.

Positive experience

While working on the STEMreach programme and also on the day of the puzzle fair you are in charge of keeping order in the classroom. Please ensure that the students and pupils know that they can turn to you whenever they feel uncomfortable or overwhelmed in a situation.

Please remind the TY students that they should never be alone with a pupil at any time and should not link with their younger peers outside the classroom or on social media.

For TY students: Running a puzzle fair with younger pupils

Develop problem solving strategies

Once you've come together in a team of two to three students and selected a puzzle, it's time to get working. First, find the most appropriate problem solving strategy. Keep in mind that there might not be one single strategy, sometimes several strategies are equally useful and sometimes one strategy is better than another. The most obvious way is not always the most effective one but you should begin with the strategy you're most comfortable with. Then consider additional strategies and try to understand all approaches.

Create a physical model

Next, think about how you can make a physical model – a hands-on puzzle – of your problem. The model should encourage the younger pupils to try solving the puzzle: it needs to be visually attractive, simple and easy to understand, solvable and fun. Remember everyone should have a positive experience in this project and it is up to you to ensure that the younger school pupils have a positive experience.

Before constructing the physical model, consider the learning outcome:

- What do you want the younger pupil to take away from doing the puzzle?
- What do you want them to know at the end of the puzzle fair?
- What experience do you want them to have?
- What can you do to attract and keep their attention?
- How can you make your particular puzzle the most exciting one in the room?

Not everyone learns the same way and not everyone will be a genius problem solver at the end of the day. Yet everyone should leave the puzzle fair feeling more confident about their problem solving abilities, encouraged to develop their skills and inspired to do more.

Now construct the physical model. Keep it simple, use materials you can find in the classroom, at school or at home. You might have to focus on a certain strategy when preparing the model. If different approaches lead to the same result, think about which strategy is either the easiest to explain in a physical model or which is the easiest to explain to the younger pupils. When creating your model, think about what you liked and disliked at school when you were their age:

- What was your favourite subject? Why?
- What was your least favourite subject? Why?
- What was your favourite teacher like?
- How did you study? What way did you prefer studying, working at school and doing your homework when you were in primary school? In your first year at secondary school?
- What did you know about maths and problem solving?
- How did you feel around older pupils?

In short, try to look at your model through the eyes of a 11 to 13 year old. If you were that age, would you be able to understand the problem? Would you be able to solve the puzzle with the physical model? If yes – great! If not, think about ways to simplify or adjust your model. The younger pupils should be able to solve it in about 10 minutes.

If you have time, ask your class to try solving your problem/puzzle using the model you made. Also see if you can add different levels of difficulty.

Run a puzzle fair

Keep in mind that everyone should have a positive experience and that you, as the older students and acting teacher on the day of the puzzle fair, have to ensure that the younger pupils have a positive experience. While the 1st year students have been at the school for a while now, it is most likely the first time that the primary pupils are in the “big” school. Be welcoming and encouraging.

On the day of the puzzle fair, set up your models and be ready about 20 minutes before the younger pupils arrives. After a brief introduction (teacher, industry partner or WIT staff), the younger pupils will move in groups from puzzle to puzzle and have about 10 minutes to solve each. You will have to guide them – as required by each individual group - to make sure that everyone finds a solution. Positive experience, remember? This will motivate the younger pupils to proactively take on more and more challenges. With your help, they will develop a positive attitude towards problem solving and they will soon become keen problem solvers.

At all times, your teacher will be in charge of keeping order in the classroom. Please turn to your teacher when you feel uncomfortable or overwhelmed in a situation. Please keep in mind that you should never be alone with a pupil at any time and do not link with your younger peers outside the classroom or on social media.

STEMreach Problem Solving Evaluation

Pre-Surveys

**CALMAST**Waterford Institute of Technology
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What STEM subjects do you teach? Please also indicate at which level (LC, JC, TY).

	LC	JC	TY
Chemistry			
Biology			
Physics			
Maths			
Applied Maths			
Science			
Other:			

What non-STEM subjects do you teach? Please also indicate at which level (LC, JC, TY).

	LC	JC	TY

How long have you been teaching?

☐ 1-2 yrs☐ 3-5 yrs☐ 6-10 yrs☐ >10 yrsDo you find it difficult to encourage problem solving in the classroom? ☐ Yes ☐ NoHow comfortable are you teaching physics? ☐ Very ☐ Somewhat ☐ Not at allHow comfortable are you teaching chemistry? ☐ Very ☐ Somewhat ☐ Not at allHave you participated in a STEMreach programme before? ☐ Yes ☐ No

If yes, which one?

.....

What made you decide to participate with your class in STEMreach?

What do you expect to gain from participating in this STEMreach programme yourself?

What do you expect your students to gain from participating in this STEMreach programme?



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STEMreach

School:

Pre-Survey for teachers

Programme:

What STEM subjects did you study at Leaving Cert?

- ☐ Chemistry ☐ Physics ☐ Biology
☐ HL Maths ☐ OL Maths ☐ Applied Maths ☐ None

How long have you been teaching?

- ☐ 1-2 yrs ☐ 3-5 yrs ☐ 6-10 yrs ☐ >10 yrs

Do you find it difficult to encourage problem solving in the classroom?

- ☐ Yes ☐ Somewhat ☐ Not at all

How comfortable are you teaching science?

- ☐ Very ☐ Somewhat ☐ Not at all

Have you participated in a STEMreach programme before?

- ☐ Yes ☐ No

If yes, which one?

.....
What made you decide to participate with your class in STEMreach?

What do you expect to gain from participating in this STEMreach programme yourself?

What do you expect your students to gain from participating in this STEMreach programme?

Pre-survey for primary teachers



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**STEMreach Problem Solving
Pre-Survey for TY students**

School:

What is STEM?

.....

What was your favourite part of Junior Cert Maths and Science?

☐ Physics ☐ Chemistry ☐ Biology ☐ Maths

What are you going to do in your Leaving Cert (what do you feel like doing at the moment)?

☐ Physics ☐ Chemistry ☐ Biology ☐ Computer Science
☐ HL Maths ☐ OL Maths ☐ FL Maths ☐ Applied Maths

Pick two words that you would use to describe maths.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Challenging
☐ Hard ☐ Very hard ☐ Useful ☐ Useless

Pick two words that you would use to describe problem solving.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Challenging
☐ Hard ☐ Very hard ☐ Useful ☐ Useless

Does anyone in your family work in science, maths, engineering or technology?

☐ Yes ☐ No

How do you feel about teaching maths/problem solving to the younger pupils?

☐ Happy ☐ Confident ☐ Excited ☐ Nervous ☐ Neutral

Have you participated in STEMreach (any programme) as a junior partner in 1st year or at primary school? If yes, what were you doing?

.....

What do you expect from the programme?

.....

.....

How do you think about the following:

	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
I enjoy maths and problem solving.					
I am good at problem solving.					
I am a good communicator.					
Problem solving is used in many jobs.					
It is important for people working with numbers to be good in maths/problem solving and really understand it.					
It is important for people working with numbers to be creative and imaginative.					
It is important for people working with numbers to be good communicators.					
It is important for people working with numbers to be good in working with other people.					
I can imagine studying maths at college.					
I can imagine studying something with numbers at college.					
I can imagine using maths/problem solving in my future job.					
Maths/problem solving is important in our daily life.					
I will benefit from good problem solving skills in my future career.					
I like working with younger pupils/children.					



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**STEMreach Problem Solving
Pre-Survey for 1st/2nd year students**

School:

What is STEM?

.....

What are you going to do in your Junior Cert (what do you feel like doing at the moment)?

☐ Physics ☐ Chemistry ☐ Biology ☐ Maths

Pick two words that you would use to describe maths.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Challenging
☐ Hard ☐ Very hard ☐ Useful ☐ Useless

Pick two words that you would use to describe problem solving.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Challenging
☐ Hard ☐ Very hard ☐ Useful ☐ Useless

Does anyone in your family work in science, maths, engineering or technology?

☐ Yes ☐ No

How do you feel about working with the older students?

☐ Happy ☐ Confident ☐ Excited ☐ Nervous ☐ Neutral

What do you expect from the programme?

.....

.....

.....

How do you think about the following:

	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
I enjoy maths and problem solving.					
I am good at problem solving.					
I am good at expressing myself and discussing with others.					
Problem solving is used in many jobs.					
I can imagine studying maths at college.					
I can imagine studying something with numbers at college.					
I can imagine using maths/problem solving in my future job.					
I want to know more about maths, problem solving and puzzles.					
I like finding different ways to work out a puzzle or problem.					
Being good at maths/problem solving can help me in my future job and career.					
Being good at maths/problem solving can help me in my everyday life.					



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**STEMreach Problem Solving
Pre-Survey for primary pupils**

School:

What is STEM?

.....

What is Problem Solving?

.....

Pick two words that you would use to describe problem solving.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Hard ☐ Useful ☐ Useless

Pick two words that you would use to describe maths.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Hard ☐ Useful ☐ Useless

Does anyone in your family work in science, maths, engineering or technology?

☐ Yes ☐ No

How do you feel about working with the older students?

☐ Happy ☐ Confident ☐ Excited ☐ Excited ☐ Nervous ☐ Neutral

What do you think a mathematician does?

.....
.....
.....
.....

How do you feel about the following:

	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
I am looking forward to going to secondary school.					
I am good at maths/problem solving.					
I can imagine going to college or university after school.					
I like maths/problem solving at school.					
I enjoy solving puzzles.					
I want to know more about maths, problem solving and puzzles.					
I like finding different ways to work out a puzzle or problem.					
Being good at maths/problem solving can help me in my future job and career.					
Being good at maths/problem solving can help me in my everyday life.					

STEMreach Problem Solving Evaluation

Post-Surveys



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**STEMreach
Post-Survey for teachers**

School:

Programme:

Number of participating students:

What STEM subjects do you teach? Please also indicate at which level (LC, JC, TY).

	LC	JC	TY
Chemistry			
Biology			
Physics			
Maths			
Applied Maths			
Science			
Other:			

What non-STEM subjects do you teach? Please also indicate at which level (LC, JC, TY).

	LC	JC	TY

How long have you been teaching?

☐ 1-2 yrs ☐ 3-5 yrs ☐ 6-10 yrs ☐ >10 yrs

Do you find it difficult to encourage problem solving in the classroom? ☐ Yes ☐ No

How comfortable are you teaching physics? ☐ Very ☐ Somewhat ☐ Not at all

How comfortable are you teaching chemistry? ☐ Very ☐ Somewhat ☐ Not at all

Would you participate in this or another STEMreach programme again? ☐ Yes ☐ No
Why?

How did your students benefit from participating in this STEMreach programme?

What did you as the teacher gain from participating in this STEMreach programme?

What would you change in order for you and/or your pupils to benefit more from this STEMreach programme?



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**STEMreach
Post-Survey for teachers**

School:

Programme:

Number of participating students:

What STEM subjects did you study at Leaving Cert?

- ☐ Chemistry ☐ Physics ☐ Biology
☐ HL Maths ☐ OL Maths ☐ Applied Maths ☐ None

How long have you been teaching?

- ☐ 1-2 yrs ☐ 3-5 yrs ☐ 6-10 yrs ☐ >10 yrs

Do you find it difficult to encourage problem solving in the classroom?

- ☐ Yes ☐ Somewhat ☐ Not at all

How comfortable are you teaching science?

- ☐ Very ☐ Somewhat ☐ Not at all

Would you participate in this or another STEMreach programme again? ☐ Yes ☐ No
Why?

How did your pupils benefit from participating in this STEMreach programme?

What did you as the teacher gain from participating in this STEMreach programme?

What would you change in order for you and/or your pupils to benefit more from this STEMreach programme?



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**STEMreach Problem Solving
Post-Survey for TY students**

School:

What is STEM?

.....

What are you going to do in your Leaving Cert (what do you feel like doing at the moment)?

- ☐ Physics ☐ Chemistry ☐ Biology ☐ Computer Science
☐ HL Maths ☐ OL Maths ☐ FL Maths ☐ Applied Maths

Pick two words that you would use to describe maths.

- ☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Challenging
☐ Hard ☐ Very hard ☐ Useful ☐ Useless

Pick two words that you would use to describe problem solving.

- ☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Challenging
☐ Hard ☐ Very hard ☐ Useful ☐ Useless

What surprised you about this programme?

.....
.....

If you could change one thing about this programme what would that be?

.....
.....

Describe one thing that you learned in this programme.

.....
.....

What did you like best about the programme? Why?

.....
.....
.....

How do you think about the following:

	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
I enjoy maths and problem solving.					
I am good at problem solving.					
I am a good communicator.					
Problem solving is used in many jobs.					
It is important for people working with numbers to be good in maths/problem solving and really understand it.					
It is important for people working with numbers to be creative and imaginative.					
It is important for people working with numbers to be good communicators.					
It is important for people working with numbers to be good in working with people.					
I can imagine studying maths at college.					
I can imagine studying something with numbers at college.					
I can imagine using maths/problem solving in my future job.					
Maths/problem solving is important in our daily life.					
I will benefit from good problem solving skills in my future career.					
I enjoyed working with the younger pupils.					
I feel I am more confident in maths and problem solving than I was before taking part in this programme.					
I would like to participate in similar programmes.					
I would recommend this programme to friends.					



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**STEMreach Problem Solving
Post-Survey for 1st/2nd year students**

School:

What is STEM?

.....

What are you going to do in your Junior Cert (what do you feel like doing at the moment)?

☐ Physics ☐ Chemistry ☐ Biology ☐ Maths

Pick two words that you would use to describe maths.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Challenging
☐ Hard ☐ Very hard ☐ Useful ☐ Useless

Pick two words that you would use to describe problem solving.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Challenging
☐ Hard ☐ Very hard ☐ Useful ☐ Useless

What surprised you about this programme?

.....
.....

If you could change one thing about this programme what would that be?

.....
.....

Describe one thing that you learned in this programme.

.....
.....

What did you like best about the programme? Why?

.....
.....
.....

How do you think about the following:

	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
I enjoy maths and problem solving.					
I am good at problem solving.					
I am good at expressing myself and discussing with others.					
Problem solving is used in many jobs.					
I can imagine studying maths at college.					
I can imagine studying something with numbers at college.					
I can imagine using maths/problem solving in my future job.					
I want to know more about maths, problem solving and puzzles.					
I like finding different ways to work out a puzzle or problem.					
Being good at maths/problem solving can help me in my future job and career.					
Being good at maths/problem solving can help me in my everyday life.					
I enjoyed working with the older students.					
I feel I am more confident in maths and problem solving than I was before taking part in this programme.					
I would like to participate in similar programmes.					
I would recommend this programme to a friend.					
I want to participate and work with younger students on this when I am in my TY year.					



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INSTITIÚID TEICNEOLAÍOCHTA PHORT LÁIRGE

**STEMreach Problem Solving
Post-Survey for primary pupils**

School:

What is STEM?

.....

What is Problem Solving?

.....

Pick two words that you would use to describe problem solving.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Hard ☐ Useful ☐ Useless

Pick two words that you would use to describe maths.

☐ Fun ☐ Boring ☐ Easy ☐ Ok ☐ Hard ☐ Useful ☐ Useless

What do you think a mathematician does?

.....

.....

.....

.....

Describe one thing that you learned in this programme.

.....

.....

What did you like best about the programme? Why?

.....

.....

If you could change one thing about this programme what would that be?

.....

.....

How do you feel about the following:

	Strongly agree	Agree	Don't know	Disagree	Strongly disagree
I am looking forward to going to secondary school.					
I am good at maths/problem solving.					
I can imagine going to college or university after school.					
I like maths/problem solving at school.					
I enjoy solving puzzles.					
I want to know more about maths, problem solving and puzzles.					
I like finding different ways to work out a puzzle or problem.					
Being good at maths/problem solving can help me in my future job and career.					
Being good at maths/problem solving can help me in my everyday life.					
I enjoyed working with the older students.					
I feel I am more confident in maths and problem solving than I was before taking part in this programme.					
I would like to participate in similar programmes.					
I would recommend this programme to a friend.					
I want to participate and work with younger students on this when I am in my TY year.					

**STEMreach Problem Solving
Photo and Video Consent Form**



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Photo and Video Consent*

I hereby confirm that parental consent was given to the school and that Calmast, Waterford Institute of Technology's STEM Engagement Centre, has the right to use any photo or video taken of class

_____ class _____ at _____ school _____

during the students' participation in the STEMreach Programme coordinated by Calmast.
All photo and video materials will be taken by Calmast staff or persons authorised by Calmast.

The photos and videos may be used on the Calmast and related websites, including social media platforms and in related marketing materials without media, time, use or geographic limitations.

The photos and videos will be used without the name of the student.
I understand that Calmast is not obliged to use the photos or videos in any way.
I confirm that I have read this consent form. I agree to the proposed uses for the photos and videos.

Name of school _____

Name/position of signee _____

Date and signature _____

* Waterford Institute of Technology's GDPR policy applies to all personal information collected.

STEMreach Problem Solving

Puzzle Ideas

1. Jumping Chips



Can you swap the positions of the red and green chips in the grid while observing the following rules:

- The red chips can only move right
- The green chips can only move left
- A chip can move into an empty square.
- A chip can jump over a different colour chip as long as there is an empty square to land in
- A chip cannot jump over two chips or over a chip of the same colour



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2. The Die Hard Jug Puzzle

In the film *Die Hard With a Vengeance*, the characters John McClane and Zeus Carver open a briefcase only to discover that in doing so they have armed a powerful bomb. It will explode in a matter of minutes unless they can disarm it. Inside the briefcase there is a weighing scales. They have at their disposal two jugs — one holds exactly 5 litres and the other holds exactly 3 litres. To disarm the bomb, they have to fill the 5 litre jug with exactly four litres of water and place it on the scale. A few grams too much or too little will detonate the bomb. The water can be obtained from a nearby fountain.

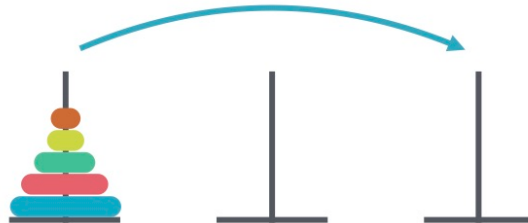
How can they disarm the bomb?



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3. Towers of Hanoi



The object of the game is to move all of the disks from the first pole to the third, one disk at a time, without ever placing a larger disk on a smaller disk.



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4. Lights On



Seven light bulbs are arranged in a circle.

Each light has a switch, but the electrician didn't wire them properly.

When you press a switch, if the light is on, it turns it off; and if a light is off, it turns it on as usual. However, it also does the same for the two lights on either side. For example, if you pressed the switch for light B in the left picture, lights A and B would turn on and light C would turn off as shown in the right picture.

Can you figure out a way to turn all the lights on?



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5. Bridges of Königsberg

The old town of Königsberg has seven bridges.



Can you take a walk through the town, visiting each part of the town and crossing each bridge only once?



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6. River Crossing



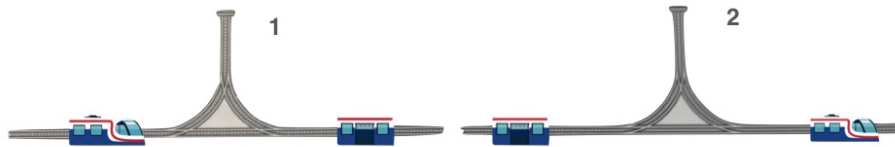
A farmer has to transport a fox, a dog, a goose, and some grain across a river. He has a boat which can carry himself and either the fox, dog, goose, or grain. If the farmer isn't present, the fox cannot be left with either the dog or the goose, or both. If needs be, the goose can be left with the grain provided the dog is present because the dog will guard the grain and won't eat the goose. Help the farmer cross the river. How can he transport all four things across the river?



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7. Passing Trains



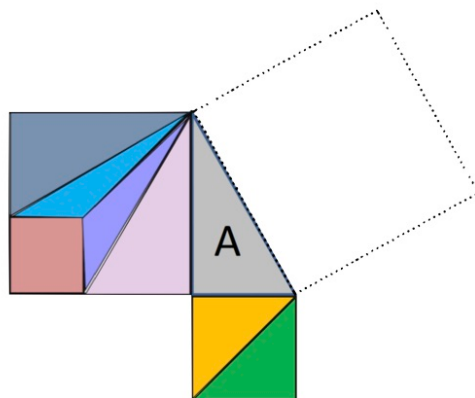
The railway engine (left in picture 1) must pass the railway car (right in picture 1). The engine can push and pull the car with its front end as well as its back end. There is just enough room for the car or the engine on the siding, and just enough room for the car or the engine on the straight part between the two curved tracks. There is lots of room on the other parts of the straight tracks. After the engine has passed, the car and the engine should still be facing way they were as shown in picture 2. While the engine and car are being moved to their new positions, they can face different directions.



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8. Pythagoras



This is a proof for
Pythagoras's Theorem
as it shows that

$$a^2 + b^2 = c^2$$



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9. Handshake Puzzle

Amy, Liam, Samira and Luke meet up. Each person shakes hands with every other person once.

How many handshakes are there in total?



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10. Golden Balls



Someone has given you nine golden balls. One of them weights a tiny bit more than the others. The others all weigh exactly the same. Using only a pan balance, how can you find the heavy ball?

Most people need three weighings or more. Can you figure out how to find it in only two weighings?



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11. Torch & Bridge Puzzle



Four friends want to cross the old bridge at night. The bridge has many holes, and to cross it safely, they need to use a torch. They have only one torch, and without it nobody can cross the bridge. The bridge is old and damaged, so only two people at once can walk across it, and a person who walks faster has to walk at a slower person's pace. It takes 10 minutes for person number one to cross the bridge, 5 minutes for person number two, 2 minutes for person number 3, and it takes the fourth person only one minute. Is it possible that all four friends can cross the bridge in less than 19 minutes?



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12. Boxes and Balls



Three boxes contain red and white balls. One box contains 2 red balls, another contains 2 white balls, and third contains 1 red ball and 1 white ball. The boxes have been labelled, but each of the labels is on a wrong box. All three boxes have lids, and you cannot see what is in them. However, you are allowed to reach into any of the boxes without peeking and take one or more balls out and look at them. Taking out as few balls as possible, figure out what the correct labels should be.



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13. Who lives where?

There are three houses on this street. Two people live in each house.
As you look at the houses...

- ...Mike lives directly to the right of Ray.
- ...Andy lives directly to the left of Mia.
- ...Mia lives directly to the left of Anna.
- ...Rose lives directly to the left of Mia.

Who lives where?



14. Racing positions

Five cars took part in a race.

- The purple car took third place.
- The yellow car came in before the purple car.
- The red car wasn't last, but it came after the yellow car.
- The green car wasn't first.
- The blue car came in before the yellow car.

Use this information to find out where each car finished.



15. Which kitten?

When Joe's cat had kittens, his friends chose one each. There were four kittens:

- Sooty and Shadow were black with pink noses.
- Tiger and Rusty were orange with black noses.
- Sooty and Tiger were nervous.
- Zack didn't want a black kitten.
- Ellie wanted a kitten with a pink nose.
- Amy didn't want a kitten that was nervous.
- Rico had the kitten that neither Amy nor Zack wanted.



Friend	Kitten
Zack	
Ellie	
Amy	
Rico	



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16. Break the Code

Caesar Cipher - is one of the earliest known and simplest ciphers. It is named after Julius Caesar (100-44 BC), who, according to Suetonius, used it with a shift of three to protect messages of military significance. It is a type of substitution cipher in which each letter in the plaintext is 'shifted' a certain number of places down the alphabet. For example, with a shift of 1, A would be replaced by B, B would become C, and so on. The discs, have the letters in the usual order. Sender and receiver must agree which circle corresponds to plaintext and which circle corresponds to ciphertext. The key is the shift, that sender and receiver must set. The original Caesar's cipher had a shift of 3. Knowing the key, the sender and receiver can create the plaintext/ciphertext correspondence as needed.

- Encode Julius Caesar famous quote: "Experience is the teacher of all things." Use your own shift number.
- Decode this message (another Julius Caesar quote), which was enciphered using the Caesar Cipher with a shift of 3:

L FDPH, L VDZ, L FRQTXHUHG.



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16. Break the Code

Caesar Cipher

1. Cut out the circles
2. Place the smaller circle over the larger circle, and place a paper fastener or a clip, through the center of both circles.
3. The two circles at the bottom of this sheet can be used alternatively if you want to encrypt your message with numbers or with your own signs.



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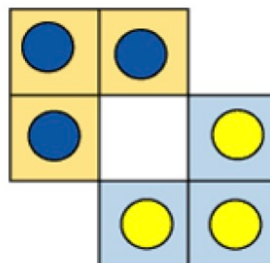
17. Switch Positions

The picture shows a 3 by 3 board with two missing corners. There are 3 blue chips on the yellow part of the board and 3 yellow chips on the blue part of the board. The problem is to put the blue chips on the blue part and the yellow chips on the yellow part. The rules are as follows:

You can move a chip from one square to a square next to it if the square is empty.

You can jump a chip over a different coloured chip next to it as long as you land in an empty space.

You cannot move or jump diagonally.



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18. The Captive Queen

A queen wants to safely free her three pets - a rabbit, cat and a dog - who are all stuck at the top of a high tower. Outside the window there is a pulley with a rope around it, and with two large baskets of equal weight at the ends. The basket outside the window is empty, and the one on the ground has a **stone in it that weighs 2 kg**.

The stone can serve as a counterweight: when an animal is put into the top basket, it goes down and the stone goes up, and when they are taken out at the bottom, the empty basket goes up and the stone comes down. The people at the bottom must be careful that the basket with the stone doesn't fall on them.

It is safe for any pet to be lowered by one basket provided their weight does not exceed the weight in the other basket by more than 1 kg, otherwise they will come down with such speed that they might injure themselves when the basket hits the ground.



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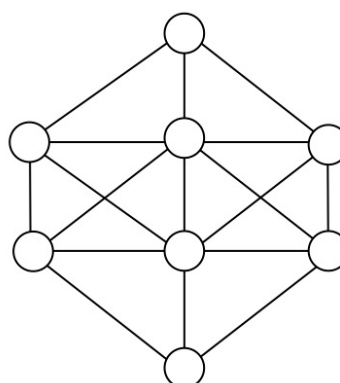


The **dog weighs 7 kg, the cat is 4 kg and the rabbit is 3 kg**. The baskets are large enough to hold two animals, or one animal and the stone. No one assists them by pulling on the ropes. Find a way for all of them to reach the bottom that uses the fewest number of steps.

19. Numbers apart

Place the numbers 1 to 8 in the circles so that no two numbers inside the circles joined by a line differ by 1.

For example, if you put a 4 in the top circle, you cannot put a 3 or a 5 in any of the circles in the row directly below it because each of those three circles is joined to the top by one line.



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20. Even Steven

Steven doesn't like odd numbers, so the box of donuts shown above meets with his approval. The problem is that he has to remove six donuts from the box in such a way that he leaves an even number of donuts in each row and each column.

How can he do this? There is more than one solution.



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21. Sword of knowledge

The dragon of ignorance has three heads and three tails. You can slay it with the sword of knowledge, by chopping off all of its heads and all of its tails. With one stroke of the sword, you can chop off either one head, two heads, one tail, or two tails.

But the dragon is difficult to slay! If you chop off one head, a new one grows in its place. If you chop off one tail, two new tails replace it. If you chop off two tails, one new head grows. If you chop off two heads nothing grows.

Show how to slay the dragon of ignorance. How many chops do you need?



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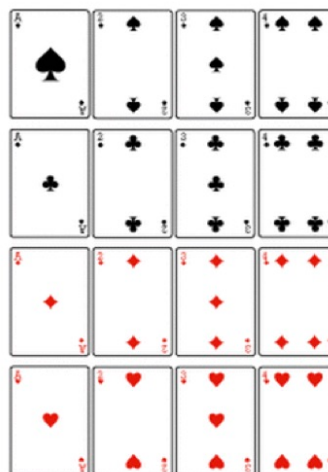


22. Catch 22

Two players alternately turn down a card and add it to the common total. The winner is the person who makes the total 22 or who forces the other player to go beyond 22.

For example, Alice turns down a 3, Bill turns down a 4 making the total 7. Then Alice turns down a 1, making the total 8, and Bill turns down another 4, making the total 12. Alice turns down a 3 (total 15). Bill turns down a 3 (total 18) and Alice wins by turning down a 4.

Another example: Alice and Bill turn down 1 and 1, then 1 and 1, then 2 and 2, then 3 and 3, then 3 and 4. The common total is 21, and so Bill wins because there are no 1's left and what ever Alice turns down will bring the total to more than 22.



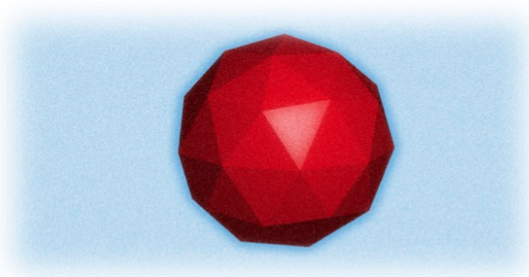
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23. Nifty shapes.

A geometry net is a 2-dimensional shape that can be folded to form a 3-dimensional shape. Here are some steps to determine whether a net forms a solid:

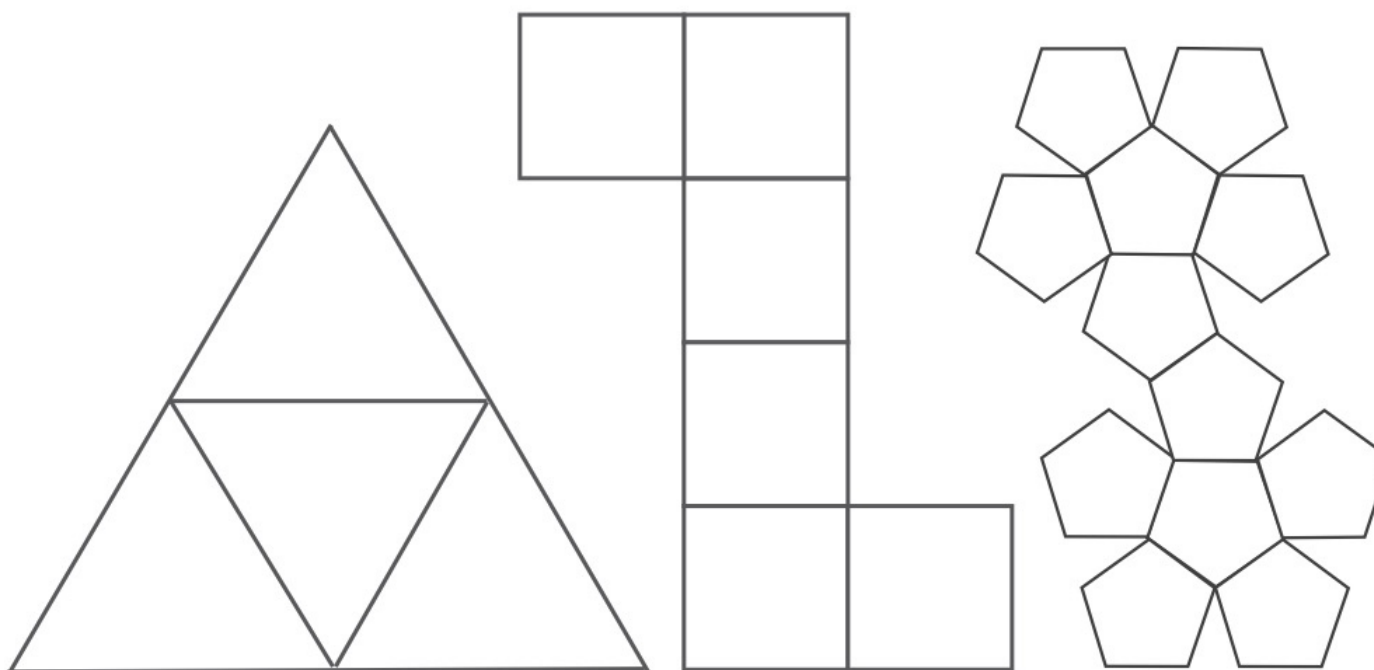
- Make sure that the solid and the net have the same number of faces and that the shapes of the faces of the solid match the shapes of the corresponding faces in the net.
- Visualize how the net is to be folded to form the solid and make sure that all the sides fit together properly.



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23. Nifty shapes.



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