

# Supporting all Learners in Mathematics through Universal Design for Learning

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# Overview of Presentation

- The Lie of the Land
  - Mathematics Achievement
  - Changing Context of Learning Support
- Introduction to Universal Design for Learning
  - Multiple Means of **Engagement**
  - Multiple Means of **Representation**
  - Multiple Means of **Action and Expression**

# Negative views of maths

Parents, Fear (Math) No More!



<https://dreme.stanford.edu/>

## Almost 4,000 Leaving Cert students fail maths

Students receive bonus for record numbers who passed on sitting higher level papers

Seven students secure top grades of 100 per cent across all eight subjects

BRIEN  
10.10.18

More than 3,700 students have failed their Leaving Cert maths

the higher-level paper, by contrast, was just under 2 per cent. While many ordinary-level students might have performed better in foundation-level

grading system. These changes involve the awarding of Central Applications Office (CAO) points for what used to be termed an H grade (50 to 49 per cent).

This has reduced the fear of failure on the part of many who might previously have sat the ordinary-level paper.

The gamble of taking on the higher-level paper has paid off for most students with a large majority securing honours grades and remarkably low failure rates.

have secured their first-choice places and Monday when offers through the CAO are made.

A small number of students have achieved stellar results, with seven students securing top grades (100s or 90-100 per cent) across eight subjects.

A further 53 students secured 100s in seven subjects, while 189 achieved 100s in six subjects. These numbers are broadly similar to last year.

Students who may be disappointed with their results have been urged not to panic and to

that there are more opportunities now than ever before, to help you achieve your ambitions in life," he said. "There are a number of pathways to further your education, whether you choose third level, a post-Leaving Cert course, or the apprenticeship and training system."

This year's results, overall, are similar to last year due to the fact that exams are marked according to a bell curve. This means that a similar proportion of students achieve a sim-

ilar number of students achieving high or low-level marks.

### Skills gaps

The Government is keen to plug skills gaps in so-called STEM subjects and wants to increase the pipeline of potential graduates. Almost a third of students sat the higher paper this year, a near-doubling of the numbers since 25 bonus points were introduced for those who score more than 40 per cent.

More than 90 per cent of those who sat higher maths were eligible for bonus points.

However, academics in higher education have expressed concern over the basic skills of Leaving Cert maths students who are passing the higher-level paper but struggling to cope at third level. Some argue it is time to re-examine the policy of awarding bonus points for the higher-level paper given the volume of diffi-

culties facing students completing maths-intensive courses.

\* The Irish Times help desk will operate at [irish-times.com/results2018](http://irish-times.com/results2018) on weekdays from 10am over the period from the release of the Leaving Cert results until after the CAO offers are released on August 20th.

Editorial comment: page 13

Call for reform  
as maths and  
science grades  
drop yet again

Katharine Donnelly  
and Brenda Heffernan

1.8.18 (18) Cert results and sci-

HELPLINE

1800 265 165

# Irish teachers are doing a great job!

## ***Trends in International Mathematics and Science Study (TIMSS) 2015***

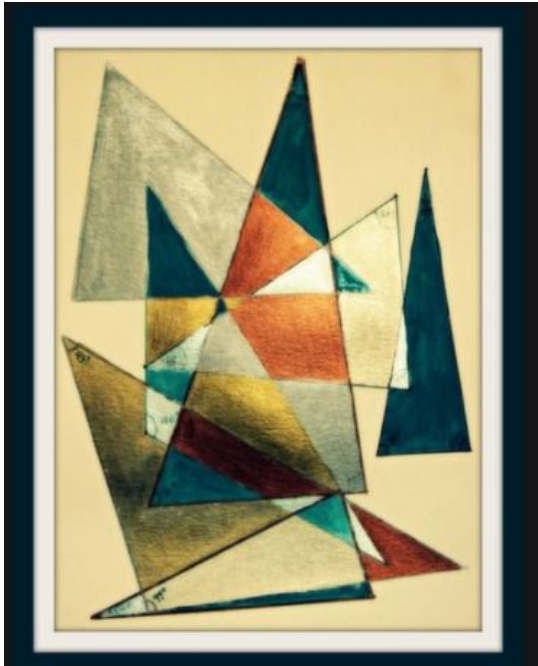
- At both 4th class and second year, Irish children achieved mean mathematics and science scores that were significantly above the international average
- Tracking achievement over a number of years (1999- 2015) shows that performance has improved among both lower- and higher-achieving pupils, but improvements in lower achieving students most marked.

# Areas for improvement

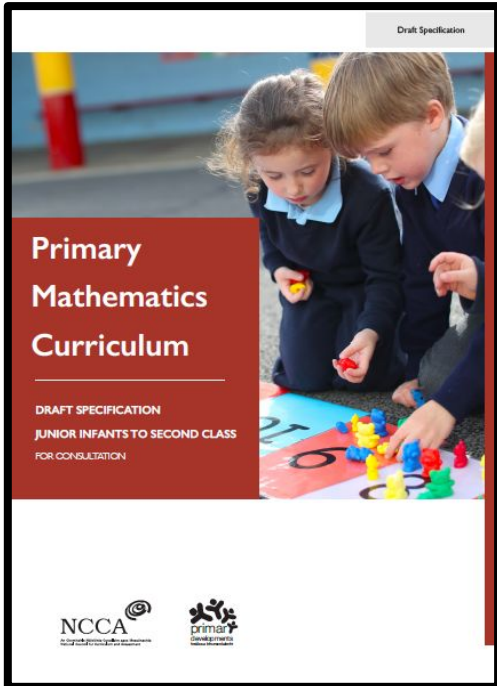
- Relative weakness in Geometric Shapes and Measures (4th class and 2nd year)
- Gender
  - Boys significantly outperform girls at 4th class in Geometric Shapes and Measures
  - Boys significantly outperform girls at 2nd year in Number
- Relative weakness in Reasoning tasks (4th Class)

## ***National Assessments of Mathematics and English Reading***

- Also show improvements but stubborn gap between DEIS and non-DEIS schools persists.



# Forthcoming primary curriculum



## ***Full specification to be published Autumn 2021***

- Foregrounds the **processes** of mathematisation: communicating, reasoning, argumentation, justifying, generalising, representing, problem-solving, and connecting.
- Presents **learning paths** which serve as reference points for planning and assessment
- Promotes the principles of **equity and access** for all children

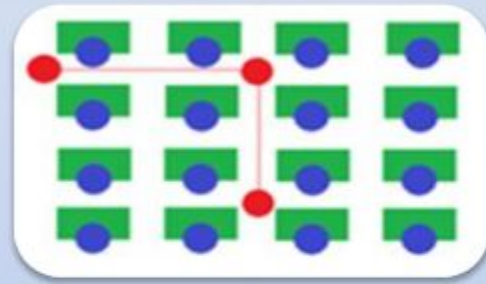
# Changing Nature of Learning Support

- Team Teaching: A group of two or more teachers working together to plan, conduct and evaluate the learning activities for the same group of learners (Goetz, 2000)
- This aligns with recommendations from NCSE which identifies **co-teaching, heterogeneous grouping, collaborative learning and problem-solving, and differentiation** as teaching strategies with the potential for inclusion (NCSE, 2010)

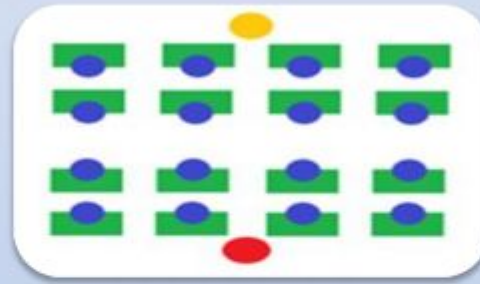


How to plan  
for and  
support  
mixed ability  
groups?

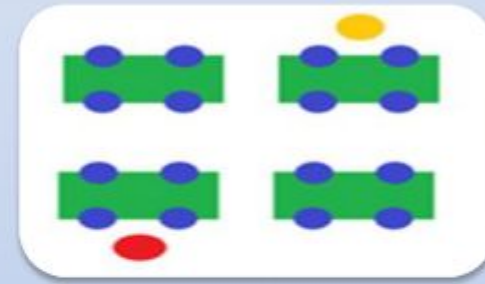
# Models of Team Teaching



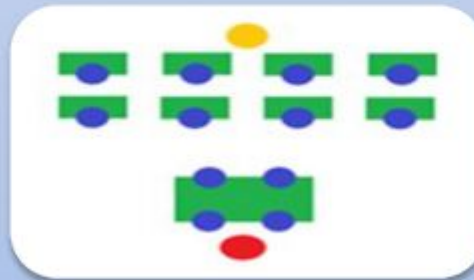
Lead and  
Support



Parallel  
Teaching



Station  
Teaching



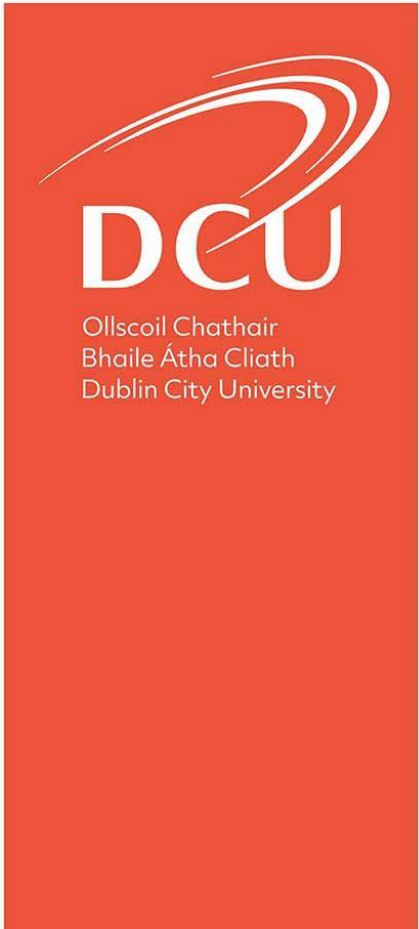
Alternative  
Teaching



Teaming  
Teaching

**Vahey & Slevin (2018)**

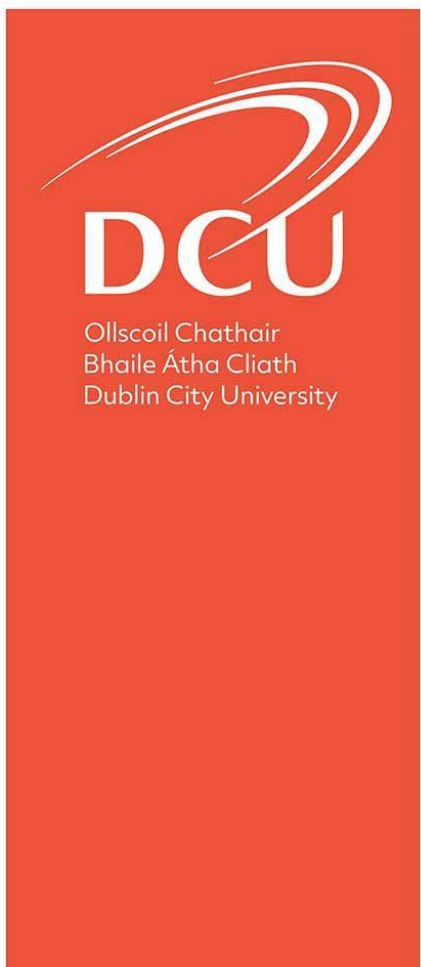




# Inclusive rather than differentiated approaches

- Most, if not all teachers, are familiar with the concept of '*differentiation*'.
- However, reducing the complexity of the curriculum or setting easier objectives for certain children is not an optimal strategy.
- Similarly, if advanced learners are merely assigned tasks to 'keep them busy', they will continue to relearn known material.
- The challenge that teachers face is designing and structuring tasks that will cater for the diverse range of abilities within a given class.



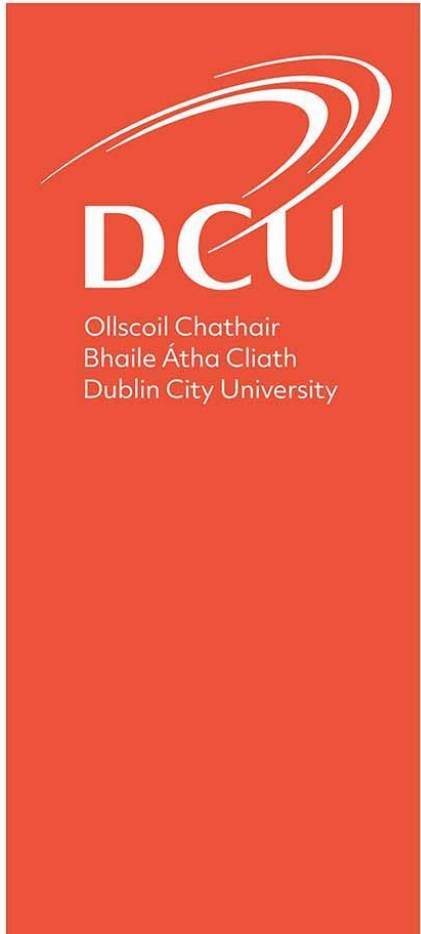


# ‘Universal Design’: Cultivating Inclusive Environments

## What is ‘Universal Design’?

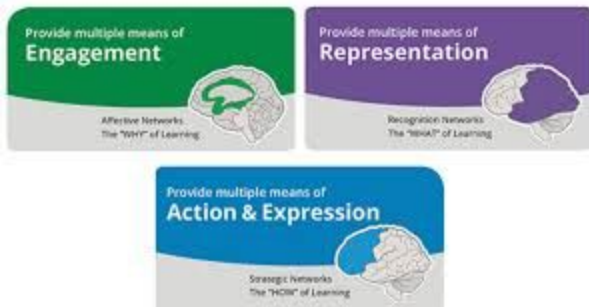
- ‘Universal Design’ strives to benefit the many, not just the few, i.e.
- It could be described as “**a process that enables and empowers a diverse population by improving human performance, health and wellness and social participation**” (Steinfeld & Maisel, 2012).
- It is an overarching belief that we should endeavour to make everything we design and produce, useable by everyone to the greatest extent possible.





# Universal Design for Learning (UDL)

- The principles of Universal Design can also be applied in an educational context. This is known as Universal Design for Learning (UDL).
- UDL guidelines that every teacher can draw upon to frame and direct their instructional learning approaches.
- Based on research into how humans learn, the UDL guidelines are very useful for all teachers who are interested in promoting and maximising inclusion in his/her classroom.
- It is unlikely that a teacher would try to implement all of these into his/her practice at once. The advice is to get to know them over time and implement them gradually.



# UDL Guidelines

In order to maximise inclusion of all students, UDL guidelines suggest that we teachers should provide:

1. Multiple Means of **Engagement**
2. Multiple Means of **Representation**
3. Multiple Means of **Action and Expression**

## Universal Design for Learning Guidelines

[GO TO THE UDL GUIDELINES](#) 

AFFECTIVE NETWORKS:  
THE **WHY** OF LEARNING



### Engagement

For purposeful, motivated learners, stimulate interest and motivation for learning.

RECOGNITION NETWORKS:  
THE **WHAT** OF LEARNING



### Representation

For resourceful, knowledgeable learners, present information and content in different ways.

STRATEGIC NETWORKS:  
THE **HOW** OF LEARNING

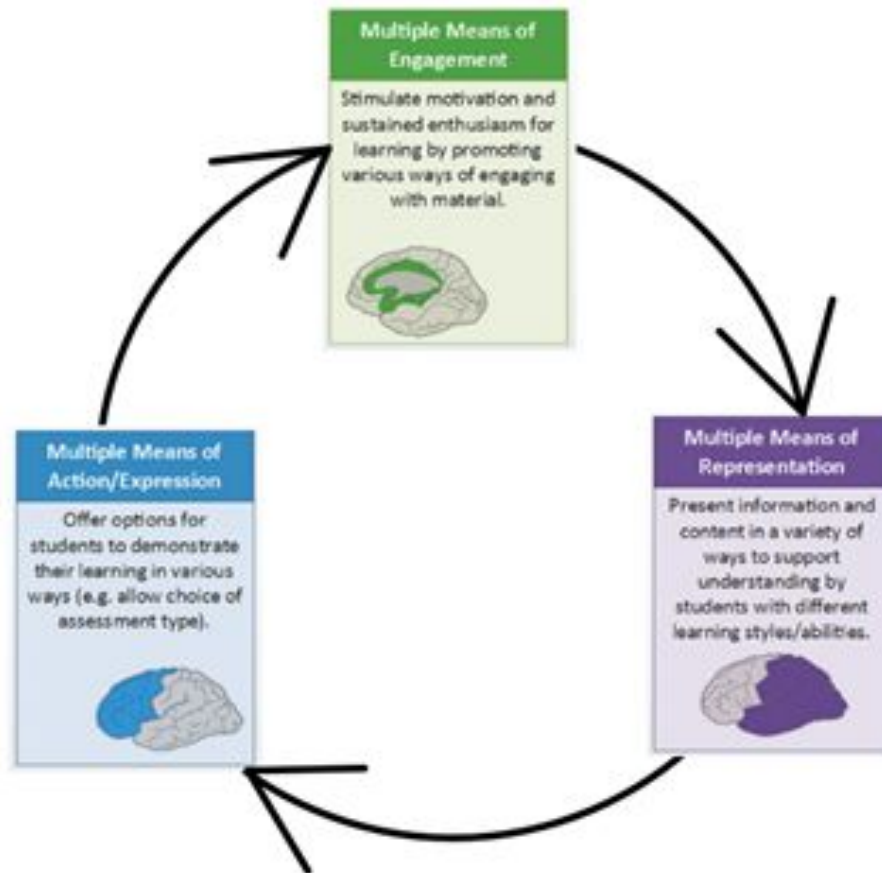


### Action & Expression

For strategic, goal-directed learners, differentiate the ways that students can express what they know.



Ollscoil Chathair  
Bhaile Átha Cliath  
Dublin City University



The synergy that exists between all three dimensions of the UDL means that **inclusive teaching** is best achieved if elements of each dimension are present in our teaching.

# Multiple Means of Engagement



- In choosing and designing activities, and in launching these activities, teachers should try to provide multiple access points to the relevant material, supporting the expectation that *all* children are able and expected to participate.
- Where possible, teachers should **use open-ended questions or tasks** that allow children to approach it by using different processes or strategies. This, in turn, affords children at different stages of mathematical development, the opportunity to offer responses.





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# Multiple Means of Engagement



## Checklist for Providing Multiple Means of Engagement

Where possible, mathematics tasks should:

- Be framed in a manner that is relevant and authentic to the learner
- Present minimal anxiety or threat to students in the launching of the task i.e. is *accessible* to all pupils
- Contain a variety of open-ended and “I wonder” questions
- Include opportunity for individual choice and autonomy in how students might approach the task
- Vary demands and resources to optimise challenge
- Foster collaboration and community



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# Tasks to Promote Engagement



- What questions come to mind for you when you see this image?
- How many Skittles will fit inside the empty light bulb? Estimate.
- Write an estimate that you know is too high. Write an estimate that you know is too low.

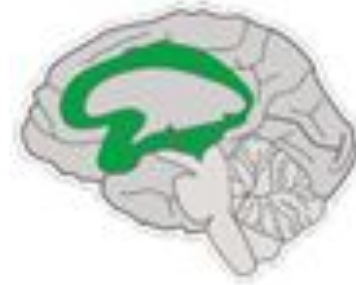
- Now how many Skittles do you think are inside?
- I wonder how many purple / green / yellow / orange there are?




Source:


<https://gfletchy.com/bright-idea/>


# Tasks to Promote Engagement





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 **-19 yellow**

 **-15 orange**

 **-19 green**

 **-17 purple**

 **-21 red**

**Total Skittles: 91**



# Multiple Means of Representation



- Learning occurs best when multiple representations are used, because they allow students to make connections within, as well as between concepts. Too often, an over-reliance on textbook material means that teachers are delivering content in a manner that is repetitive and in some case, of little relevance to pupils who benefit from alternative representation.
- Similar to engagement, there is not one means of representation that will be optimal for all learners, therefore, providing a number of means of representation is essential.





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# Multiple Means of Representation



## Checklist for Providing Multiple Means of Representation

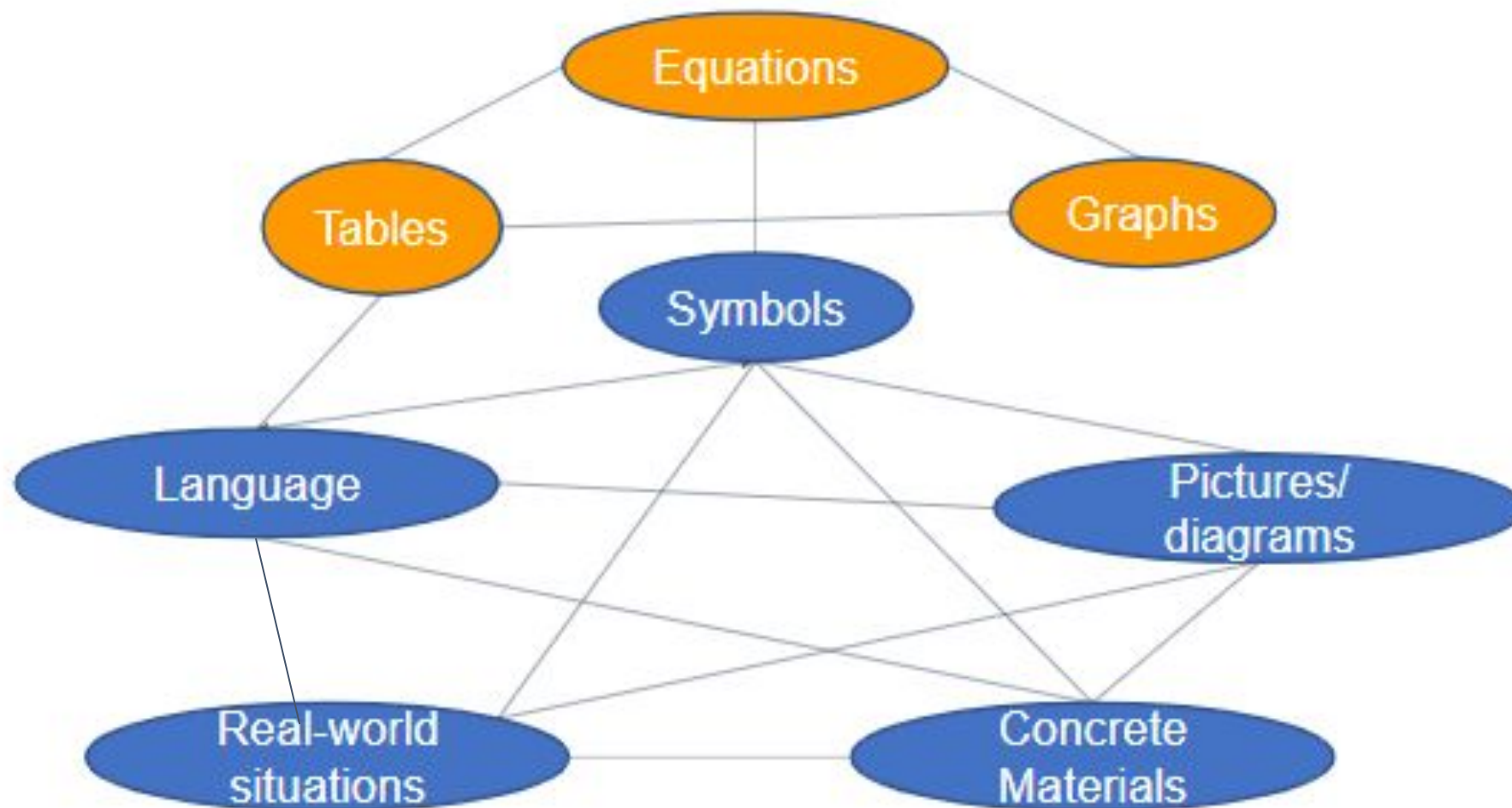
Where possible, mathematics tasks should:

- Have content that does not depend on a single sense like sight, hearing, movement or touch
- Illustrate through multiple media
- Activate or supply background knowledge
- Highlight previously learned skills that can be used to solve unfamiliar problems
- Provide multiple entry points to a lesson and optional pathways through the content
- Offer ways of customising the display of information to the pupils, if required e.g. magnifying text, the font and colour of text and backgrounds, the volume or rate of speech



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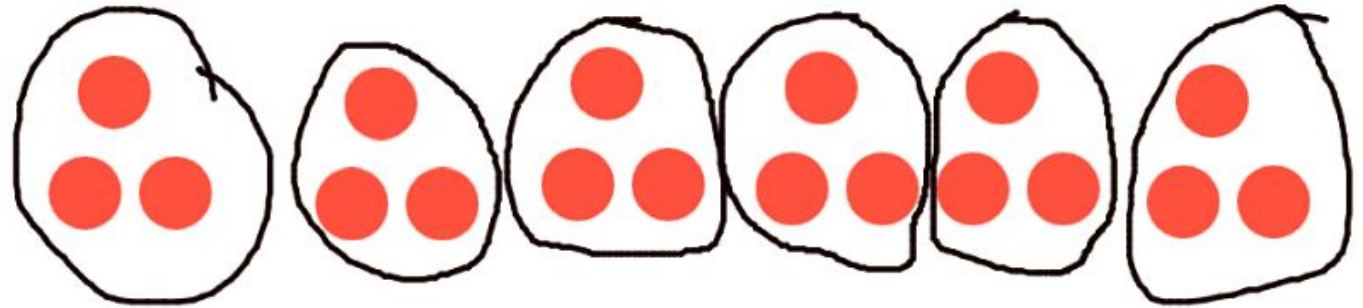
# Multiple Means of Representation



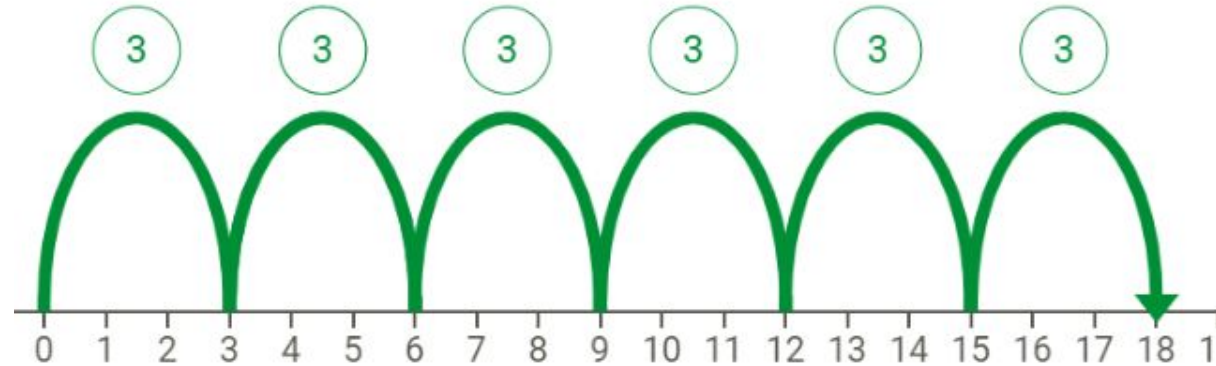


# Ways of representing multiplication

**Equal Groups**

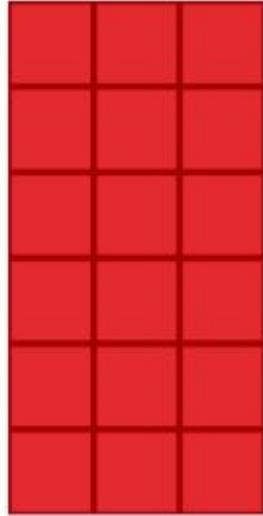


**Skip Counting**



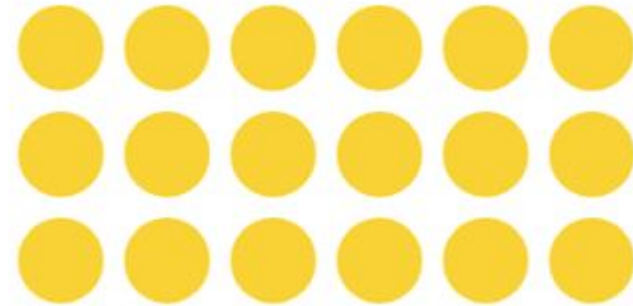
**Repeated Addition**

$$3 + 3 + 3 + 3 + 3 + 3 = 18$$

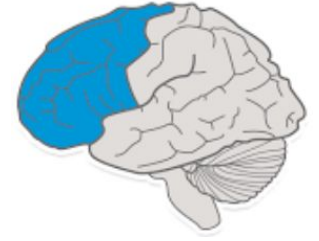


Area Model (6 rows, 3 columns)

Array Model  
(3 rows, 6 columns)



# Action and Expression



Inclusive approaches respect difference and do not force all children to use the same method.

Enabling students to use a variety of methods for responding to and navigating tasks helps to develop a sense of ownership and *agency*.

Children should have access to a wide variety of suitable resources which they may use to guide their thinking if they wish.

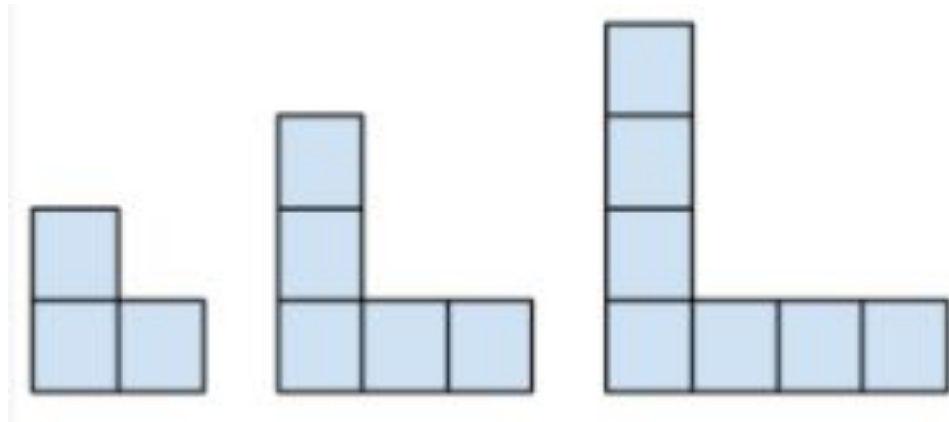
# Action and Expression

## Checklist for Providing **Multiple Means of Action and Expression**

Where possible, mathematics tasks should:

- ✓ Encourage a variety of methods for pupils to respond and navigate through tasks
- ✓ Provide access to assistive tools and resources for pupils to use if needed
- ✓ Provide scaffolds that can gradually be released with increasing independence and skill
- ✓ Provide differentiated feedback
- ✓ Provide multiple examples of solutions to authentic problems i.e. sharing of ideas

# Patterns in 2nd/3rd Class



## Questions

What would the next figure look like?

How many squares in the 10th term?

How many squares in the 100th term?

[See Maths4All.ie](http://Maths4All.ie)





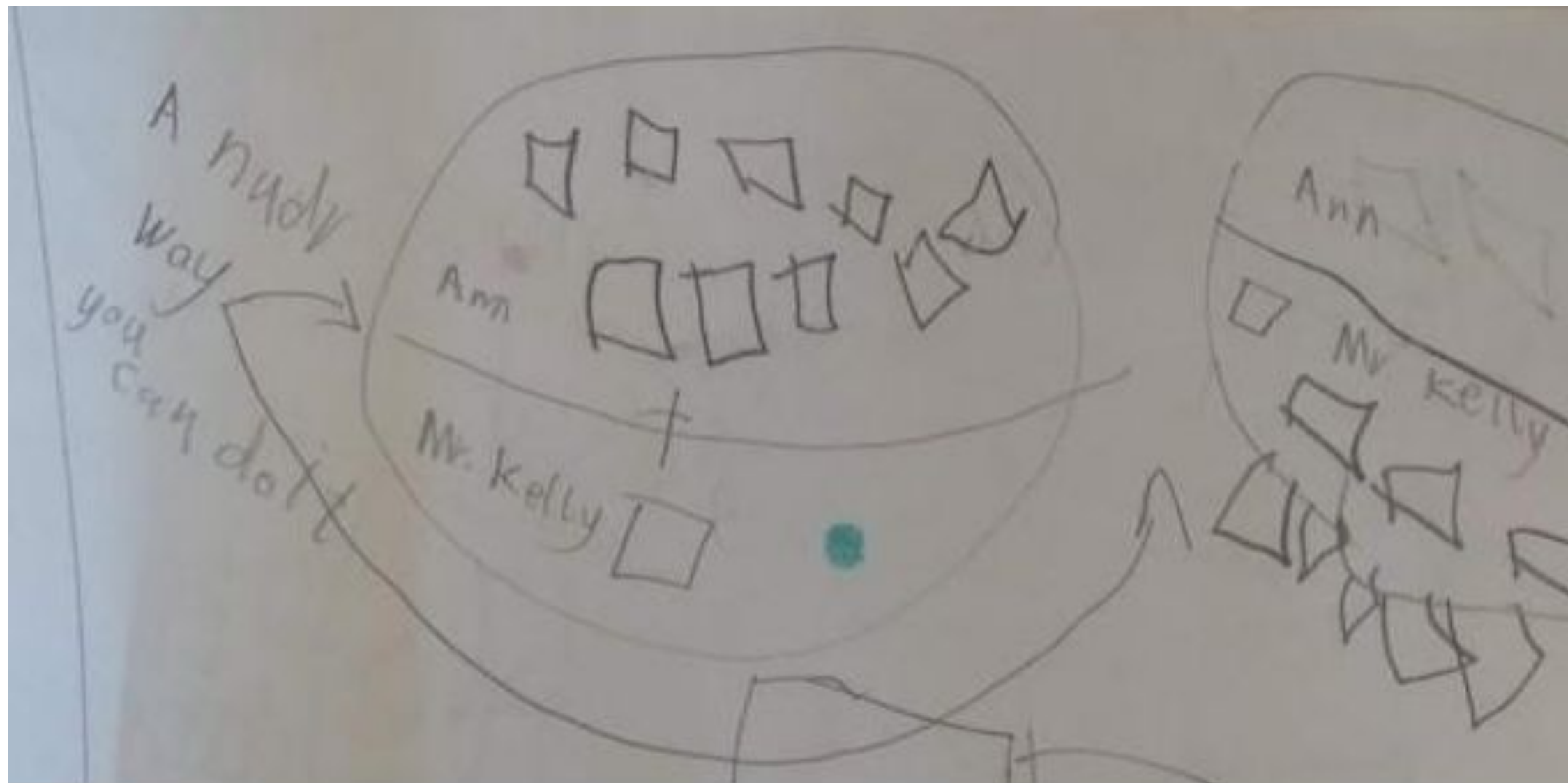
# Problem Solving in Senior Infants/ First Class

The school principal Mr Kelly needs some help. He is expecting a delivery of ten packages. He can stack some of the boxes in his office and some in Ann's office (the secretary).

How many different ways can he share the boxes between his office and the secretary's office?

See [Maths4All.ie](https://www.maths4all.ie)





ann Mr. Bell  
010

all Mr Kelly

4 6

Ann 5 + 5	Kellys 9 + 1	Ann 8 + 2	Kellys 1 + 9	Ann 2 + 8
Ann 10 + 0	Kellys 0 + 10	Ann 3 + 7	Kellys 7 + 3	Ann 4 + 6
Kelly 6 + 4				



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0 + 10 = 10

1 + 9 = 10

2 + 8 = 10

3 + 7 = 10

4 + 6 = 10

5 + 5 = 10

6 + 4 = 10

7 + 3 = 10

8 + 2 = 10

9 + 1 = 10

10 + 0 = 10

# UDL in action

- **Pose a problem that children can engage with.**
- **Class discusses estimates or solutions done mentally and these are recorded on the board.**
- **Students work in pairs or independently.**
- **Familiar materials should be available but never required for a solution.**
- **Students are helped to describe/write about solution methods and encouraged to question each other.**



# Things to consider when planning for inclusion

- Identify lesson goals
- Select **engaging** task (*accessible, spark motivation, relevant, opportunities for open-ended questions/discussion*)
- Consider how the mathematics in the task will be **represented** (*multisensory, link to relevant prior knowledge, offer multiple entry points for all learners*)
- Consider how children **act to express** their mathematical thinking (*enabling choice of methods for responding to tasks, providing differentiated feedback*)

# What next?

## **Team Teaching:**

Explanatory and support materials available from a number of sources: [PDST](#), [NCSE](#), [Slevin & Vahey 2018](#)

## **High Threshold Low-Ceiling Tasks:**

See [Nrich](#) for overview and examples

## **Three Act Tasks:**

[See GFletchy.com](#)

## **Draft Curriculum**

See [NCCA](#)

## **NEPS Maths Support Guidelines**

See [here](#)

## **Junior Cycle for Teachers**

<https://www.jct.ie/maths/resources>



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