PDST
Professional Development Service for Teachers | An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí
POST PRIMARY MATHS

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Challenging All Students' Mathematical Thinking.

Workshop Booklet

Name:_____

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Student Grouping in Maths Classes

- Boaler (2008) reported that heterogeneous grouping with a specific set of pedagogical strategies can allow students of different socioeconomic and cultural backgrounds, as well ability levels, to interact in a meaningful way that promotes respect and diversity. All students should be given opportunities to solve complex mathematical problems through collaboration with others and being exposed to different perspectives in order to truly promote equity in the mathematics classroom.
- There is much evidence to support that mixed ability grouping in mathematics appears to strongly benefit the majority of students (Venkatakrishnan & William,2003; Boaler, 1997; Linchevski & Kutscher, 1995).

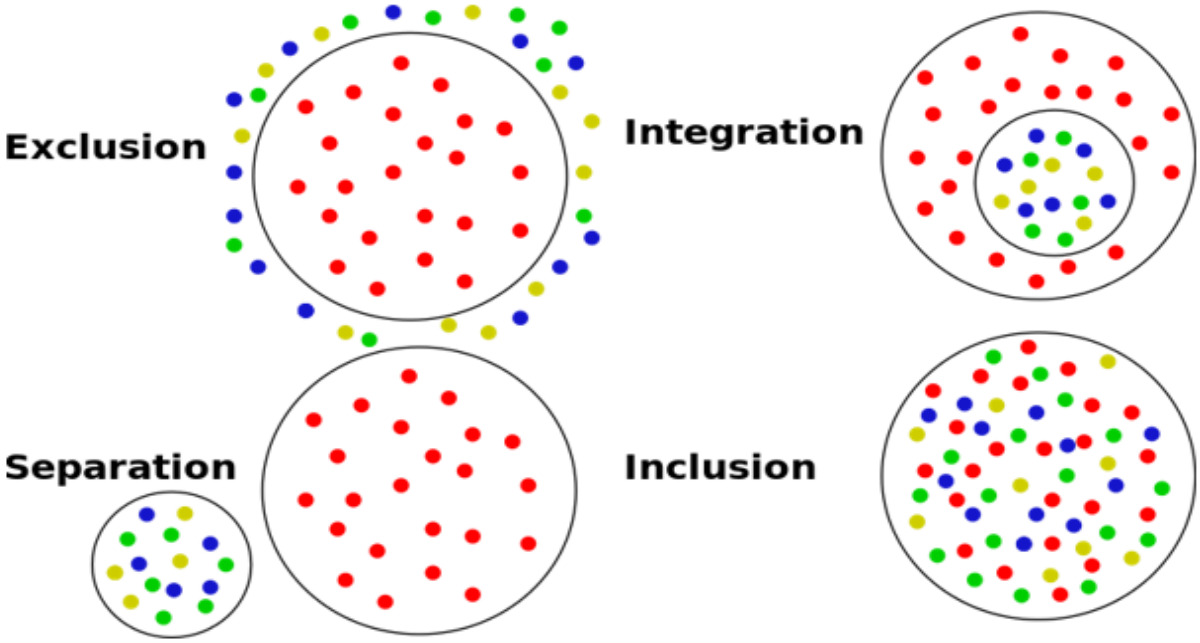
  https://blog.lboro.ac.uk/cmc/2021/03/16/mixed-ability-maths-groups-influence-pupils-mindsets-teachers-mindsets-and-teachers-beliefs-and-practices/

From Boaler, J. Wiliam, D. & Brown, M. (2000). Students' experiences of ability grouping: Disaffection, polarisation and the construction of failure. *British Educational Research Journal, 26*(5), 631-649.
"Significant numbers of students experienced difficulties working at the pace of the particular set in which they were placed. For some students the pace was too slow, resulting in disaffection, while for 6 others it was too fast, resulting in anxiety. Both responses led to lower levels of achievement than would have been expected, given the students' attainment on entry to the school."

PISA

Although Irish students are doing really well in many respects and PISA scores consistently show that on average Irish students perform above the OECD average in Mathematics, one area for concern is that the percentage of Irish students in the top performing bracket (PISA levels 5 and 6) is below the OECD average . This percentage also dropped from 10.7% in 2012 to 8.2% in 2018 compared to OECD values of 12.1% in 2012 and 10.9% in 2018.
This information gives a rationale for focussing some of our thinking on higher-achieving students today.

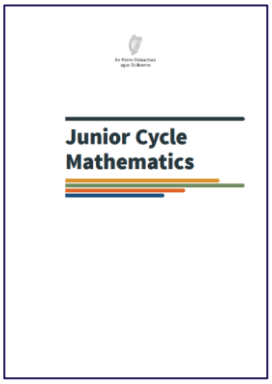
Inclusion in my School?



Rich Tasks

A rich task is :

- *Accessible to all learners*
- *Has Multiple approaches and representations*
- *Encourages, Collaboration and discussion*
- *Fosters, Engagement, curiosity and creativity*
- *Can develop Cross-topic connections*
- *Should give Opportunities for extension*



Prior Knowledge (From Junior Cycle Syllabus)

Statistics and probability strand

SP.1 investigate the outcomes of experiments so that they can:

a. generate a sample space for an experiment in a systematic way, including tree diagrams for successive events and two-way tables for independent events

b. use the fundamental principle of counting to solve authentic problems

SP.2 investigate random events so that they can:

a. demonstrate understanding that probability is a measure on a scale of 0-1 of how likely an event (including an everyday event) is to occur

b. use the principle that, in the case of equally likely outcomes, the probability of an event is given by the number of outcomes of interest divided by the total number of outcomes

c. use relative frequency as an estimate of the probability of an event, given experimental data, and recognise that increasing the number of times an experiment is repeated generally leads to progressively better estimates of its theoretical probability

Learning Outcomes (From Leaving Certificate Syllabus)

Students learn about	Students working at OL should be able to	In addition, students working at HL should be able to

1.1 Counting	– count the arrangements of n distinct objects ($n!$) – count the number of ways of arranging r objects from n distinct objects	– count the number of ways of selecting r objects from n distinct objects – compute binomial coefficients
1.2 Concepts of probability	– use set theory to discuss experiments, outcomes, sample spaces – discuss basic rules of probability (AND/OR, mutually exclusive) through the use of Venn diagrams – calculate expected value and understand that this does not need to be one of the outcomes – recognise the role of expected value in decision making and explore the issue of fair games	– extend their understanding of the basic rules of probability (AND/OR, mutually exclusive) through the use of formulae – Addition Rule: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ – Multiplication Rule (Independent Events): $P(A \cap B) = P(A) \times P(B)$ – Multiplication Rule (General Case): $P(A \cap B) = P(A) \times P(B \mid A)$ – solve problems involving sampling, with or without replacement
1.3 Outcomes of random processes	– find the probability that two independent events both occur – apply an understanding of Bernoulli trials* – solve problems involving up to 3 Bernoulli trials – calculate the probability that the 1st success occurs on the n^{th} Bernoulli trial where n is specified	– solve problems involving calculating the probability of k successes in n repeated Bernoulli trials (normal approximation not required) – calculate the probability that the k^{th} success occurs on the n^{th} Bernoulli trial – use simulations to explore the variability of sample statistics from a known population,
1.7 Analysing, interpreting and drawing inferences from data	– recognise the concept of a hypothesis test	

Reflection on Rich Tasks

For each of the three statements below, please tick one of the 5 boxes and give a reason.

This example rich task was effective in doing the following:

1. Providing motivation and challenge to higher-achieving students while being accessible to all the students in the class

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Reason(s):				

2. Promoting the development of key skills (communication, working with others, critical and creative thinking, information processing) and mathematical competency (conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition)

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Reason(s):				

3. Reinforcing mathematical learning previously seen by students

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Reason(s):				

Assessment

Asking questions is the simplest way of assessing**.** There are other ways, one of which is written. When we give a written assessment or any other kind, we should know why we are giving it. Is it summative or formative and what response should we give?
Grades result in an ego related mindset and signify that the unit of work is over. Comments result in a task related mindset. (Clark, 2005)
Hattie and Clarke (2019) say we should only give grades or comments.
When giving comments, the quality is more important than the frequency.
Comments that require student feedback are most effective but students need time to read them and a chance to use them to improve their work.
Oral Feedback is most powerful but students should write their own interpretation of feedback immediately.
In summative assessment, feedback is too late to change students' learning.

Formative Feedback Statements

"The key question is, does feedback help someone understand what they don't know, what they do know, and where they go? That's when and why feedback is so powerful, but a lot of feedback doesn't—and doesn't have any effect." - John Hattie

Formative Feedback Statements

1. Tell us more. What is the slope? What does this mean?

2. Gold star
3. Explain why you think this
4. How can we tell where a point lies in relation to a circle. Is the distance from the centre to the point shorter than the radius? Longer than the radius? The same as the radius? What does this mean?
5. Beautiful, neat work
6. Well done!!
7. You have given one root of the equation. Are there any others?
8. Develop these ideas further
9. What type of graph would be most suitable to present these data?
10. Good, but not as good as your brother's!
11. How do you know...?
12. You must try harder
13. First place in the class
14. Try one of these or one of your own instead of a bar chart - stem and leaf chart, histogram
15. Lovely diagram
16. You're the best
17. 10/10
18. The slope being zero at this point means... (finish this sentence)
19. You gave very good reasons why the triangles are congruent. To improve your work, you need to include all of the reasons. Look back and check to see which ones you have left out.
20. What justification can you give for this being a right-angled triangle?

Activity 1

The sorting sheet

Yes	No

Activity 2

Classification worksheet

Reminder prompt	Scaffold prompt	Example prompt

Formative Feedback on Student Work

Write down 1 - 3 comments for each student. Remember “quality not quantity” and Dylan William’s questions “Where are they? Where are they going? How will they get there?” Decide what type of prompt (reminder, scaffold or example) is most suitable for each student and why.

Student A

Student B

Student C

Reflection On Formative feedback

Remember the criteria for Effective Feedback (from the NCCA document)

- Focused on the quality of the student work
- Related to agreed success criteria
- Identifies success and achievement
- Indicates suggestions for improvement
- Prompts student thinking
- Allows time for improvement to take place

1. How will I implement effective formative feedback in my maths classes?
2. How will feedback be recorded and acted upon by the students?
3. What's an achievable workload for myself, the teacher?

Criteria For Good Practice

What makes for good practice?

A) I give my best students different work to do so that they are all challenged.

B) Students set questions for each other to challenge each other.

C) Students regularly present their work and ideas to the class

D) Anyone who finishes early gets an extra worksheet so they have more to do.

E) Students tackle open ended tasks that have no defined correct answer or method. They can use the maths that they know to present solutions.

F) Students take part in Mathsweek activities.

G) Students get to pick their own questions from the textbook. They can attempt the questions appropriate to their level.

H) We have a problem solving class every Friday. Students get to choose their problems from a box of problems.

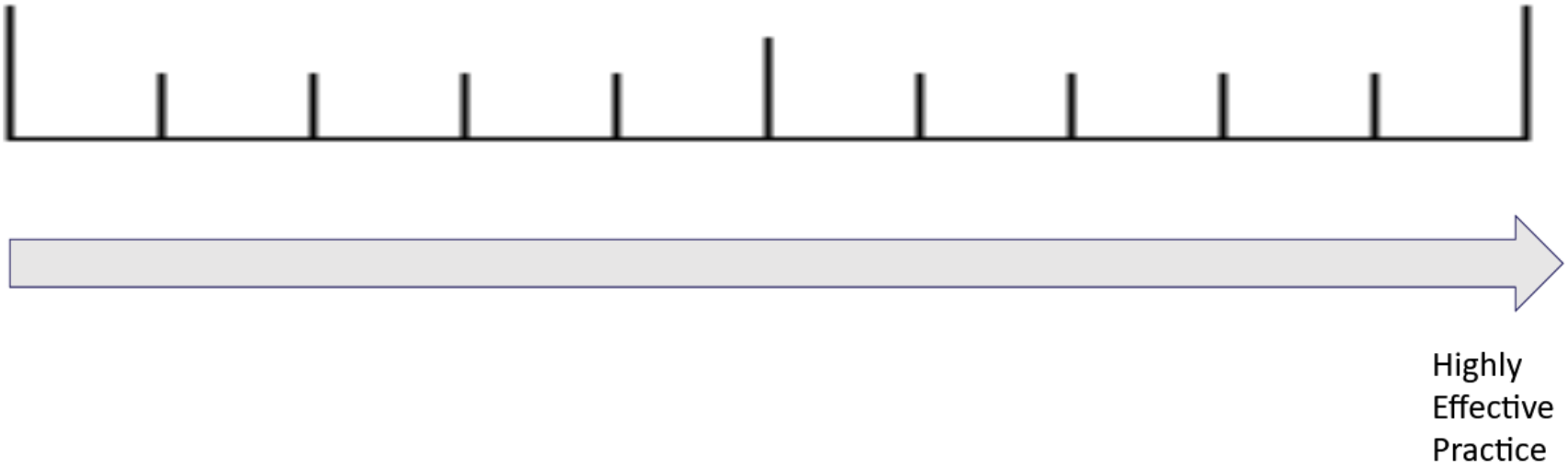
I) Our best students compete in the IMTA maths competition.

J) Students are encouraged to come up with multiple ways to solve the same problem so they are always busy.

K) The better students in my class help those who need it.

L) Students correct each other's work.

What makes for good practice?



Learning Outcomes

How and when will I think about these with my students?

Reading List

Introduction

Florian, L. and Spratt, J. (2013) Enacting Inclusion: A Framework for Interrogating Inclusive Practice. European Journal of Special Needs Education, 28, 119-135. https://doi.org/10.1080/08856257.2013.778111

Perkins, R. and Shiel, G. (2016) PISA in Classrooms: Implications for the teaching and learning of mathematics in Ireland

Perkins, R., Clerkin, A and Chubb, E. (2020) Students' perspectives on learning mathematics and science: Results from TIMSS 2015 in Ireland

Boaler J. (2017) Positive Norms https://www.youcubed.org/wp-content/uploads/2017/08/2017-Positive-Norms-DeFacilitationNotesion-Paper-1.pdf

O'Meara, N., Prendergast, M. & Treacy, P. (2020). What's the point? Impact of Ireland's bonus points initiative on student profile in mathematics classrooms. Issues in Educational Research, 30(4), 1418-1441. http://www.iier.org.au/iier30/omeara.pdf

Boaler, J. Wiliam, D. & Brown, M. (2000). Students' experiences of ability grouping: Disaffection, polarisation and the construction of failure. *British Educational Research Journal, 26*(5), 631-649.

Formative Assessment

Dylan Wiliam, LSI: Learning Sciences International, Strategy 1: Clarifying, Sharing, and Understanding Learning Intentions, https://youtu.be/fC29IyqPVr0

Vygotsky on Zone of Proximal Development, https://www.simplypsychology.org/Zone-of-Proximal-Development.html

NCCA, Focus on Learning Formative Feedback, 2015

Hattie, J., & Clarke, S. (2019). *Visible learning: Feedback*.

Rich Task Background

Rich Tasks and Contexts *https://nrich.maths.org/5662*

Foster, C. Developing mathematical fluency: comparing exercises and rich tasks. *Educ Stud Math* 97, 121–141 (2018). https://doi.org/10.1007/s10649-017-9788-x

Rich Task Ideas

Factors, primes etc.: https://donsteward.blogspot.com/2011/04/find-number.html

Difference of 2 (hollow) squares: https://nrich.maths.org/11257
https://nrich.maths.org/742
https://nrich.maths.org/658&part=

Sum to a sixth: https://donsteward.blogspot.com/search/label/functions

Algebraic Fractions
https://donsteward.blogspot.com/search/label/algebraic%20fractions