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Problem Posing Pro-Forma using photographs

Assumption
A numerical or maths problem has multiple solutions or none, it is framed as an open-ended question. There is no clear path to the answer – students cannot easily use a formula. Within the problem students are often given too much information or not enough.

1. Activity Name: How many different ways can you arrange the flags?

2. Expected duration of activity: 40 minutes (but more time may be required depending on the depth of learning to be developed.

3. What EQF level is the activity (approximately)? EQF levels 2-4.

4. What is the topic? Number patterns that can lead into factorial functions

5. What are the Learning Outcomes? Explore patterns in number leading to an understanding of factorials; for example, 3! (read this as “3 factorial”) is 3 x 2 x 1 = 6.

6. Prerequisite/prior knowledge assumed? Students may be aware of the need to work systematically and to record their work in an effective way, however; these ideas may be taught through this activity

7. In what ways does the problem, or the way the problem is delivered to the students:
   - encourage critical way of investigating and thinking? No guidance should be given initially to students on how to record different permutations. Students will therefore be free to investigate various methods to explore the relationship between the number of flags and the number of permutations for displaying them.

   - encourage analysis? Students should be encouraged to analyse number patterns as they add additional flags

   - allow students to be creative? Students may use pen and paper, physical objects, GeoGebra, spreadsheets or other methods to explore the problem.

   - allow independent learning? Students may work individually although group work would be preferable to encourage discussion and reflection.

   - allow for co-operative learning? Working in groups encourages students to share their ideas, articulate their reasoning and to ask questions of one another.

- allow students time to think? The teacher/tutor should allow enough time for the activity so that students are able to explore without a time pressure and hence allow for deeper learning.

- have a relevant or interesting context? Photographs display real life context

- allow for multiple ways of solving or investigating the challenge? Students should be encouraged to explore different approaches to investigate the problem including the use of a simpler example.

8. Resources or materials required? Photograph, paper, different coloured pens, or objects that can represent the different flags, Geogebra, Excel or other spreadsheet application.

9. What technology is required in the delivery of the problem? The photograph may be displayed through PowerPoint or other similar presentation software.

10. What technology might potentially be required in the solving of the problem? The problem does not require any technology to solve, however; where students wish to use GeoGebra, Excel or other spreadsheet programme this may be of benefit.

11. Suggestions for delivery

    PowerPoint slide 1
    Present the photograph to students. Then pose the problem…

    How many different ways could these flags be displayed?
    Allow some time for students to consider how they might approach this and allow them to ‘have a go’.

After a short time, bring students together and introduce the strategy of exploring the problem using a simpler example.

PowerPoint slide 2

The flags of Europe, Italy and Venice are displayed in this photograph. How many different ways could the flags be arranged?

Students should work collaboratively to explore this problem.

Encourage the students to start by considering how they might record what they are doing and what they find out. Some students may wish to draw pictures, letters, or manipulate physical objects whilst others may come up with alternative ideas. Some students may prefer to use technology.

The teacher/tutor should encourage groups to work systematically to make sure that they discover every possible arrangement for displaying the flags.

Students should be able to work out that for 3 flags, there are 6 different arrangements. Students should share their approaches with the rest of the class and discuss how they know that every possibility has been found.

If we add another flag to the display, how many different ways could 4 flags be displayed?

Students may use the same approach as before or choose a different approach if they think this is more effective.

After some time, the students should be able to identify 24 different ways to display the flags.

Again the teacher/tutor should lead a discussion on what strategies students used to be sure that they have identified every combination without any

duplications. Can the students find any pattern emerging that would enable them to hypothesise for n number of flags? Students should be encouraged to hypothesise for 5 flags and then test their hypothesis. If appropriate, teachers/tutors may introduce the term, 'factorial'.

Can students solve for 14 flags?

Solutions:
1 flag = 1 permutation
2 flags = 2 permutations = 2x1
3 flags = 6 permutations = 3x2x1
4 flags = 24 permutations = 4x3x2x1

14 flags = 14! = 87178291200