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REDUCING MATHS ANXIETY AND ENHANCING PROBLEM-SOLVING SKILLS THROUGH GOAL FREE PROBLEMS

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Introduction

Maths anxiety continues to undermine pupils' confidence, progress, and enjoyment – an issue that becomes particularly evident in Year 6, a time marked not only by academic pressure and high-stakes assessments but also by significant life transitions, such as preparing for secondary school. Research indicates that girls often experience higher levels of maths anxiety than boys, which can negatively impact their engagement and performance (Devine et al., 2012). Alongside this, developing mathematical problem-solving skills is a key educational goal. One pedagogical approach gaining traction is the use of goal-free problems, which aim to reduce cognitive overload and allow students to explore problems, think more deeply, and develop mathematical strategies - all without the pressure of reaching a single 'correct' answer. This study investigates the effectiveness of goal-free problems in reducing maths anxiety and promoting problem-solving confidence in Year 6 pupils, highlighting gender differences.

Background of the Problem

The study was conducted across Year 6 pupils at Safa British Safa School. The Year 6 teachers observed several pupils, especially girls, showing visible stress or avoidance behaviours during structured maths problems. These behaviours included reluctance to start tasks, needing frequent reassurance, or lack of resilience to complete tasks. This has been a consistent issue across academic years, resulting in lower attainment in girls than boys (particularly in Term 1 of the school year). If left unaddressed, this anxiety can damage long-term attitudes towards mathematics, as well as academic performance. By implementing goal-free problems, a low-pressure environment is created which encourages deeper thinking and greater confidence. In turn, this should help to improve academic performance, as well as reduce the gender-gap in attainment.

Literature Review

Maths anxiety is a well-researched and widely recognised barrier to learning, defined by Ashcraft and Krause (2007) as "a feeling of tension that interferes with the manipulation of numbers and the solving of mathematical problems in various life and academic situations." It can reduce working memory capacity, leading to avoidance, low confidence, and underachievement (Ashcraft and Ridley, 2005).

One effective strategy for reducing this mathematical anxiety is the use of goal-free problems, introduced by Sweller (1988) to reduce cognitive load, thereby improving conceptual understanding. Devine et al. (2012) highlighted the imbalance of maths anxiety, noting that girls often report higher anxiety levels despite equal ability.

In addition, several studies suggest that open-ended tasks like goal-free problems enhance pupils' metacognitive awareness and reasoning skills (Kazemi and Stipek, 2001). Boaler (2016) advocates for problem-solving tasks that allow for exploration and risk-taking, aligning with the goal-free approach. These types of problems allow learners to develop flexible problem-solving strategies. The interconnectedness of maths anxiety, gender dynamics, and the need to develop problem-solving skills indicates a significant opportunity for targeted strategies such as goal-free problems to make a meaningful difference.

Methods

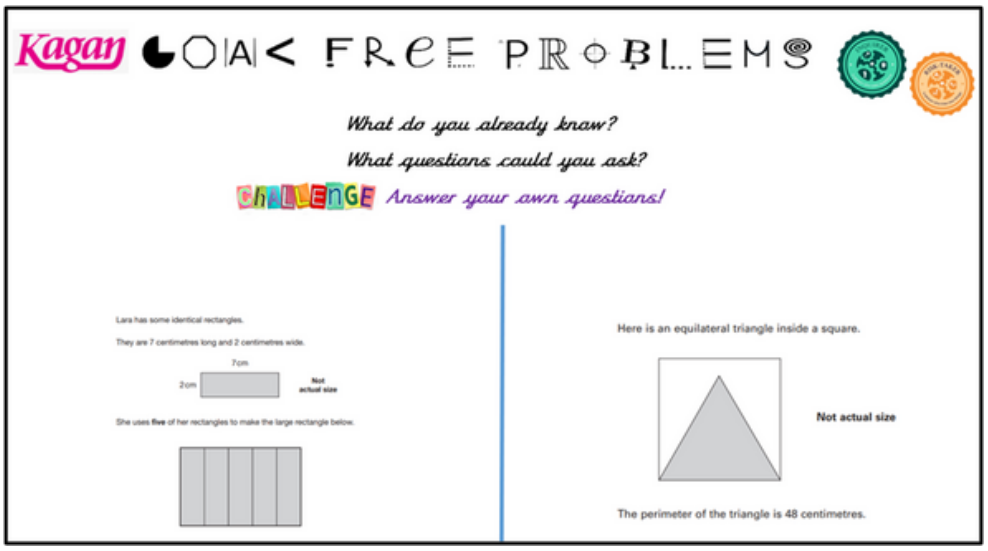
This action research utilised a mixed-methods approach to evaluate the impact of goal-free problems on maths anxiety and problem-solving skills across a Year 6 cohort. The research questions were:

- Do goal-free problems reduce maths anxiety among Year 6 pupils?
- Are there gender-based differences in response to goal-free problems?
- Do goal-free problems support the development of problem-solving strategies?

Methodology

The sample of this research study consisted of 69 Year 6 pupils who participated in topic-based goal free problems lessons across the academic year (13 in total). Lessons were designed to be low-pressure, with collaborative group work encouraged. Pupils were given mathematical prompts (see **Figure 1**) without specific instructions, where they answered open-ended questions such as "What do you already know?" or "What questions could you ask?" Subsequently, data was collected via pre- and post-topic assessment scores, a post-implementation of goal-free problems survey, teacher observations, and pupil reflections.

Figure 1 : An example of a goal-free problems task.



Participants

69 Year 6 pupils participated (39 girls, 30 boys) from six classes across the year group at Safa British School, with all pupils from mixed-ability groupings. The five other Year 6 teachers also participated in a post-implementation of goal-free problems interview.

Data Collection

The methodology of this research incorporated both quantitative and qualitative data, in the form of online surveys for pupils to complete, teacher observations and interviews post-implementation of goal-free problem lessons, and analysis of summative data. These were used to not only assess the impact on the pupil's anxiety levels and increased problem-solving skills, but also to gain a deeper insight into the teachers and pupils' perceptions on the strategy.

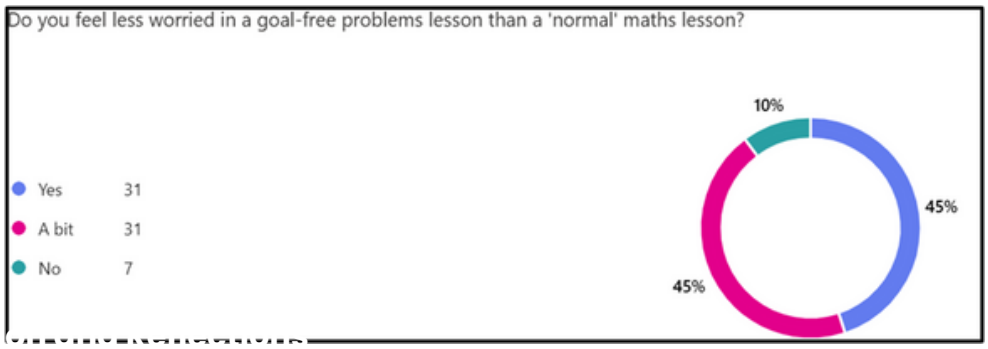
Data Analysis

The data was analysed using descriptive statistics to identify key trends across pupil responses, with a central component being pupil voice to indicate the effectiveness of goal-free problems on their own perceptions of maths anxiety and problem-solving skills. Summative data was collected from pre- and

post-topic tests to analyse the impact of the implementation of goal-free problems on the academic achievement of pupils. This approach allowed triangulation of qualitative and quantitative data.

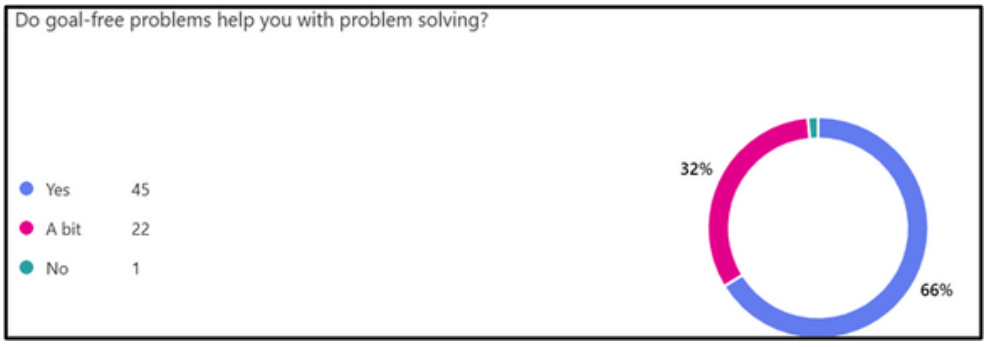
With regards to pupil voice, an overwhelming majority of 90% of participants stated that they felt less worried, or 'a bit' less worried in goal free problems, rather than 'normal' maths lessons (see **Figure 2**), suggesting pupils' anxieties surrounding maths were significantly reduced during goal-free problems lessons over the course of the year.

Figure 2: Feelings of worry compared to traditional lessons



A significant 98% of participants found goal-free problems to support their problem-solving skills, indicating an improvement in pupils' overall confidence in their critical thinking skills to tackle more complex problems within mathematics (see **Figure 3**).

Figure 3: Impact on Problem Solving



From analysing the internal summative data for the Year 6 Baseline and End of Year Data (see **Figure 4**), it is evident that pupils' academic achievement increased substantially from the start to the end of the year. At the start of the year, only 25% of pupils were performing above expectations, while by the end of Year 6, this rose to 83%.

This significant improvement suggests that the introduction of goal-free problems positively impacted pupil outcomes. The rise in 'exceeding' scores indicates that cognitive load and anxiety helped more pupils access higher-level reasoning and problem-solving questions – reflecting pupil feedback about increased confidence, reduced worry, and deeper thinking.

Figure 4: Internal mathematics data for Year 6 (baseline to end of year)

Maths Baseline											
Emerging	%	Emerging +	%	Expected	%	Expected +	%	Exceeding	%	Exceeding +	%
3	16.00%	1	66.67%	5	20.83%	0	0.00%	0	0.00%	0	0.00%
0	4.17%	1	45.83%	6	25.00%	3	12.50%	4	16.67%	0	0.00%
6	16.67%	2	45.83%	5	20.83%	2	8.33%	0	0.00%	0	0.00%
4	5.00%	3	59.09%	3	13.64%	1	4.55%	1	4.55%	0	0.00%
4	22.73%	0	36.36%	3	13.64%	3	13.64%	4	18.18%	0	0.00%
4	#DIV/0!	0	72.73%	2	9.09%	0	0.00%	0	0.00%	0	0.00%
21	#DIV/0!	7	54.42%	24	17.17%	9	6.50%	9	6.57%	0	0.00%
Total Count	70										
At and Above	42	60.00%									
Above	18	25.71%									
Baseline	Weak										

Maths											
Emerging	%	Emerging +	%	Expected	%	Expected +	%	Exceeding	%	Exceeding +	%
0	0.00%	0	0.00%	1	4.35%	5	21.74%	9	39.13%	8	34.78%
0	0.00%	2	8.70%	1	4.35%	2	8.70%	8	34.78%	10	43.48%
0	0.00%	3	12.50%	6	25.00%	3	12.50%	6	25.00%	6	25.00%
0	0.00%	1	4.35%	3	13.04%	1	4.35%	13	56.52%	5	21.74%
0	0.00%	2	8.70%	1	4.35%	1	4.35%	10	43.48%	9	39.13%
0	0.00%	0	0.00%	3	13.64%	9	40.91%	6	27.27%	4	18.18%
0	0.00%	8	5.71%	15	10.79%	21	15.42%	52	37.70%	42	30.39%
Total Count	138										
At and Above	130	94.20%									
Above	115	83.33%									
T2	Outstanding										

Examples of Teacher Verbatim
Teacher feedback echoed the trends seen in pupil responses. Notably it was evident that staff observed similar benefits in their classrooms.

"A real benefit to having such student-led, open-ended opportunities is that the pupils' problem-solving skills and resilience have developed in ways that I have not seen before." – Year 6 Teacher A

"The fact there is not right or wrong has prevented enormous amounts of anxiety, particularly in my female pupils." - Year 6 Teacher N

Results

The impact of goal-free problems on pupils' maths anxiety and problem-solving skills was overwhelmingly positive. 90% of participants stated that they felt less worried during goal-free problems lessons (see **Figure 2**). Of these, 80% were female, suggetsing a greater reduction in maths anxiety among girls. Figure 3 shows that 98% of pupils reported an improvement in their problem-solving skills, while 80% expressed a desire for more goal-free lessons in the future (see **Figure 5).**

In terms of emotional engagement, 54% of pupils reported feeling 'happy' or 'excited' and a further 38% of pupils described themselves as 'curious' during these lessons (see **Figure 6**), indicating consistently high levels of engagement and enjoyment. Additionally, **Figure 7**, the word cloud of open-ended responses, highlights recurring themes such as 'fun', 'interesting', and 'deep reasoning', reinforcing the positive pupil experience.

Figure 5: Pupils' desire for goal-free problem lessons

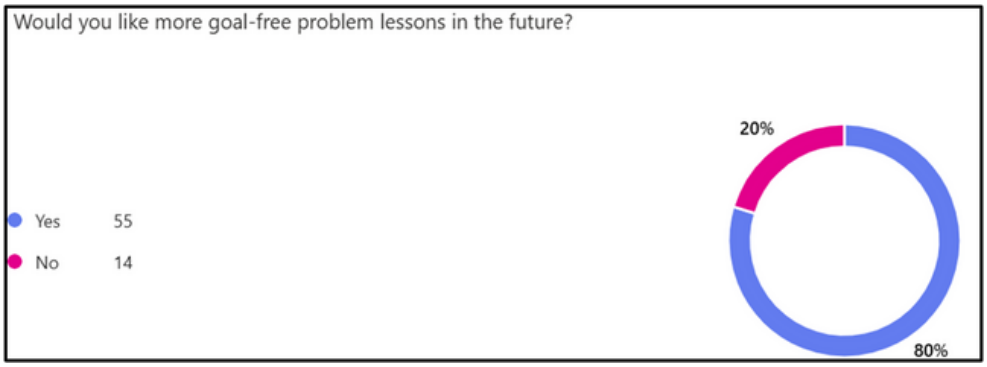


Figure 6: Pupils' feelings during goal-free problem lessons

Figure 7: Pupils' descriptions of goal-free problems

Discussion and Reflections

The findings suggest that goal-free problems reduce maths anxiety and increase engagement, especially for pupils who may find traditional tasks intimidating. The high rates of curiosity, reduced worry, and increased critical-thinking skills reinforce Sweller's (1988) theory of reduced cognitive load. The positive emotional engagement, seen in the data from pupils, supports Boaler's (2016) idea that exploratory, non-intimidating environments enhance conceptual understanding.

Wider Impact

Colleagues at Safa British School have expressed interest in adapting this approach, particularly after seeing the improvement in pupil confidence and engagement. Sharing this in continuous professional development has inspired a more inclusive approach to the teaching of mathematics at Safa British School, as well as trialing this approach in other subject areas.

Conclusion

This action research confirms that goal-free problems enhance problem-solving skills and reduce maths anxiety among pupils. The combination of quantitative results and qualitative pupil voice makes a compelling case for integrating goal-free problems regularly at all ages in primary maths lessons. A further study may delve deeper into the impact of goal-free problems on long-term attainment across a range of ages.

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