IOCES 2026 Conference
The 1st International Online Conference on Education Sciences
15–17 June 2026 | Online
MDPI

The Art of Transforming Invisible Paths: A Practical Proposal for Applying Mathematics in Mechanical Contexts

Francisco Seguí Blasco, Rubén Caballero Toro
Universidad Miguel Hernández

INTRODUCTION & AIM

The STEM framework, in accordance with Project-Based Learning (PBL), is proposed as an ideal solution to achieve contextualized mathematics teaching.

The practical proposal, to be implemented in the 1st year of compulsory secondary education (ESO), is based on building a scale model of the mechanism known as the "Tusi couple". In this way, students learn essential learning outcomes through direct experimentation.

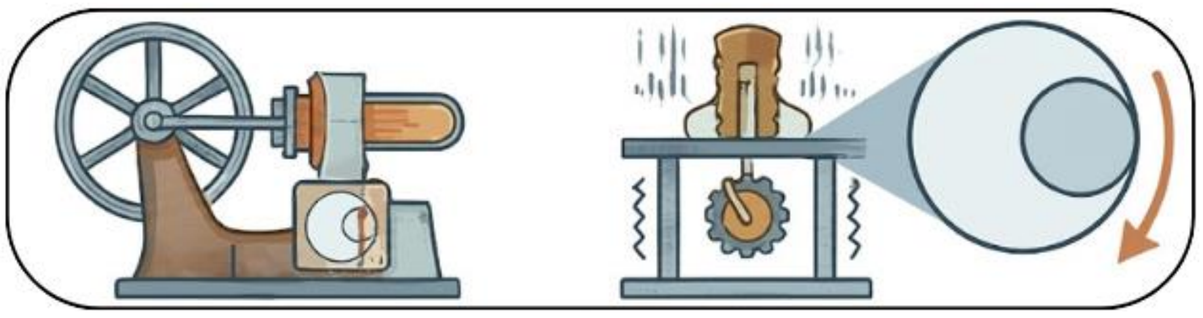
METHOD

The bibliographical analysis was carried out using the PRISMA 2020 method. The process included the databases: Scopus, Web of Science, and Google Scholar. The descriptors used included: "project-based learning (PBL)", "STEM education", "Tusi couple", and "mechanism design".

Specific Competences		Key Competences					
		STEM2	CD2	CD3	CD5	CE3	CCEC4
CE2	Rigorous reasoning and patterns	---	---	---	X	---	---
		---	X	---	---	---	---
CE4	Computational thinking	---	---	---	X	---	---
CE5	Mathematical representations	---	---	---	X	X	X
CE6	Communication of processes	X	---	---	---	---	---
CE7	Historical and social relevance	---	---	X	---	---	---

RESULTS & DISCUSSION

It was confirmed that the 1:2 radius ratio allows for the conversion of rotational into linear motion, with applications in Stirling engines and rolling pendulums.



The PBL methodology and the STEM approach foster motivation and performance. By experiencing motion and its transformation, students transition from isolated thinking to contextualized conceptualization.

PROPOSAL PRACTICE. "FIGURES IN ACTION: POLYGONS AND AREAS"

The practical proposal comprises 5 phases.

1. Pupils become engineers, they must understand the blueprints and the relationship of trajectories before building.
2. In pairs, they must find 2 real-world applications of the Tusi couple mechanism and investigate the concept of a hypocycloid.
3. **Proportions**

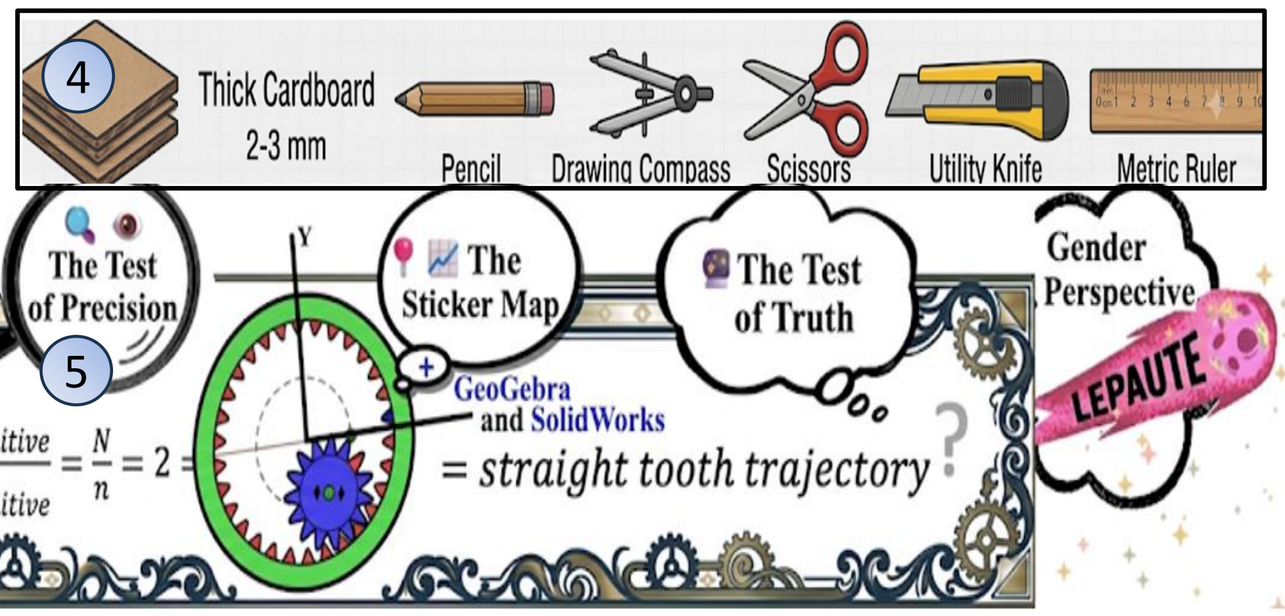
$$\frac{R_{large\ primitive}}{R_{small\ primitive}} = \frac{N}{n}$$

Length Calculations

$$L_{primitive\ pinion} = 2 \cdot \pi \cdot R_{small\ primitive}$$

$$L_{primitive\ gear} = 2 \cdot \pi \cdot R_{large\ primitive}$$

4



CONCLUSION

There are some limitations: cardboard can hinder smooth gear operation, and constraints related to time, training, or software licenses such as SolidWorks make deeper implementation more difficult.

This proposal enables students comprehend mathematics as the basis of everyday technology.

FUTURE WORK / REFERENCES

As future lines of work, it is proposed to incorporate 3D printing and, in high school, to use dynamic geometry software to study more complex curves.

-Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. International Journal of STEM education, 3(1), 11. DOI: 10.1186/s40594-016-0046-z