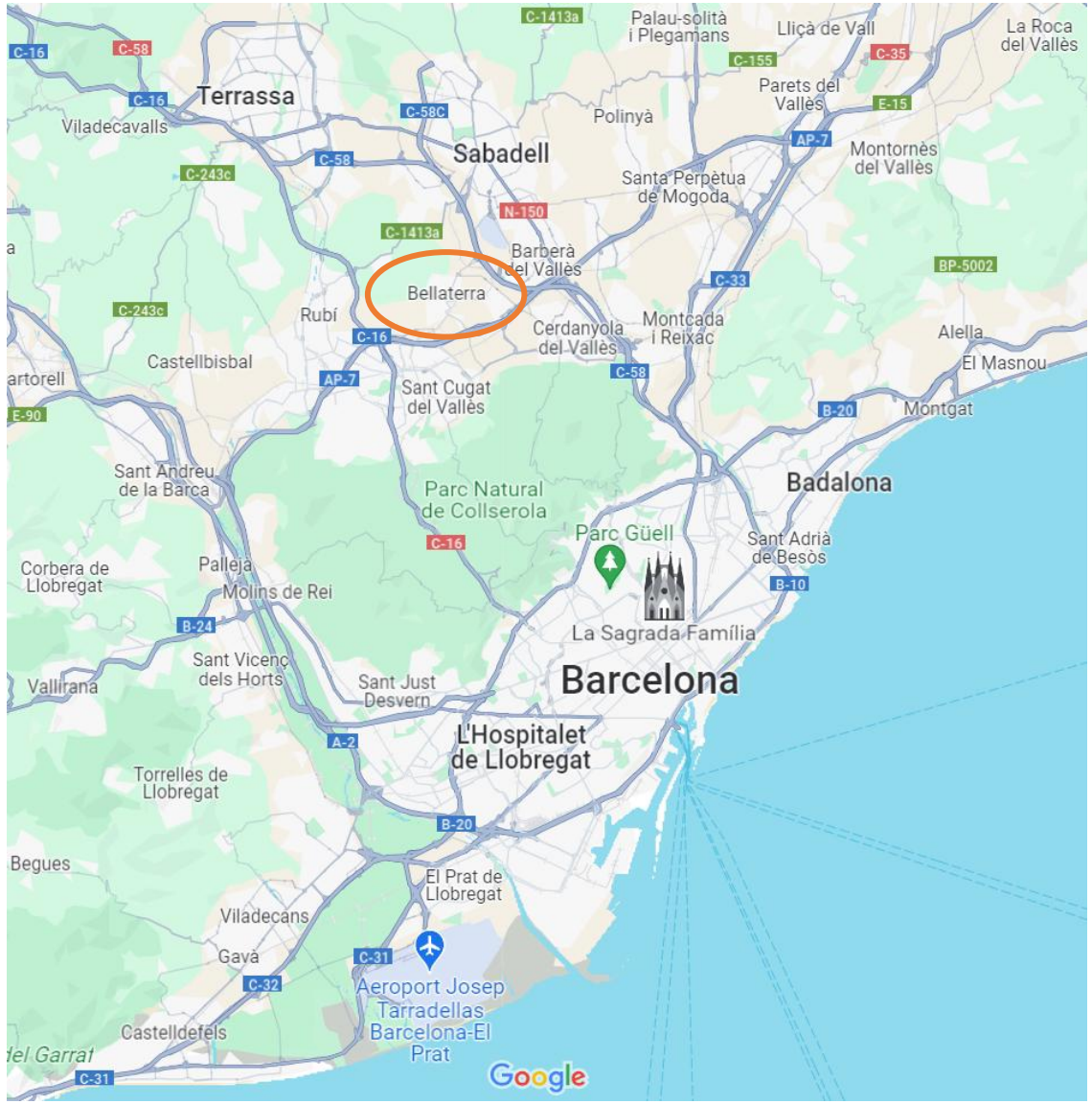
Introducing mathematical modelling in schools

Lluís Albarracín

lluis.albarracin@uab.cat



Universitat Autònoma de Barcelona





109

bachelor's degrees (2022-2023)

143

official master's degrees (2022-2023)

135

UAB Master's Degrees (2021-2022)

314

lifelong learning programmes (2021-2022)

27,301

undergraduate students (25,709 full-time equivalent) (2022-2023)

3,127

official master's students (2022-2023)

Fermi problems

as activities to introduce mathematical modelling

Estudio de actividades de modelización matemática para orientar la formación inicial y continua del profesorado de educación obligatoria (MMA4TEACHERS)

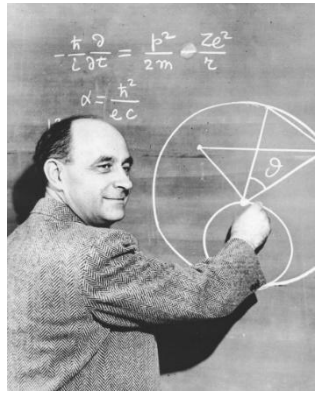
PID2021-126707NB-I00







Fermi problems (FP)



- FPs are characterized by presenting a situation that provides little or no concrete information to guide the resolution process (Efthimiou & Llewellyn, 2006).

- Some examples:
- Estimating the number of cars in a 3 km traffic jam on a highway (Peter-Koop 2009);
- Approximate estimation of the number of hemoglobin molecules the body makes each second (White 2004);
- Estimate how many shopping malls there are in the United States (Anderson & Sherman 2010).

¿Cuántas personas viven detrás de las ventanas iluminadas que veo desde mi habitación de hotel?



- Real, open-ended problems that require students to make assumptions about the situation in order to reach an estimate (Ärlebäck, 2009), following the Fermi method (Arlebäck & Albarracín, 2019)

- Break down into simpler subproblems.
- Chain of educated guesses and/or reasonable partial estimates until the final estimate is reached.

Sequences of Fermi problems

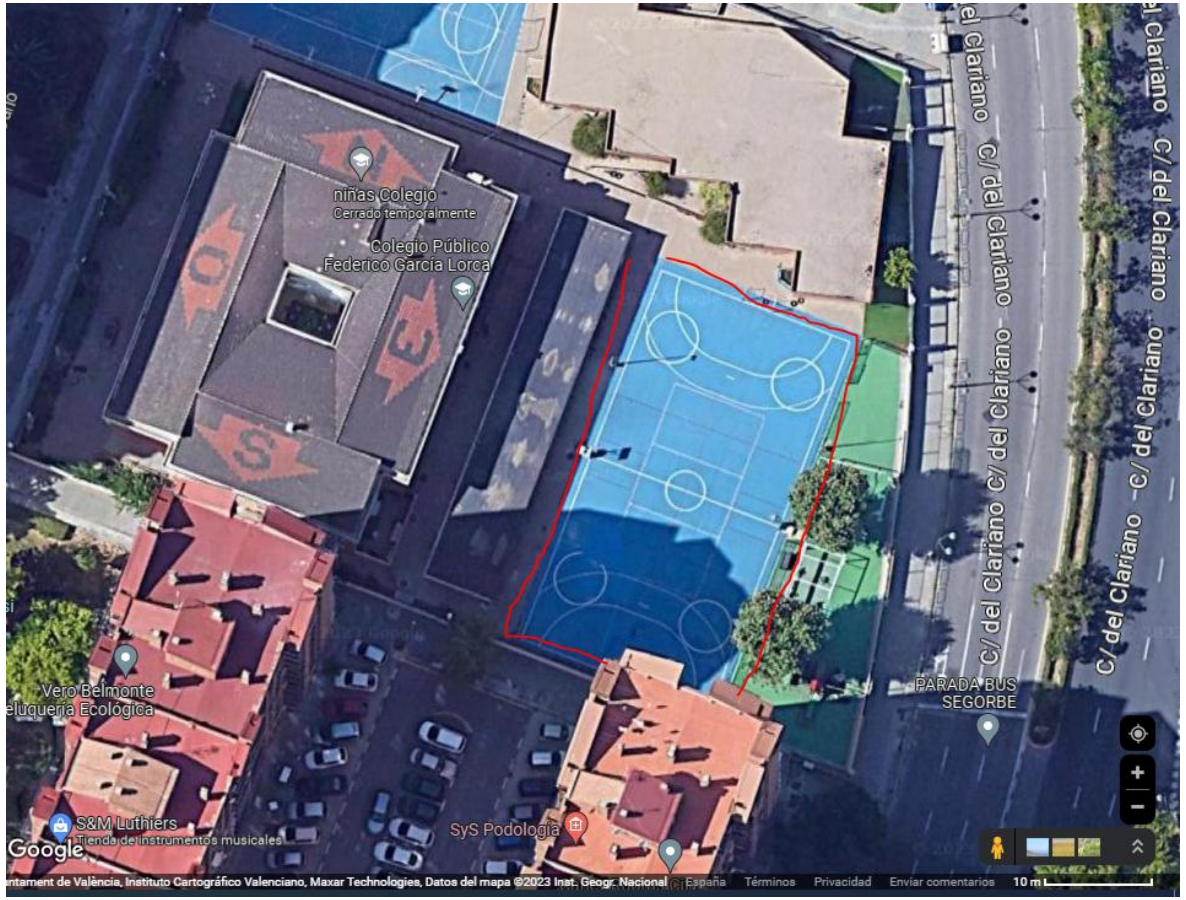
A1. How many people would fit in the high school playground?
A2. How many people would fit in the American Airlines Arena (Miami) during a concert?
A3. And what about in the town hall square of your city during a demonstration?
A4. How many trees are there in Central Park (New York)?

B1. How many drops of water would fill a whole bucket?
B2. How many coins would fit into a cubic safebox of 1 m^3?
B3. How many glasses of water are needed to fill a swimming pool?
B4. How many oranges would fit in a truck?

C1. What is the sum of the ages of all the people in the school?
C2. How many e-mails are sent in your province every day?
C3. How much are all the cars of your city worth altogether?
C4. How many textbooks are sold in your city every academic year?

D1. How long would it take to walk right around your town once?
D2. How long would it take to cycle from Los Angeles to Toronto?
D3. How long would a spacecraft take to reach the moon?
D4. How long would it take to fly around the Earth once by plane?

Estimating persons/objects in a surface



We want to organize a concert in the school playground to raise funds for the end-of-year trip,

How many tickets can we sell?

Models and mathematical procedures

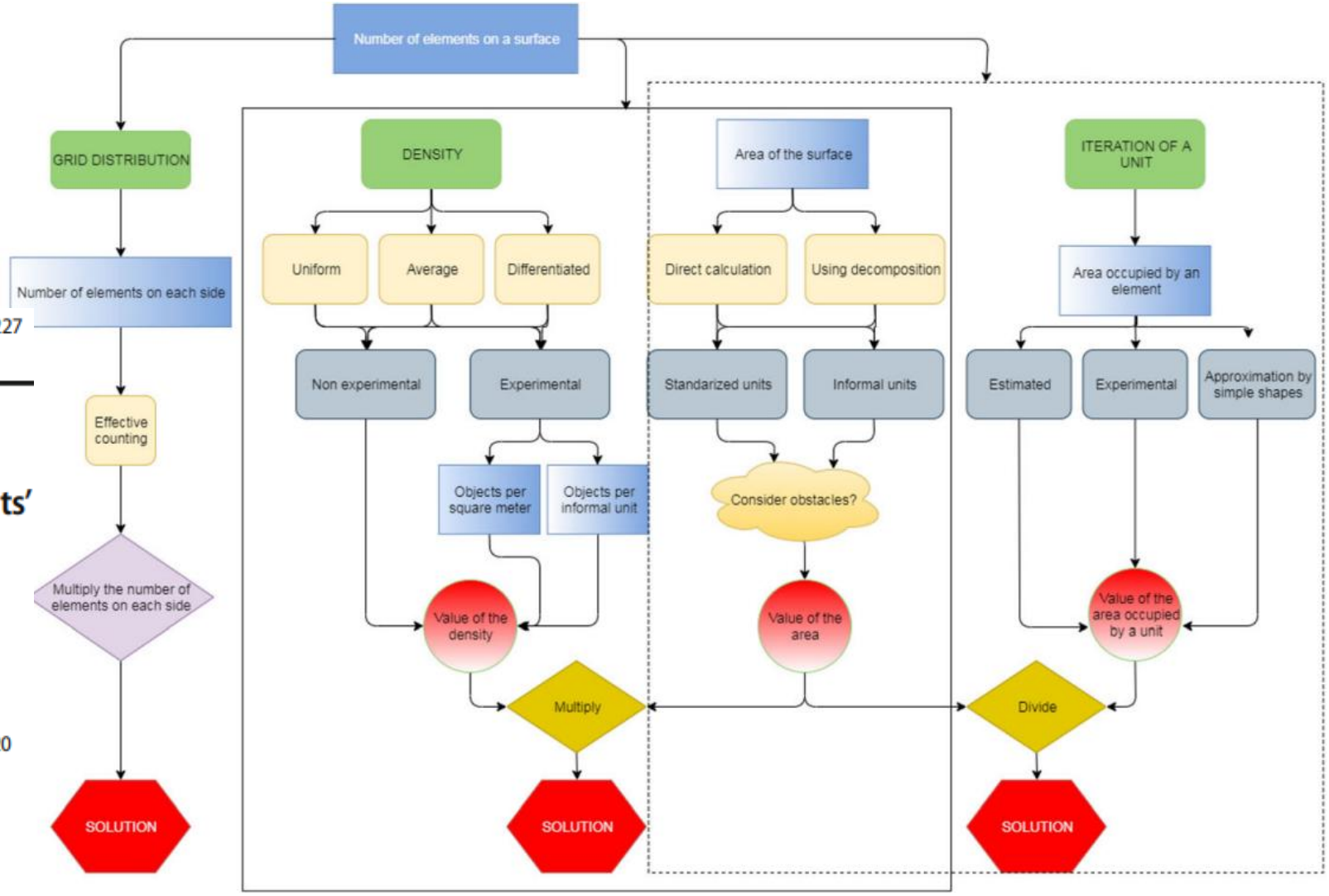


International Journal of Science and Mathematics Education (2021) 19:1209–1227
https://doi.org/10.1007/s10763-020-10107-4

The Role of Context for Characterising Students' Strategies when Estimating Large Numbers of Elements on a Surface

Lluís Albarracín [1] · Irene Ferrando [2] · Núria Gorgorió [1]

Received: 10 July 2019 / Accepted: 2 June 2020 / Published online: 19 June 2020
© Ministry of Science and Technology, Taiwan 2020



Estimating persons/objects in a surface

Teaching Mathematics and its Applications: An International Journal of the IMA (2021) **00**, 1–15
https://doi.org/10.1093/teamat/hrab027 Advance Access publication

Supporting mathematical modelling by upscaling real context in a sequence of tasks

Lluís Albarracín[†,*], Carlos Segura[‡], Irene Ferrando[‡] and Núria Gorgorió[†]

MODESTUM OPEN ACCESS

EURASIA Journal of Mathematics, Science and Technology Education, 2018, 14(10), em1579
ISSN:1305-8223 (online)
Research Paper https://doi.org/10.29333/ejmste/92285

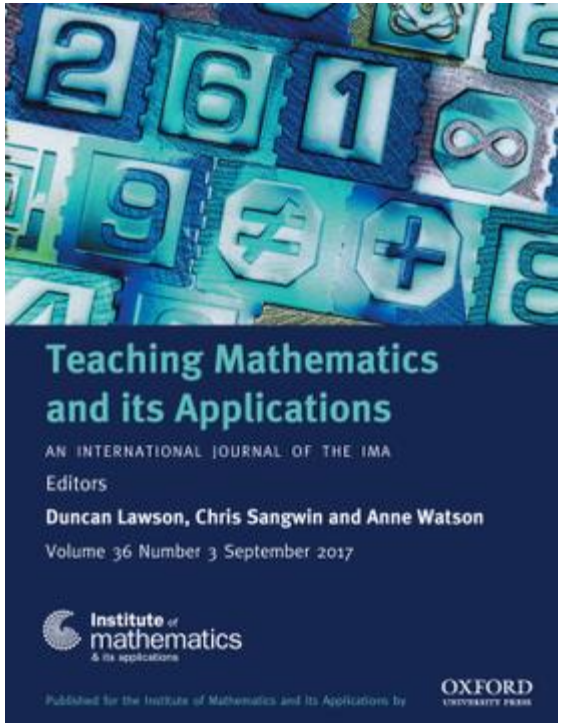
Students Estimating Large Quantities: From Simple Strategies to the Population Density Model

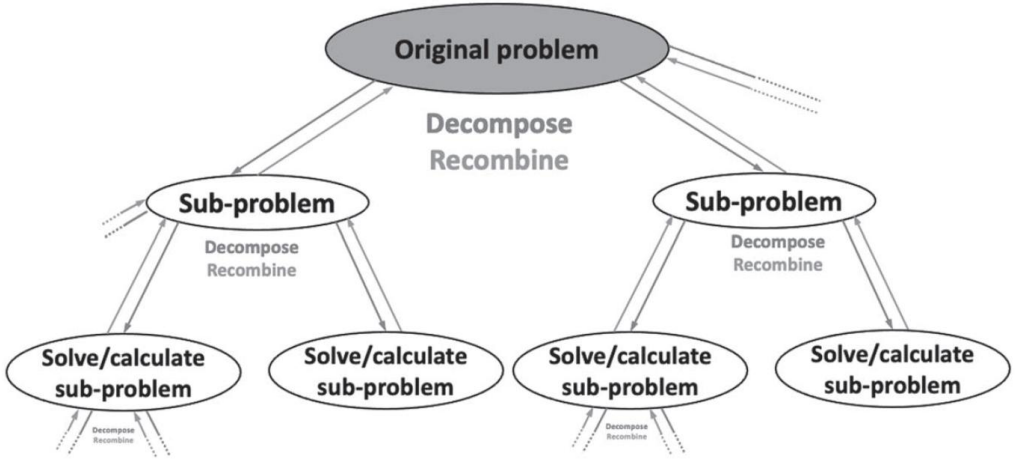
- Sequences of FP to promote model developement

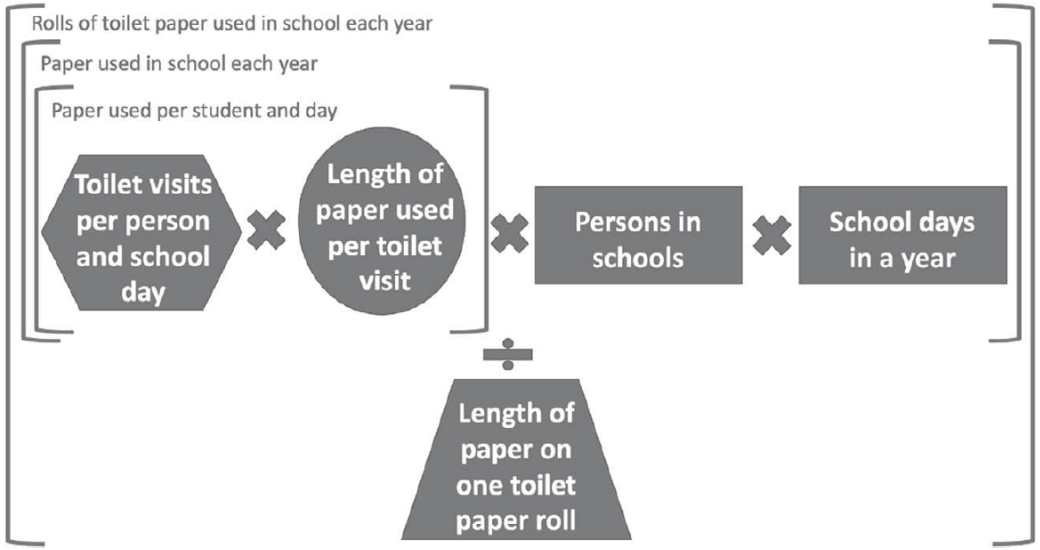
Table 3. Evolution of the strategies

Team	Prop Ind P1	Prop Team P1	P1	P2.1	P2.2	P2.3	P2.4
A							
B							
C							
D							
E							
F							

Fermi problem Activity Templates







JOURNAL ARTICLE

Fermi problems as a hub for task design in mathematics and stem education

Get access >

Jonas Bergman Ärlebäck ✉, Lluís Albarracín

Teaching Mathematics and its Applications: An International Journal of the IMA, hrad002,
https://doi.org/10.1093/teamat/hrad002
Published: 09 March 2023 **Article history** ▾

Modelling projects in the school

oriented towards Social Impact





Identifying students' home to school paths

mathematics

MDPI

Article

Mathematical Modeling Projects Oriented towards Social Impact as Generators of Learning Opportunities: A Case Study †

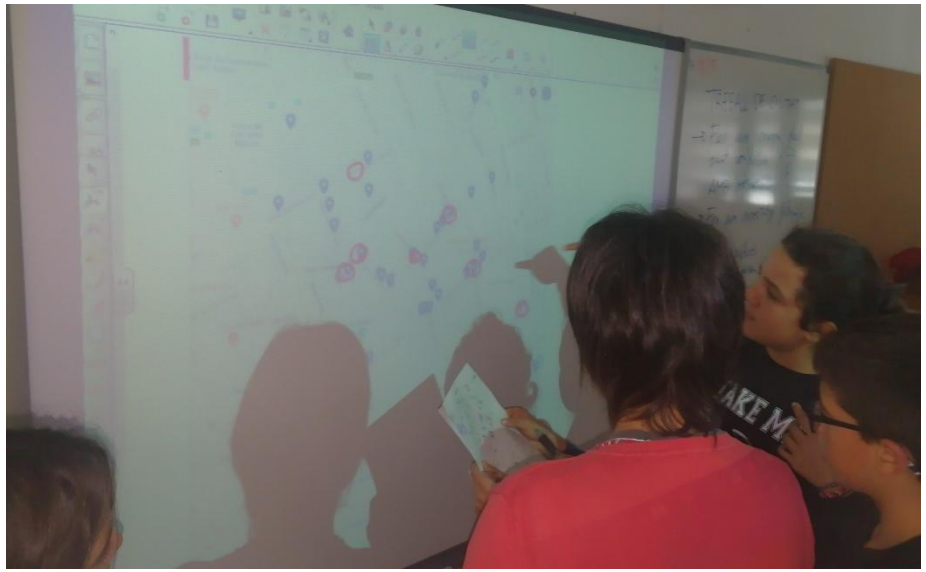
Lluís Albarracín * and Núria Gorgorió







Identifying and studying dangerous spots in the streets







Elaborating safe paths for students and citizens

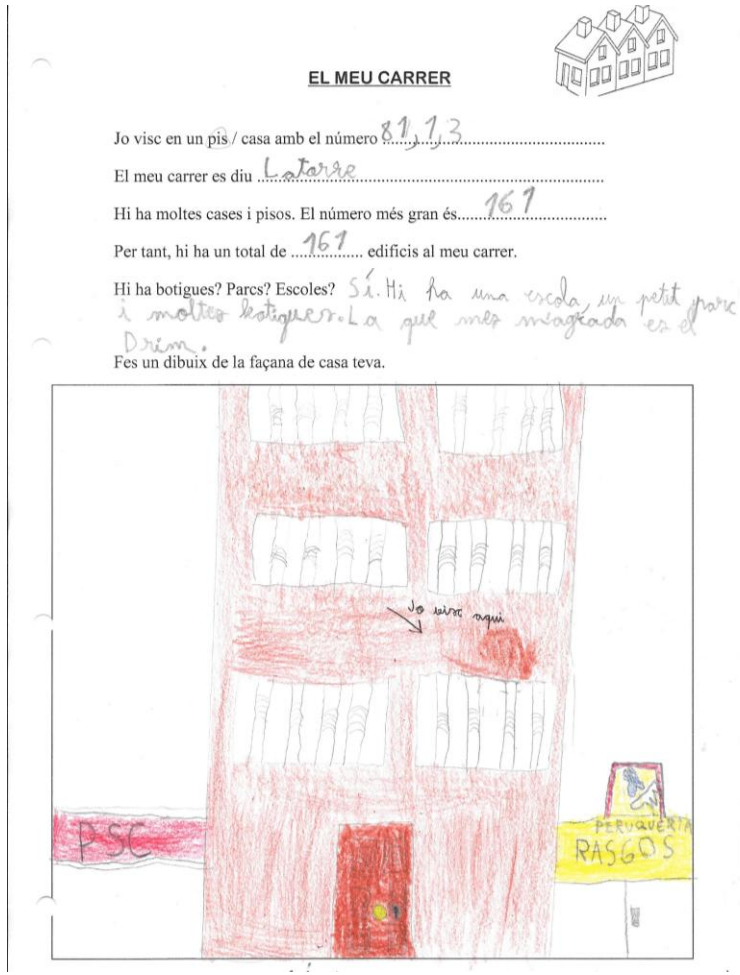




Early Childhood Education Journal
https://doi.org/10.1007/s10643-020-01104-x

Large Number Estimation as a Vehicle to Promote Mathematical Modeling

Lluís Albarracín[1]



EL MEU CARRER

Jo visc en un pis / casa amb el número 81, 1, 3

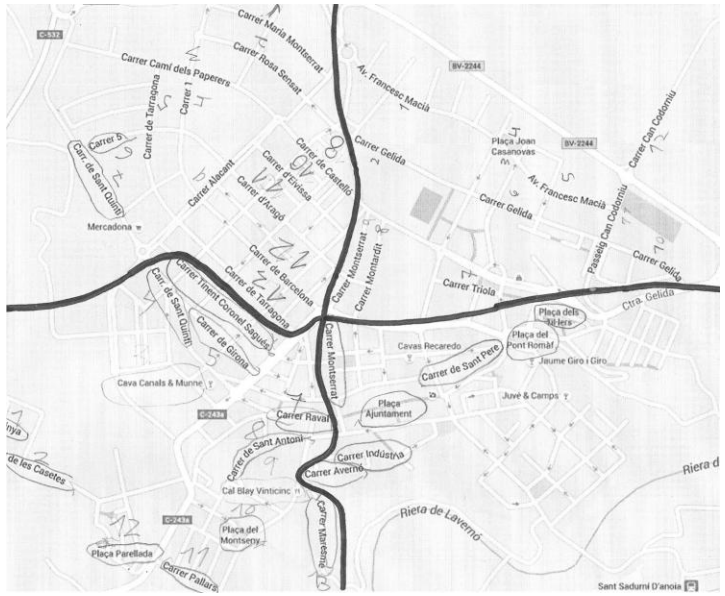
El meu carrer es diu La Torre

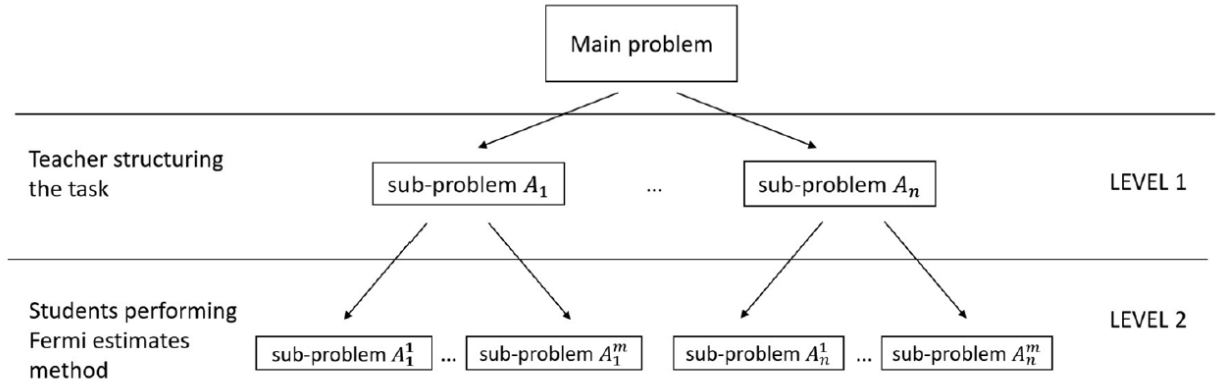
Hi ha moltes cases i pisos. El número més gran és 161

Per tant, hi ha un total de 161 edificis al meu carrer.

Hi ha botigues? Parcs? Escoles? Sí. Hi ha una escola un petit parc i moltes botigues. La que més m'agrada és el parc Drim.

Fes un dibuix de la façana de casa teva.





References

- Albarracín, L. (2021). Large Number Estimation as a Vehicle to Promote Mathematical Modeling. *Early Childhood Education Journal*, *49*(4), 681-691. https://doi.org/10.1007/s10643-020-01104-x
- Albarracín, L., Ferrando, I., & Gorgorió, N. (2021). The Role of Context for Characterising Students' Strategies when Estimating Large Numbers of Elements on a Surface. *International Journal of Science and Mathematics Education 19*(6), 1209-1227. https://doi.org/10.1007/s10763-020-10107-4
- Albarracín, L. & Gorgorió, N. (2018). Students estimating large quantities: From simple strategies to the population density model. *EURASIA Journal of Mathematics, Science and Technology Education, 14*(10), 1–15.
- Albarracín, L., & Gorgorió, N. (2019). Using Large Number Estimation Problems in Primary Education Classrooms to Introduce Mathematical Modelling. *International Journal of Innovation in Science and Mathematics Education*, *27*(2), 45-57.
- Albarracín, L., & Gorgorió, N. (2020). Mathematical Modeling Projects Oriented towards Social Impact as Generators of Learning Opportunities: A Case Study. *Mathematics, 8*(11), 1-20. doi.org/10.3390/math8112034
- Anderson, P. M., & Sherman, C. A. (2010). Applying the Fermi estimation technique to business problems. *Journal of Applied Business and Economics, 10*(5), 33–42.
- Ärlebäck, J. B., & Albarracín, L. (2024). Fermi problems as a hub for task design in mathematics and stem education. *Teaching Mathematics and its Applications*, *43*(1), 25-37. https://doi.org/10.1093/teamat/hrad002
- Efthimiou, C. J., & Llewellyn, R. A. (2006). Avatars of Hollywood in physical science. *The Physics Teacher, 44,* 28–33.
- Peter-Koop, A. (2009). Teaching and understanding mathematical modelling through Fermi–problems. In B. Clarke, B. Grevholm, & R. Millman (Eds.), *Tasks in primary mathematics teacher education* (pp. 131–146). Dordrecht: Springer.
- White, H. B. (2004). Math literacy. *Biochemistry and Molecular Biology Education, 32*(6), 410–411.

Fermi problems as activities to introduce mathematical modelling
+
Mathematical Modeling Projects oriented towards Social Impact

Lluís Albarracín

lluis.albarracin@uab.cat

Departament de Didàctica de la Matemàtica i les Ciències Experimentals

Esta publicación es parte del proyecto PID2021-126707NB-I00, financiado por MICIU/AEI/10.13039/501100011033/FEDER, UE.