Cognición matemática temprana:
el surgimiento de la capacidad simbólica

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LÍNEA DE INVESTIGACIÓN EN COGNICIÓN MATEMÁTICA

CENTRO INTERDISCIPLINARIO EN COGNICIÓN PARA LA ENSEÑANZA Y EL APRENDIZAJE.

http://cognicionnumerica.psico.edu.uy

SUCCC
SOCIEDAD URUGUAYA DE CIENCIAS COGNITIVAS Y DEL COMPORTAMIENTO

Math Cognition Research Group

CICEA

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Actual lines of research

Math cognition and...

- home numeracy activities
- non-symbolic processing
- games and math
- the use of tics in class
- math assessment and long term school trajectories
- gender gap

In this presentation…

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Origins…

The **Ceibal Project** (*Plan Ceibal)* is an initiative by the Uruguayan government aimed at enhancing education and social equity through digital inclusion.

Launched in **2007** and inspired by MIT's OLPC model, Ceibal's components and objectives are:

- One Laptop per Child (aka *Ceibalita)*
- Internet Connectivity
- Educational Resources
- **Research and Innovation**

Plan Ceibal currently covers the entirety of Uruguay's student population.

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What we have been doing in Uruguay with tablets and math?

In 2013, Ceibal delivered the first 10,700 **tablets** to children between 4 and 6 years old.

Our team began collaborating with Ceibal, researching the use of tablets and computers to facilitate learning, with a special focus on early mathematics.

From non-symbolic to symbolic Math

Based on the idea that difficulties in number processing are often a result of the challenges in mapping magnitudes to the numerical symbols,

We performed an intervention aimed at improving **Approximate Number System (ANS)** accuracy in a target group of **800 six-year-old children**.

Odick, D., Valle Lisboa, J., Eisinger, R., Gonzalez, M, Maiche, A., & Halberda, J. (2016) Approximate number and approximate time discrimination each correlate with school math abilities in young children. Acta Psychologica, vol. 163 pp 17-26.

2013 – 2020: From *digital utopianism* to research

Actual key questions:

- Can we use technology and, in particular, the deployment of the Ceibal Plan, to assess the early mathematical competencies of all children in Uruguay?
- Can we have technological tools in Uruguay that teachers can use in their classes to assess children?
- Can we systematically compare the effects of intervention programs under these digital and analog formats to determine the most effective method for educational enhancement?

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However, technology can be a great ally in education.

Continuous assessment in the classroom is possible if we rely on the technological resources available in Uruguay (i.e., tablets).

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Inspired by this possibility, we create:

PUMA *(Prueba Uruguaya de Matemáticas, or* Uruguayan Mathematics Test*)*, a context-specific earlymath assessment test specific to assess children in initial school stages (5 y.o) and first grade (6 y.o).

https://puma.cicea.uy/
(instrumento en continuo desarrollo)

PUMa

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One product: **PUMA,** Early math assessment instrument.

PUMA *is game-like and it propose a trip around uruguay to each child.*

The 2023 version has 76 trials and allows for assessing an entire group in no more than 30 minutes.

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PUMA

Characteristics

- Digital and self-management.
- 8 sub-tasks.
- Increasing difficulty.
- Include symbolic and non-symbolic components.
- Total duration: 15 min.
- Available also in portuguese

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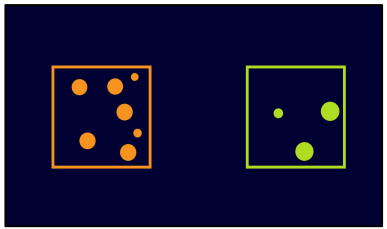
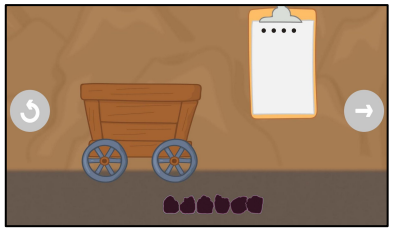
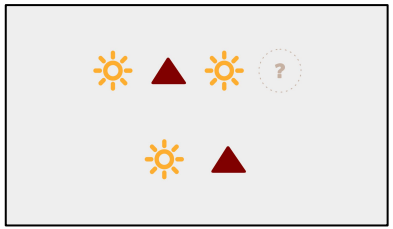
PUMA: tasks & scores

3 non-symbolic tasks: 34

1. ANS: 21
2. Counting: 6
3. Patterns: 7

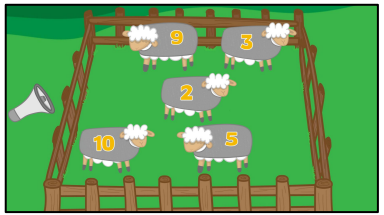


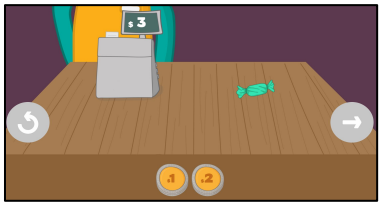


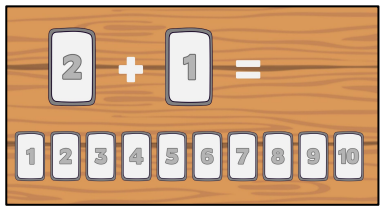


5 symbolic tasks: 42

1. Order Forwd: 7
2. Order Backwd: 7
3. Transcoding: 12
4. Quantity composition: 8
5. Calculation fluency: 8







PUMA: Uruguayan scale

2023 data collection

- 31 Education Centers, 61 groups
- N= 1100 students (482K5 and 612 of 1st grade)
- Age in months = 78.3 (70.8-85.8)

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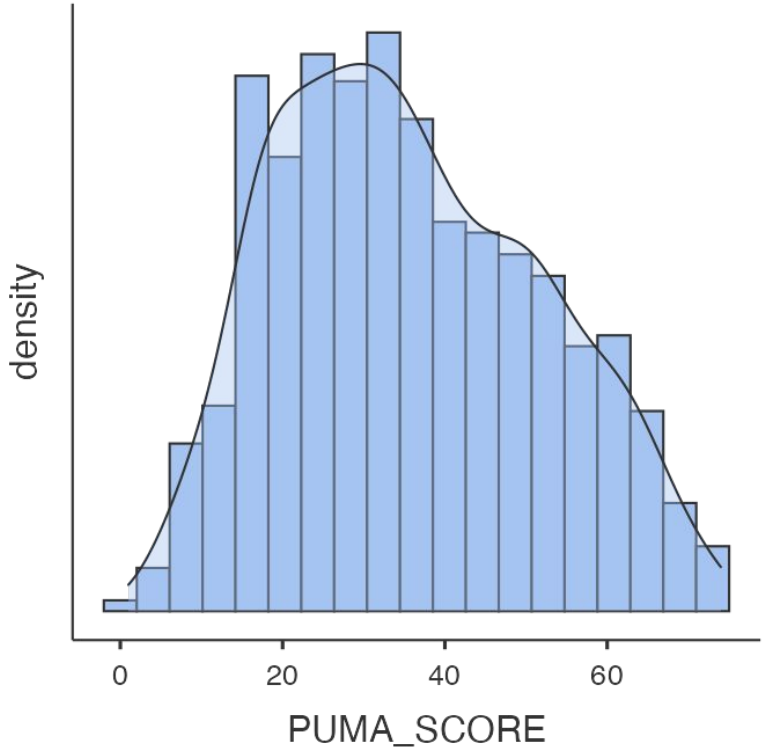
We work hard
20
30
40

PUMA

RESULTS

- Raw score: total of trials answered correctly (máx: 76)
- Check of internal consistency

	Number of tasks	Cronbach Alpha
Puma	8	0.85
Symbolic	5	0.96
Non-symbolic (different tasks)	3	0.83



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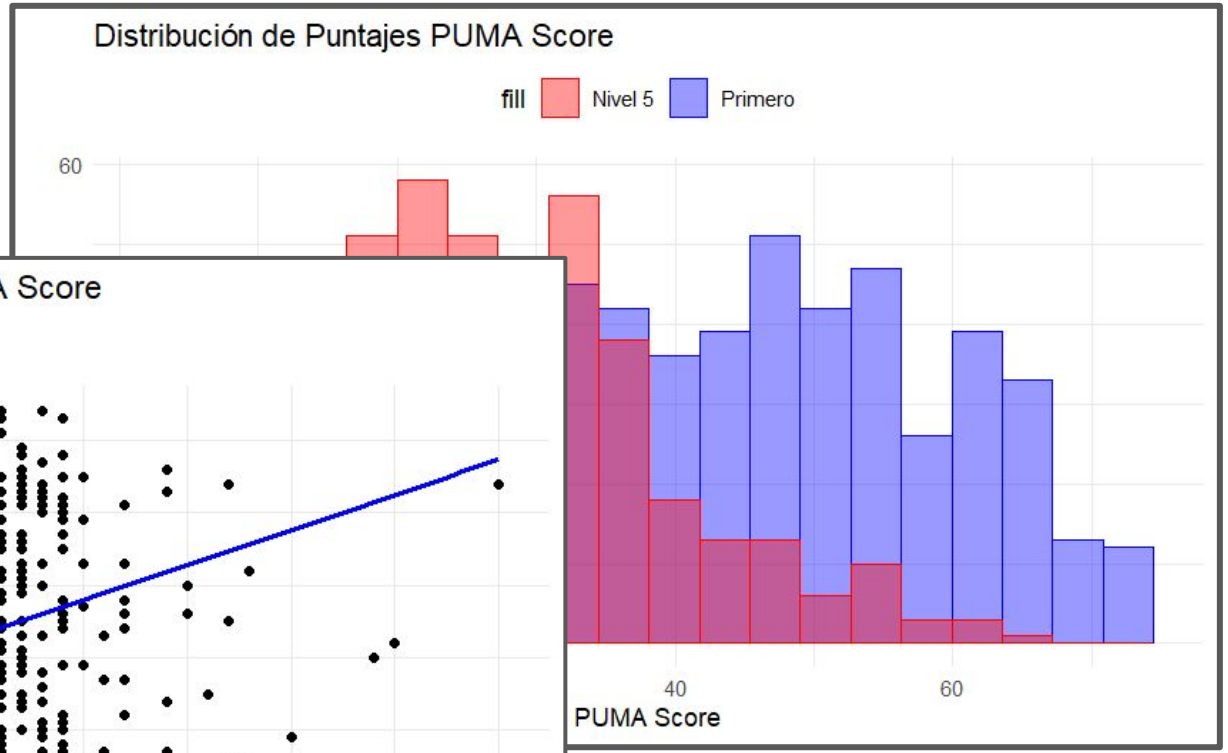
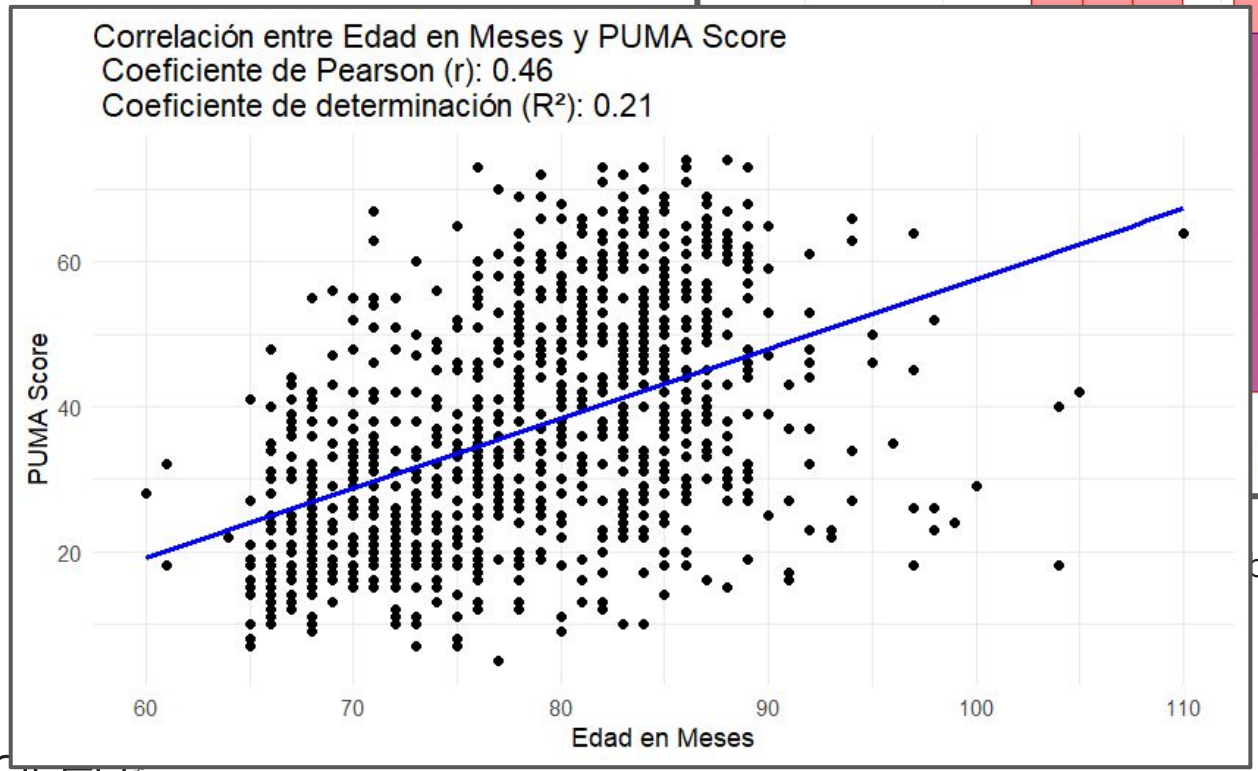
PUMA



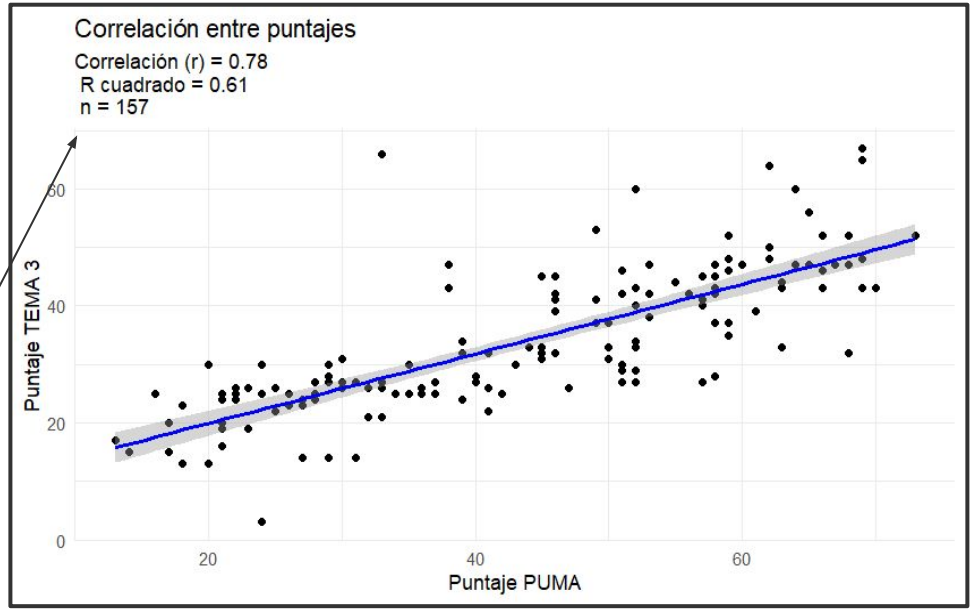


bution of PUMA scores

PUMa

CORRELATION WITH TEMA-3

Positive Pearson's correlation ($p < 0.01$); N = 157



TEMA-3 (Test of Early Mathematics Ability, Third Edition) is a standardized assessment that measures a child's early mathematical skills, including number sense, counting, and basic arithmetic.

PUMA seems to be a great math assessment

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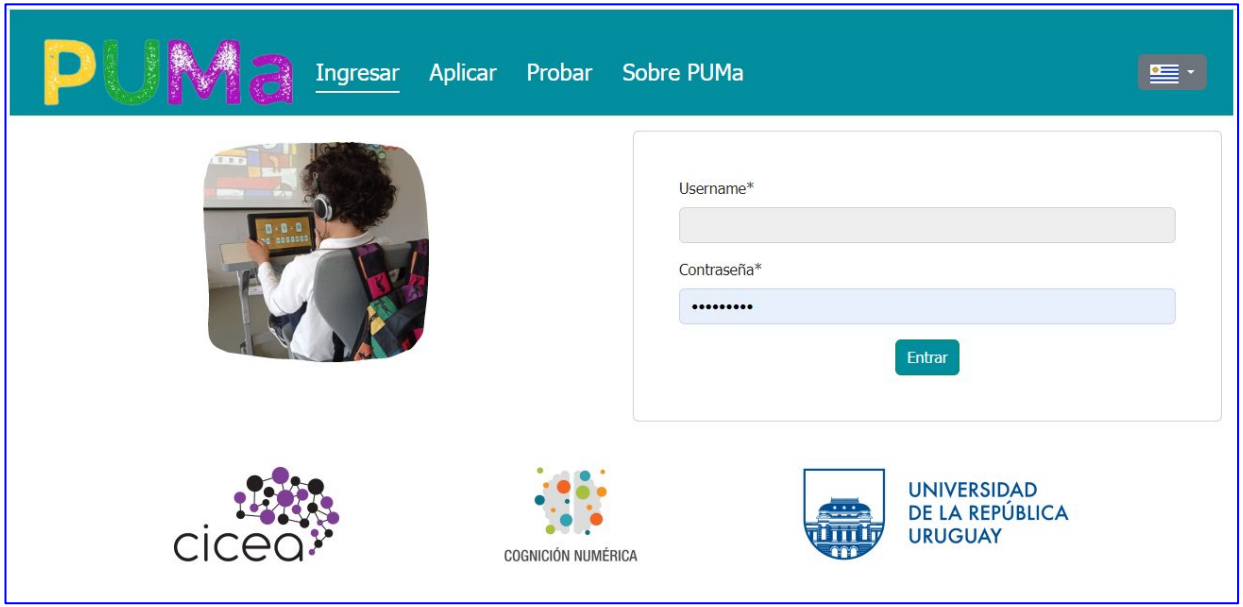
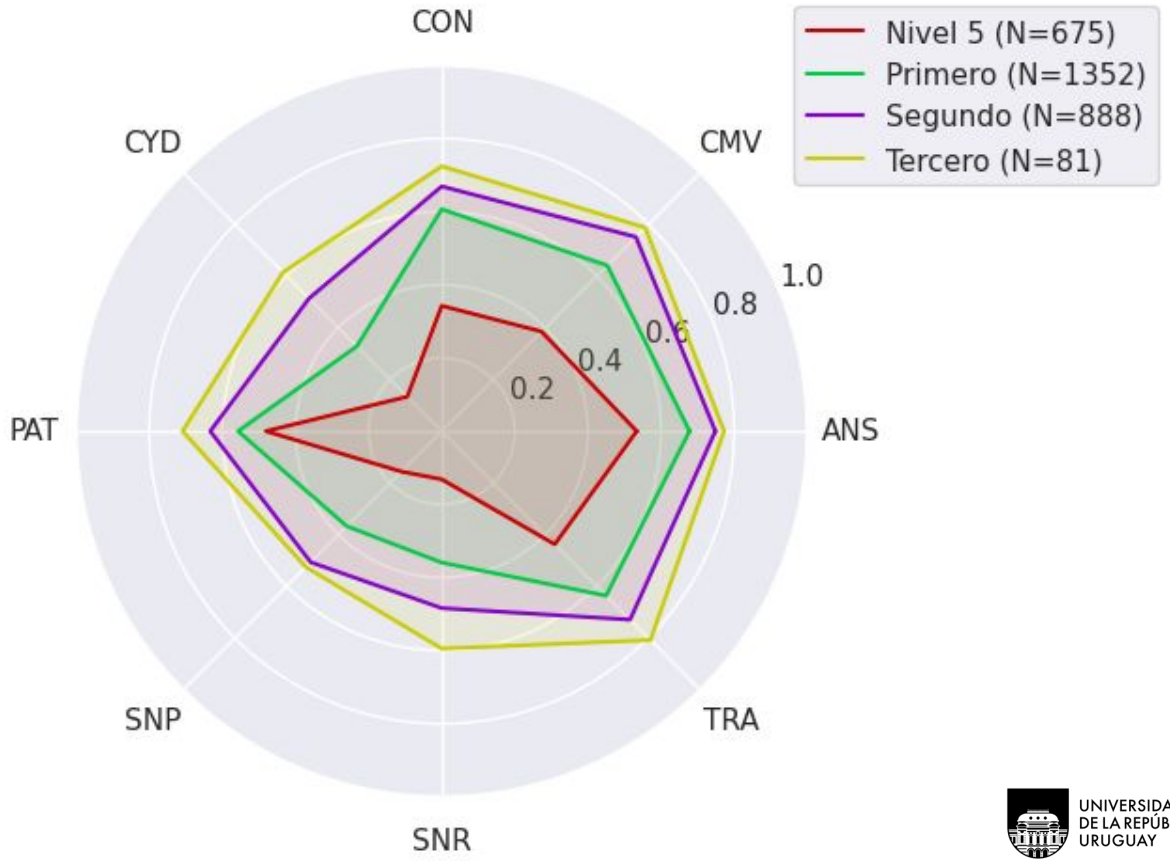
PUMA: a system for assessment

1. Different type of users: **maestra, directora, inspectora e investigador.**
2. Mediated login via teacher's PIN (no data loss)
3. Personalized final report for each group/teacher/school



Online Data directly in the platform PUMA
(updated to yesterday):

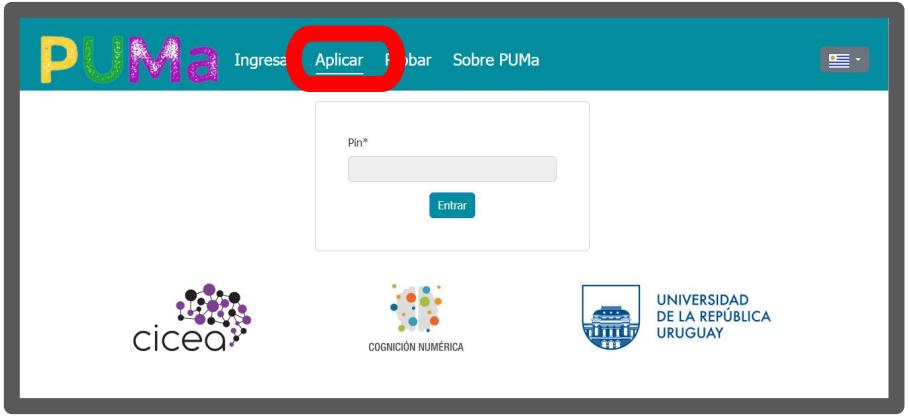
puma.cognum@gmail.com



1. Usuario maestra:

(can104; 0001)

- Puede aplicar la prueba a todos en su clase



- Las maestras entran a la plataforma mediante un pin de 4 cifras usando la opción “Aplicar” de la web

La maestra elige al estudiante al que le va a dar la tablet y se asegura que tenga sus auriculares puestos: la plataforma guiará al estudiante por toda la prueba guardando sus resultados con el identificador del estudiante.

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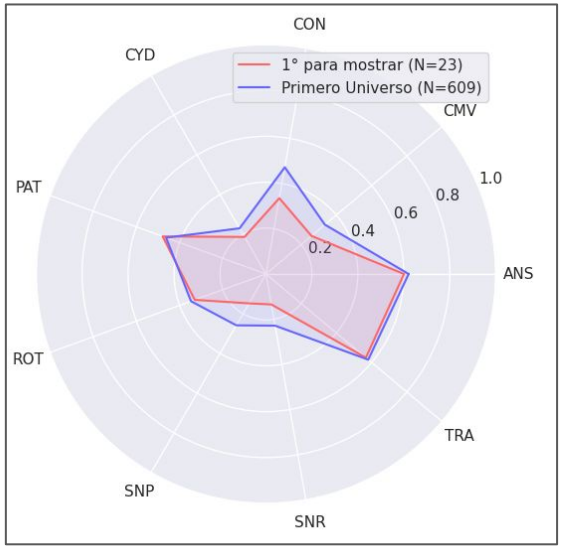
Ejemplo de los análisis disponibles:

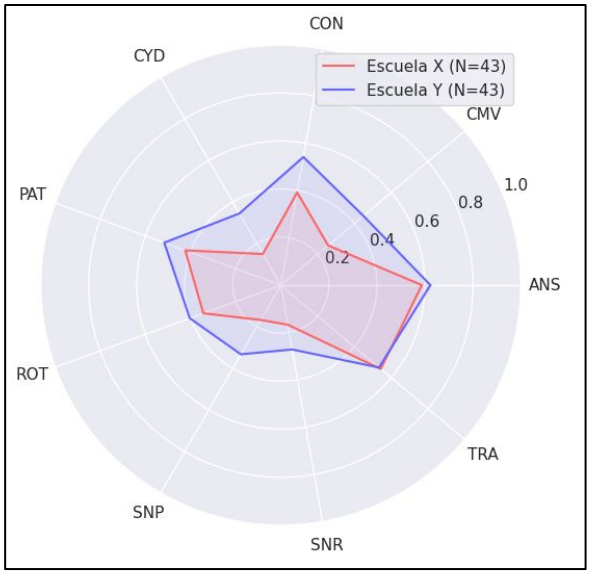


2. Usuario Director/a:

- Visualiza todos los resultados de los grupos que pertenecen a su Escuela y los puede comparar y analizar

3. Usuario Inspector/a:

- Visualiza todos los datos de todos los grupos que pertenecen a sus Escuelas



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Experiencias y Análisis que nos ha permitido PUMa

- Más de 90 centros educativos en Uruguay han incorporado PUMa como herramienta de evaluación, tanto en el ámbito público como privado.
- Se ha utilizado en Argentina, Brasil y España
- Los docentes valoran positivamente el uso de la herramienta: viable de aplicar
- Es utilizado por los docentes como herramienta de seguimiento del desempeño del niño (3 momentos del año).

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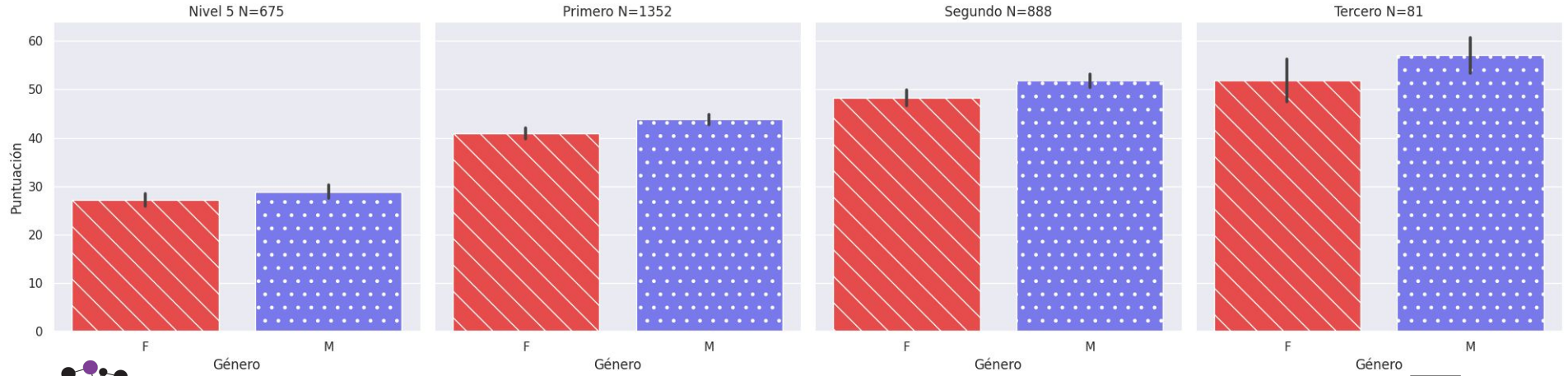
Gender Gap

- Se observan diferencias en los resultados obtenidos entre niñas y niños, siendo estos últimos quienes obtuvieron mejores resultados.
- Nuestros resultados muestras que son mayores en 1° que en inicial.



NIVEL 5 PRIMERO SEGUNDO TERCERO

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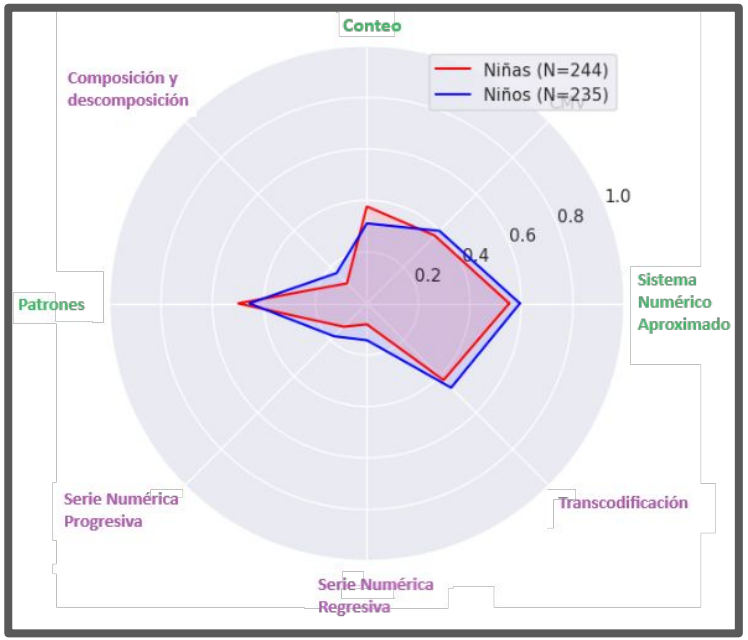
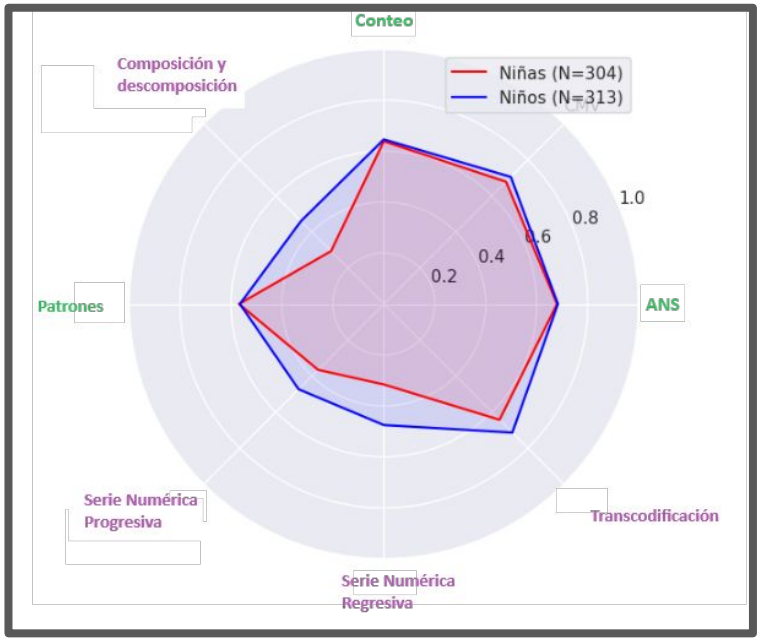
Gender Gap

- Estas diferencias se dan en matemáticas simbólicas





NIVEL 5

PRIMERO

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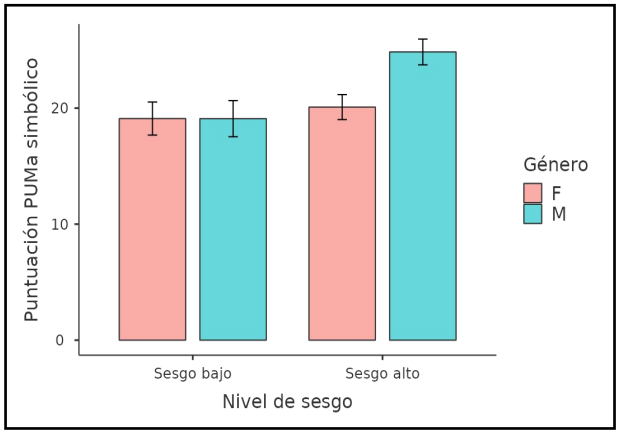
Gender Gap:
muchas preguntas aún; pero al menos ahora podemos verlo….

Sesgo de género y M. simbólica



- Sesgo Alto: Brecha de género significativa en matemáticas simbólicas (t(165) = -3.06, p = 0.002).
- Sesgo Bajo: No hay diferencias significativas (p > 0.05).

Future perspectives

- We hope PUMa could become a commonly used tool that allows teachers to anticipate the mathematical difficulties of some students, at least in LA.

- Having tools for mass assessment of specific competencies allows us to understand problems that sometimes go unnoticed.

- This is the case with **gender differences in mathematics**, which, far from being a biological difference, seem to be related to aspects of the education system or the educators themselves…We need to continue researching to fully understand the issue and to be able to reverse these unfair differences that undermine the opportunities of girls.

¡GRACIAS!

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