The affective dimension implied in Mathematical Problem Solving by future Primary Education teachers

Iñigo Rodríguez-Arteche, King Juan Carlos University (Spain)

Mónica Arnal-Palacián, University of Zaragoza (Spain)

The affective dimensión implied in Mathematical Problem Solving by future Primary Education teachers

- Introduction (theoretical framework)
- Objectives
- Method
- Results
- Conclusions
- Future perspective

Introduction

TEACHER TRAINING PROGRAMS…

They should be based on the promotion of **professional competencies.**

They should encourage a shift from traditional to **alternative teaching approaches.**

They should promote **reflection and metacognition** about educational strategies.

(Perrenoud, 2001; Van Driel & Berry, 2012; Gess-Newsome, 2015)

Introduction (II)

TEACHER TRAINING PROGRAMS…

They should not ignore the **role of emotions** in science and mathematics teaching and learning.

Educational research has highlighted the influence of the affective domain (beliefs, attitudes, emotions…) on the personal and social **construction of knowledge**.

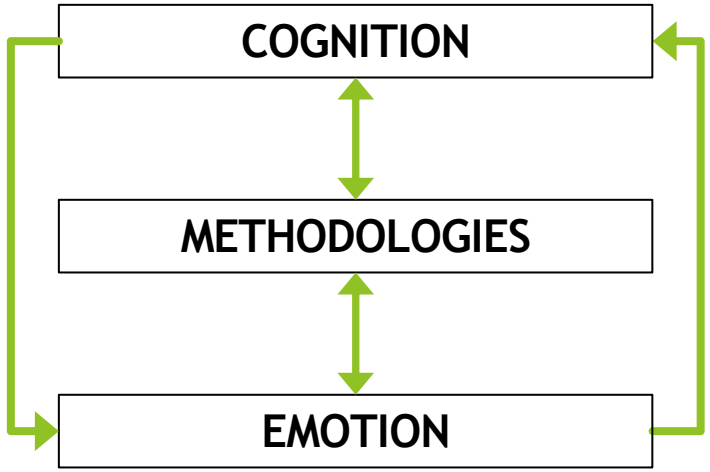
Beyond Cold Conceptual Change: The Role of Motivational Beliefs and Classroom Contextual Factors in the Process of Conceptual Change

Paul R. Pintrich; Ronald W. Marx; Robert A. Boyle

Review of Educational Research, Vol. 63, No. 2. (Summer, 1993), pp. 167-199.

Introduction (III)

TEACHER TRAINING PROGRAMS…



(Marcos-Merino, 2019; Mellado et al., 2014)

Problem-Based Learning (PBL) as an instructional learner-centred approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop viable solutions to an ill-structured problem, with the help of a tutor who conducts a thorough scaffolding **(Savery, 2006).**

PBL has demonstrated multiple **educational benefits** in promoting scientific and mathematical competencias, together with a better conceptual understanding **(Hmelo-Silver, 2004; Ibáñez & Martínez-Aznar, 2007).** However, transferring this methodology to classrooms can be **challenging (Capps & Crawford, 2013; Ireland et al., 2014).**

Introduction (IV)

MATHEMATICS TEACHER TRAINING PROGRAMS…

Research has revealed fundamentally negative emotions of pre-service Primary Education teachers towards Mathematical Problem Solving (MPS) **(Mellado et al., 2014).**

Some emotions frequently reported are nervousness, anxiety, and frustration **(Caballero & Guerrero, 2015).** This perception could condition future student learning and inhibit these individuals from applying MPS in the classroom.

In general, women tend to underestimate their competencies and have lower self-efficacy beliefs as compared to their male peers **(Frenzel, Pekrun, & Goetz, 2007).**

The affective dimensión implied in Mathematical Problem Solving by future Primary Education teachers

- Introduction (theoretical framework)
- **Objectives**
- Method
- Results
- Conclusions
- Future perspective

Objectives

Three main objectives are set on the affective dimension of pre-service Primary Education teachers regarding Mathematical Problem Solving (MPS):

1. Characterize their epistemological and educational beliefs, attitudes, emotions, self-efficacy, and satisfaction with the training previously received in the Degree.
2. Analyze differences, depending on gender, in perception about MPS.
3. Analyze differences, depending on previous training, in perception about MPS.

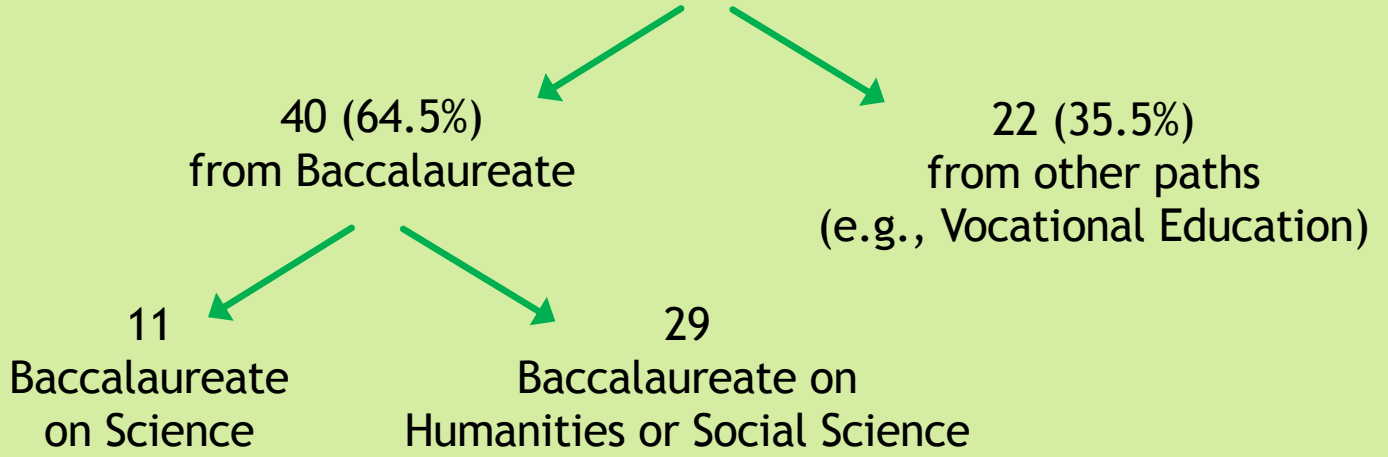
The affective dimensión implied in Mathematical Problem Solving by future Primary Education teachers

- Introduction (theoretical framework)
- Objectives
- **Method**
- Results
- Conclusions
- Future perspective

Method

SAMPLE

- 62 participants (average age: 23.1) who take *"Mathematics and its Didactics III"* (3rd year of the Degree in Primary Education, Spain)
- 27 women (43.5%) and 35 men (56.5%)



OBJECTIVE 2

OBJECTIVE 3

Method

INSTRUMENT

Validated questionnaire **(Caballero & Guerrero, 2015)** of 21 items with a Likert scale from 1 (strongly disagree) to 4 (strongly agree).

The items can be classified in four dimensions regarding Mathematical Problem Solving (MPS):

- ***Epistemology (nature of MPS)*** → 5 items
- ***Self-efficacy in MPS*** → 6 items
- ***Attitudes and emotions towards MPS*** → 9 items
- ***Evaluation of previous university training regarding MPS*** → 1 item

Method

DATA ANALYSIS

- Descriptive statistical analysis: frequencies, means and standard deviations.
- Mann-Whitney's U-test. H0: «Perception towards MPS is not conditioned by gender» (p<.05)

  n=27 women and n=35 men
- Mann-Whitney's U-test. H0: «Perception towards MPS is not conditioned by prior training» (p<.05)

  n=11 Baccalaureate on Science and n=29 Baccalaureate on Humanities or Social Science

OBJECTIVE 1

OBJECTIVE 2

OBJECTIVE 3

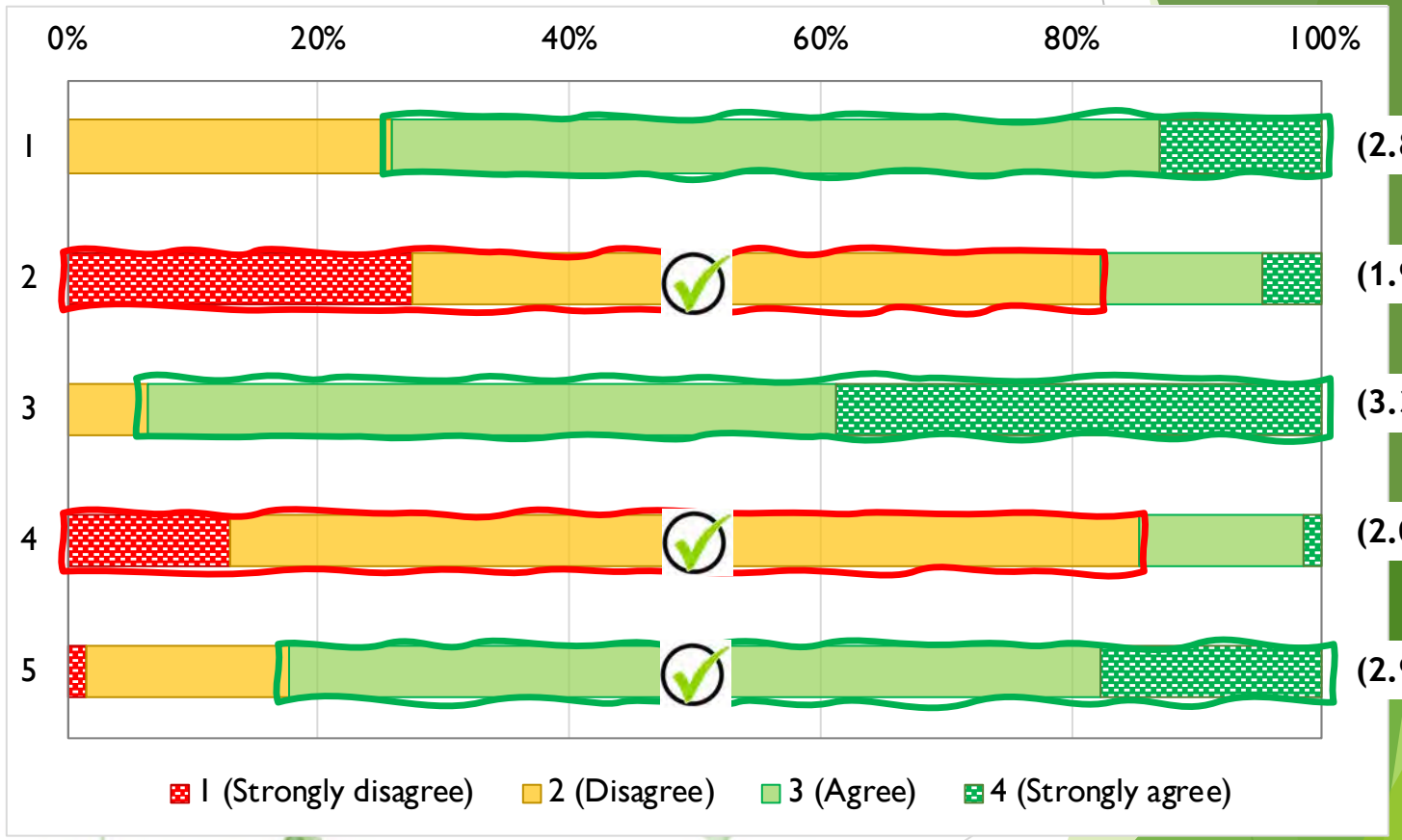
The affective dimensión implied in Mathematical Problem Solving by future Primary Education teachers

- Introduction (theoretical framework)
- Objectives
- Method
- **Results**
- Conclusions
- Future perspective

Results (I)

A. BELIEFS ABOUT THE NATURAL OF MATHEMATICAL PROBLEMS AND THEIR TEACHING

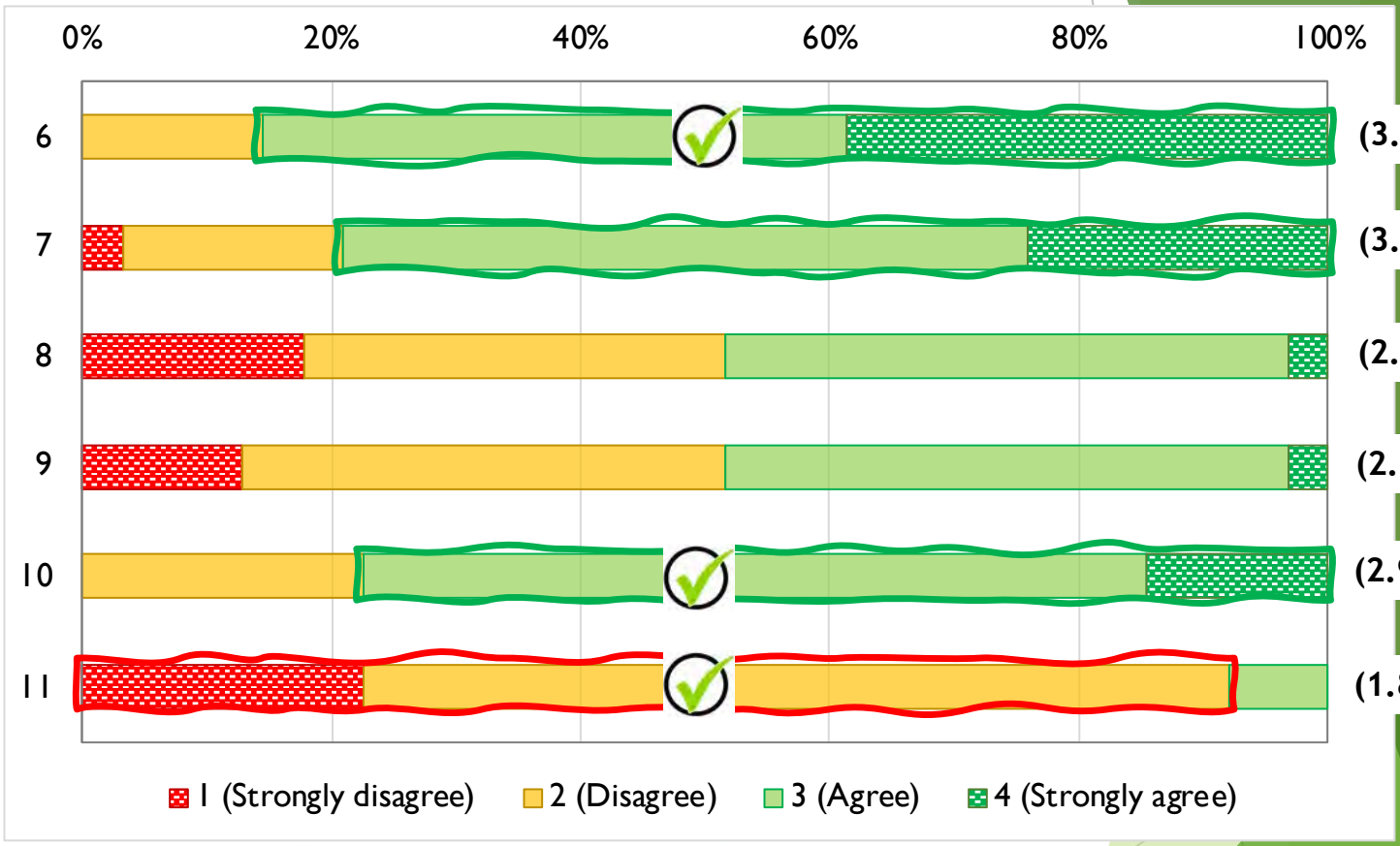
1. Almost all math problems can be solved in a few minutes if you know the formula, rule or procedure that the teacher has explained or that appears in the textbook.
2. When solving a math problem, the final result is more important than the procedure previously followed.
3. Knowing how to solve the problems posed by the teacher in class, it is easy to solve others of the same type where some changes have been applied regarding data.
4. The skills or strategies used in math classes regarding problem-solving have nothing to do with those used to solve problems in everyday life.
5. I try different ways and methods to solve a problem.



OBJECTIVE 1

Results (II)

6. When more study time is spent on maths, better results are obtained in problem solving.
7. When I solve a problem I usually doubt whether the result is correct.
8. I have confidence in myself when I face math problems.
9. I am calmed and relaxed when I solve math problems.
10. When I work hard to solve problems I usually find the right result.
11. Luck influences successful resolution of math problems.

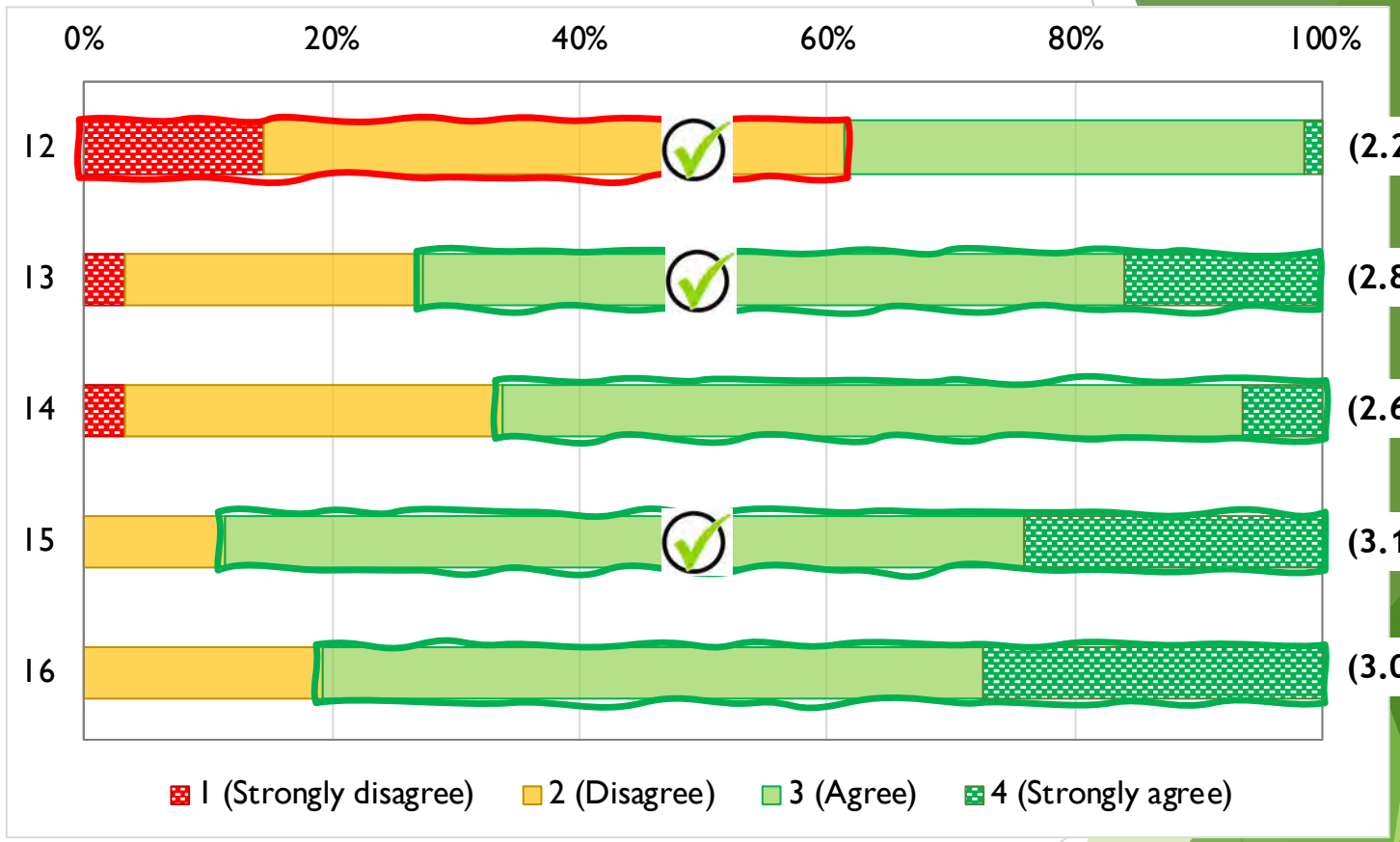


OBJECTIVE 1

Results (III)

12. When I face a difficult problem, I usually give up easily.
13. When I face a problem I experience a lot of curiosity about knowing the solution.
14. I feel anguish and afraid when the teacher asks me "by surprise" to solve a problem.
15. When I solve problems in a group I have more confidence in myself.
16. When I get stuck or blocked in solving a problem, I start to feel insecure, desperate, nervous...

C. ATTITUDES AND EMOTIONAL REACTIONS TOWARDS MATHEMATICAL PROBLEM SOLVING



OBJECTIVE 1

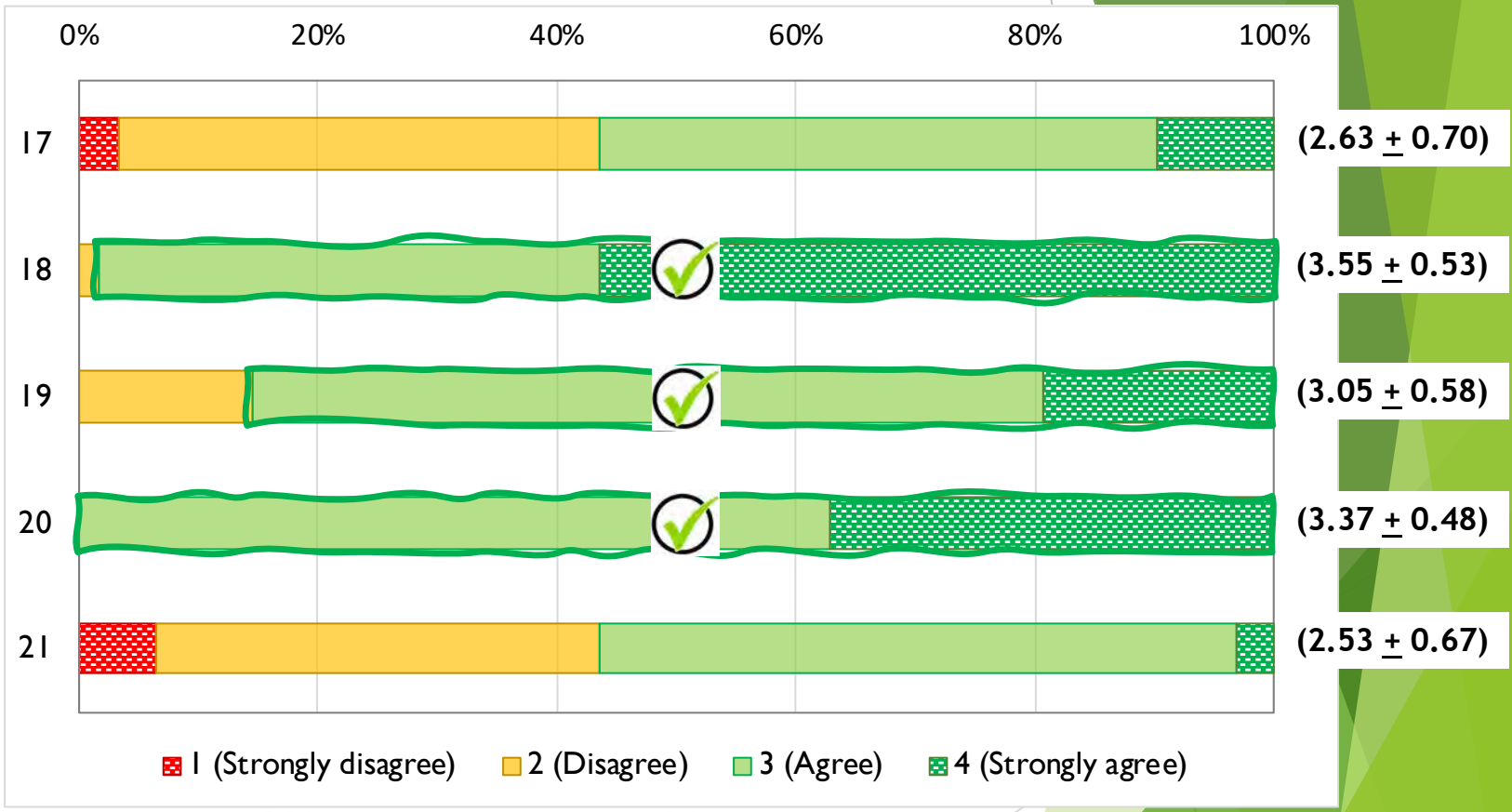
Results (IV)

C. ATTITUDES AND EMOTIONAL REACTIONS TOWARDS MATHEMATICAL PROBLEM SOLVING

17. If I can't find a solution to a problem, I feel like I've failed and wasted my time.
18. It gives me great satisfaction to successfully solve a mathematical problem.
19. When my attempts to solve a problem fail, I try again.
20. Solving a problem requires effort, perseverance and patience.

---

21. In the Degree in Primary Education, I have discovered other ways to address math problems.



D. EVALUATION OF PREVIOUS TRAINING RECEIVED IN THE DEGREE IN PRIMARY EDUCATION REGARDING MATHEMATICAL PROBLEM SOLVING

Results (V)

OBJECTIVE 2

H0: Perception towards MPS is not conditioned by gender.

M: Men (*n*=35) W: Women (*n*=27)

	Ag %	Di %	Mean	
8. I have ***confidence*** in myself when I face math problems.	M: 60.0% W: 33.3%	M: 40.0% W: 66.7%	M: 2.57 ± 0.73 W: 2.04 ± 0.79	$U = 308.5$, $p < .05$
14. I feel ***anguish*** and ***afraid*** when the teacher asks me "by surprise" to solve a problem.	M: 54.3% W: 81.5%	M: 45.7% W: 18.5%	M: 2.51 ± 0.65 W: 2.93 ± 0.54	$U = 321.5$, $p < .05$

More positive (less negative) emotional reactions in men

	Ag %	Di %	Mean	
6. When more ***study time*** is spent on maths, better results are obtained in problem solving.	W: 92.6% M: 80.0%	W: 7.4% M: 20.0%	W: 3.44 ± 0.63 M: 3.09 ± 0.69	$U = 342.0$, $p < .05$
20. Solving a problem requires ***effort***, ***perseverance***, and ***patience***.	W: 100.0% M: 100.0%	W: 0.0% M: 0.0%	W: 3.52 ± 0.50 M: 3.26 ± 0.44	$U = 349.0$, $p < .05$

More positive attitudes in women

Results (VI)

OBJECTIVE 3

H0: Perception towards MPS is not conditioned by prior training.

S: Baccalaureate on Science (*n*=11) O: Baccalaureate on Humanities or Social Sciences (*n*=29)

	Ag %	Di %	Mean
8. I have ***confidence*** in myself when I face math problems.	S: 63.6% O: 34.5%	S: 36.4% O: 65.5%	S: 2.64 ± 0.48 O: 2.14 ± 0.90
9. I am ***calmed*** and ***relaxed*** when I solve math problems.	S: 63.6% O: 41.4%	S: 36.4% O: 58.6%	S: 2.64 ± 0.48 O: 2.28 ± 0.78

Differences are not significant at 95% confidence interval

More positive emotional reactions in those with a scientific background.

	Ag %	Di %	Mean
16. When I get stuck or blocked in solving a problem, I start to feel ***insecure, desperate, nervous...***	O: 86.2% S: 72.7%	O: 13.8% S: 27.3%	O: 3.21 ± 0.66 S: 2.91 ± 0.67
17. If I can't find a solution to a problem, I feel like I've ***failed*** and ***wasted my time.***	O: 65.5% S: 36.4%	O: 34.5% S: 63.6%	O: 2.76 ± 0.62 S: 2.27 ± 0.62

Differences are not significant at 95% confidence interval

More negative emotional reactions in those without a scientific background.

The affective dimensión implied in Mathematical Problem Solving by future Primary Education teachers

- Introduction (theoretical framework)
- Objectives
- Method
- Results
- **Conclusions**
- Future perspective

Conclusions

- ✓ This study has let us obtain a **characterization** of the perceptions of pre-service elementary teachers about MPS.
  - ⇨ Algorithmic and repetitive vision of MPS (although different strategies may have room).
  - ⇨ Medium-low self-efficacy towards MPS (which can improve with time and effort).
  - ⇨ Ambivalent emotions towards MPS (e.g., satisfaction and curiosity, but also fear, nervousness or frustration).
  - ⇨ Mixed opinions about prior training on MPS in the Degree in Primary Education.

- ✓ **Attitudes** towards perseverance and study time are more positive in **women**.
- ✓ **Men** feel more confident and less afraid of MPS (more positive **emotional reactions**).

(Frenzel, Pekrun, & Goetz, 2007)

Conclusions

These results should support the proposals implemented around MPS in the initial training of teachers, seeking to promote a more dynamic and flexible view of mathematical problems, as well as feeling of positive emotions and attitudes towards its learning.

The affective dimensión implied in Mathematical Problem Solving by future Primary Education teachers

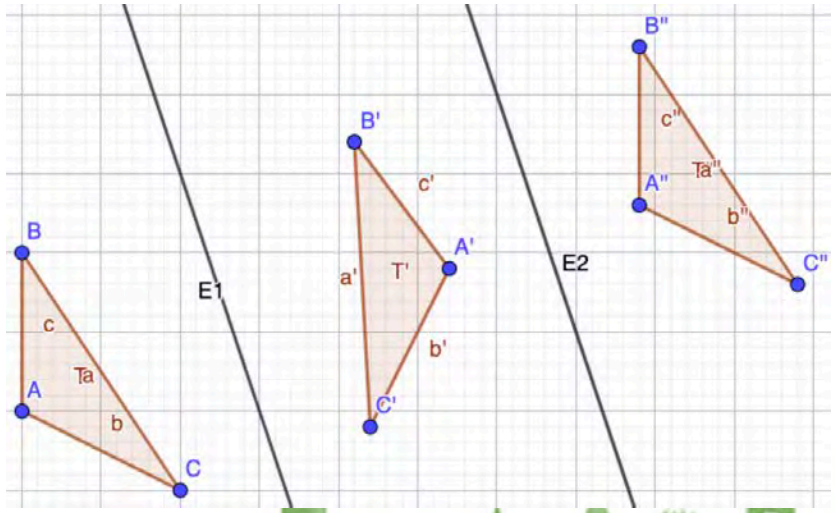
- Introduction (theoretical framework)
- Objectives
- Method
- Results
- Conclusions
- Future perspective

Future perspective

Design of a problem-based approach to deal with mathematical content + teaching & learning strategies + professional competencies.

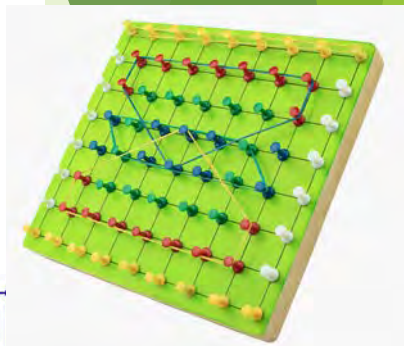
Is the composition of two symmetries commutative?

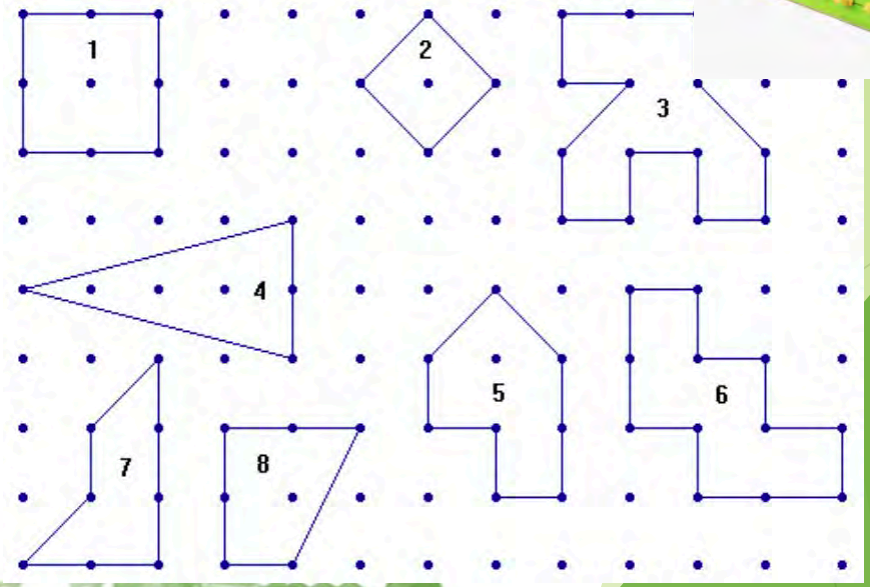
Use of GeoGebra



Can you propose other polygons that have the same area / perimeter as the following ones?

Use of Geoboard





Future perspective

Design of a problem-based approach to deal with mathematical content + teaching & learning strategies + professional competencies.

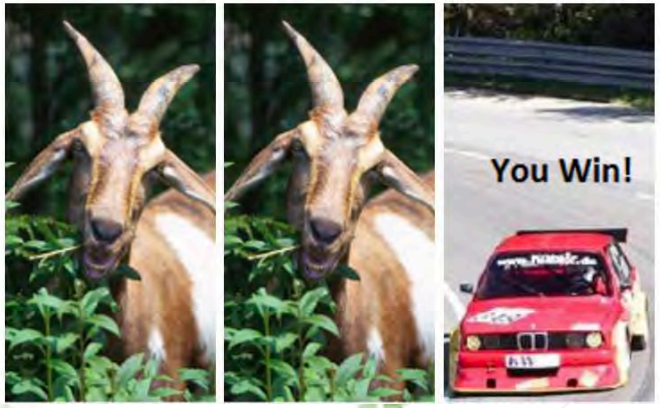
A match ends in 1 minute. If you are winning by 2 points, which players should play? And if you are losing by 8?

Statistics & Context-Based Learning

The Monty Hall Problem

Probability & Use of Simulators

- To play the game, click on a door.
- After the prize is revealed, click a second door to "stay" or "switch."



Keep track of your results:

	Stay	Switch
Wins	0	3 (75%)
Losses	0	1 (25%)
Total	0	4

Cumulative Win

Reset

Repeat Stay strategy 10 time

Animate:

Stop animation

Thank you for your attention!

References

Caballero, A., & Guerrero, E. (2015). Un cuestionario sobre dominio afectivo y resolución de problemas de matemáticas. In L.J. Blanco-Nieto, J.A. Cárdenas, & A. Caballero (Eds.), *La resolución de problemas de Matemáticas en la formación inicial de profesores de Primaria* (pp. 39–57). Cáceres: Universidad de Extremadura.

Capps, D.K., & Crawford, B.A. (2013). Inquiry-Based Instruction and Teaching about Nature of Science: Are they Happening? *Journal of Science Teacher Education*, *24*(3), 497-526.

Frenzel, A.C., Pekrun, R., & Goetz, T. (2007). Perceived learning environment and students' emotional experiences: A multilevel analysis of mathematics classrooms. *Learning and Instruction*, *17*(5), 478-493.

Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK. Results of the thinking from the PCK Summit. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining Pedagogical Content Knowledge in Science Education* (pp. 28-42). London: Routledge.

Hmelo-Silver, C.E. (2004). Problem-Based Learning: What and How do Students Learn? *Educational Psychology Review*, *16*(3), 235-266.

Ibáñez, T., & Martínez-Aznar, M.M. (2007). Solving Problems in Genetics, Part III: Change in the view of the Nature of Science. *International Journal of Science Education*, *29*(6), 747-769.

Ireland, J.E., Watters, J.J., Brownlee, J.L., & Lupton, M. (2014). Approaches to Inquiry Teaching: Elementary teacher's perspectives. *International Journal of Science Education*, 36(10), 1733-1750.

References

Marcos-Merino, J.M. (2019). Análisis de las relaciones emociones-aprendizaje de maestros en formación inicial con una práctica activa de Biología. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, *16*(1), 1603.

Mellado, V., Borrachero, A.B., Brígido, M., Melo, L.V., Dávila, M.A., Cañada, F., ... Bermejo, M.L. (2014). Las emociones en la enseñanza de las ciencias. *Enseñanza de las Ciencias*, *32*(3), 11–36.

Perrenoud, P. (2001). De la pratique réflexive au travail sur l'habitus. *Recherche & Formation*, 36, 131-162.

Pintrich, P.R., Marx, R.W., & Boyle, R.A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research, 63*(2), 167–199.

Savery, J.R. (2006). Overview of Problem-Based Learning: Definitions and Distinctions. *Interdisciplinary Journal of Problem-Based Learning*, *1*(1), 9–20.

Van Driel, J.H., & Berry, A. (2012). Teacher Professional Development Focusing on Pedagogical Content Knowledge. *Educational Researcher*, *41*(1), 26-28.