Empowering Classroom Groups: A Driving Obligation of Math Faculty in Open-access Institutions in Chile

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CONTEXT

Open-access Institutions in Chile

Professional institutes and technical training centers

- Most common type of open-access institution, similar to community colleges in the U.S.
- 45% of all undergraduates in Chile
- All private
- Serve students from low social economic backgrounds
- Teaching institutions with small classrooms (20-30 students)
- 64% first year retention
- Mathematics as a gatekeeper

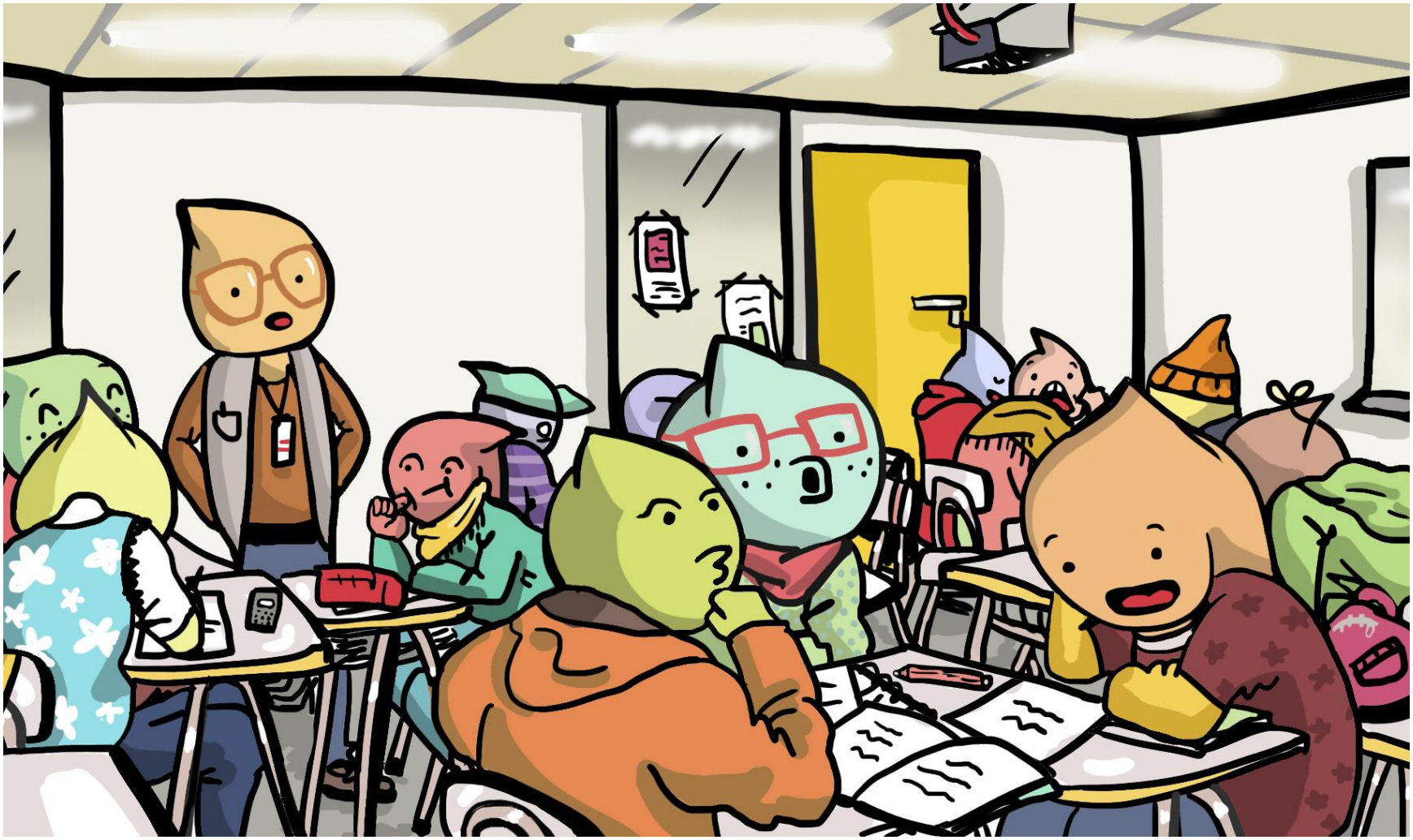
The key role of mathematics

- Influential factor in access (Kim et al., 2015), retention (Melguizo et al., 2014), and academic success (Hodara & Jaggars, 2014)
- Subject where students struggle the most, an obstacle for student persistence and degree of completion (Cox, 2009; Gasiewski et al., 2012)
- In Chile, ~50% failure rate (Unpublished data)
- Evidence shows the benefits of student centered education in math and other STEM fields (Freeman et al., 2014)

Instructors' interactions with student groups

- Student-centered teaching means new forms of interactions between instructors and students
- Instructors' interactions shape teaching and learning of mathematics (Sfard, 2001; Yackel & Cobb, 1996), and its quality impact student work (Chiu, 2004) and student learning (Kunter & Voss, 2013)
- Despite the evidence, change is difficult for instructors to enact (Cohen, 1990; Mesa et al., 2014) or they may have good reasons not to (Couburn, 2004)
- Interactions between instructor and student groups will become a central feature of classroom teaching

Instructors' interactions with student groups



Instructors' interactions with student groups

CONCEPTUAL FRAMEWORK

Professional Obligations

PRACTICAL RATIONALITY

TEACHING OF MATHEMATICS

Understand the teaching of mathematics not as a set of behaviors, but as a system of practices.

Practices that can be explained

(Bourdieu, 1998; Buchmann, 1987; Merton, 1967; Shulman, 1987)

Professional Obligations

- **Individual**

  The student has the right to know, be, and feel as he or she can within certain boundaries provided by the institution and still deserve the teacher's attention
- **Interpersonal**

  There is a group of many students, with diverse needs, sharing space, time, and attention
- **Institutional**

  The institution has its ways of doing things, schedules, the content of the curriculum, assessment, etc…
- **Disciplinary**

  The mathematical knowledge the teacher organizes needs to be a valid representation of the mathematical knowledge handled by the discipline

(Chezan, Herbst & Clark, 2016; Herbst, 2003; Herbst & Chazan, 2011)

Research Question

How do instructors' interactions with student groups relate to instructional practices and decision making in the teaching of mathematics in open-access institutions of higher education?

STUDY METHODS

Participants

- 11 math instructors at a large institution in Chile (more than 20,000 students)
- 6 to 33 years of teaching experice, and 17 on average
- All “full-time” faculty
- All participants of a one-year long professional development, where they have to implement problem-solving sessions of approximately 45 minutes:
  - Randomly created groups of 3 students
  - Instructors deliver the problem and assist the groups if they had doubts or issues working on the problem
  - If a group is stuck, they will receive a simplification. If the problem was solved, they will receive an extension of the same problem.

Data Collection

Videos of classroom teaching

- Implementations of the problem-solving activity were videorecorded
- In total, we used 25 videos, at least 2 for each instructor

Videos of discussion sessions

- Additionally, instructors participated in discussions in groups of three
- Watched and discussed 3-5 min episodes
- Facilitated by a monitor
- Sessions were recorded and transcribed
- In total, we used 8 sessions

Analysis of classroom teaching
Coding of each instructor interaction

Category	Variable Name	Code Description
General Interaction	Interruptions	The beginning of the interaction interrupts students work
	Questioning	The instructors interacts primarily with questions
	Student Talking	Fraction of students who speak in relation to group
Problem Solution	Inquiry	Instructor's actions in response to a solution
	Judgment	The instructor says whether the solution is good or wrong
	Students Arguments	At least one student presents his or her arguments

Descriptive Statistics

Category	Variable	*n*	*Yes %*
General Interaction	Interruptions	688	24.27
	Questioning	689	61.10
	Student Talking [more than one]	688	75
Problem Solution	Inquiry	385	68.05
	Judgment	385	58.96
	Students Arguments	688	56.89

OLS Regressions

- Dependent variable: *depth of the solution obtained,* which indicates whether a group solved the problem and how far it went in solving further problem extensions
- Independent variables: student arguments, number of members, number of interactions, and duration of interactions
- Allowed for intragroup correlations

Analysis of discussion sessions

- Coded instructors' justification
- Used thematic analysis (Braun & Clarke, 2012) for interpersonal obligations

Professional obligation	Justifications associated
Disciplinary	24%
Institutional	19%
Individual	16%
Interpersonal	**28%**

RESULTS

How do instructors interact with student groups in math classrooms?

Pairwise Correlations

ID	Variables	1	2	3	4	5	6
1	Interruptions†	1.00					
2	Questioning κ=0.59	-0.05	1.00				
3	Student talking	-0.12**	0.19***	1.00			
4	Inquiry κ=0.84	-0.19***	0.25***	0.24***	1.00		
5	Judgment κ=0.53	-0.10*	-0.19***	0.09	0.18***	1.00	
6	Students Arguments κ=0.81	-0.10*	0.30***	0.38***	0.46***	-0.06	1.00

ID: number for identifying the variable; †: variables completely synchronized; κ: Fleiss' Kappa Value
***p < 0.001 ; ** p < 0.01 ; * p <0.05

Regression Analyses for Variables Predicting Depth of the solution obtained *(N=123)*

Variable Name	β	Std. Err
Student Argument	0.863*	0.331
Number of Members	-0.106	0.076
Number of interactions (with the group)	0.139*	0.047
Duration of interactions	-0.069	0.167
Constant	0.398	0.520
R2		0.112
F		12.23***

***p < 0.001 ; ** p < 0.01 ; * p < 0.05

RESULTS

How do they justify these interactions?

Themes associated to interpersonal obligations

- Controlling and managing the instructional task (42%)
- Improving the classroom climate (31%)
- Empowering the group (27%)

Empowering the group: Comunicating high expectations

When you are looking at what is happening, what you are seeing, the discussions, you are listening to the discussions that are going on, you are noticing where they are going, where they are heading the problem. **Then sometimes they have everything there, but they don't see it […] Then I ask them there… More or less I said "Why did you write this? Explain to your partner why"**, but I do not remember whether it was at that precise moment, but they always have very good things, then sometimes I make them follow an idea from what they have done on the sheet they are working on. (Axel)

Empowering the group: Reinforcing the team idea

Do you know why I did that [making clear that the whole group should agree with the solution]? Because I didn't work like that before. **Because if one student convinced me, it was okay for me, but now I realized that everyone should be convinced**. They could have thought that it was going to be in the same way: If just some of them agree, then it was okay. Because of that, I insisted, because they surely were going to call me when one of them was ready. […] One [of the group] ends and she wants to show immediately what she did and she doesn't think in anyone else, then you have to say it [that everyone in the group should agree]. (Ana).

Empowering the group: the issue of the advanced student

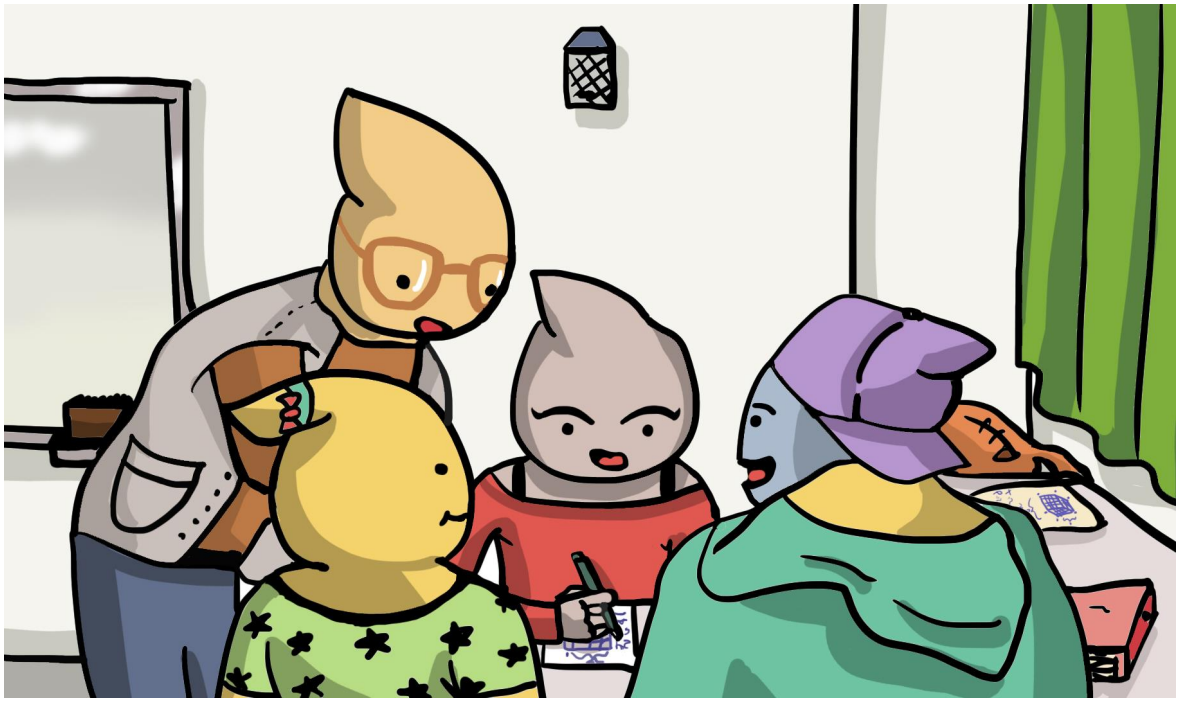
When they [students] call you immediately, they call to give you supposedly the answer of the problem, but the other two [students of the group] do not understand. The one who called me, for example, he handles the subject quite a lot, then it is very likely that he has solved the first part [of the problem] and wants to give the answer. That always happens in the groups. Always, always happens. The one who handle more tries to… He wants to answer quickly. **Then if I give him a chance to do that, the other two [students of the group] lose the opportunity to go deep into the problem. Then because of that I cut it** [an student's question]. (Agustín)

DISCUSSION

Connecting the analyses

- The group as a new layer of demands imposes challenges to students and instructors
- However, it also opens the possibility to create a more challenging situation for students
- Instructors asked questions and wanted students to verify their solutions as a group
- Instructors' engagement with promoting group discussion and participation was related to how deep groups went into the solution of the problem
- Focusing on ways of producing student arguments may be a productive work for professional development

Thank you!



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