Classroom network analysis for pedagogical decision-making in Physics and Science Education

Javier PULGAR (1,2), Pablo DE RUYT (2), Francisco SALINAS (3),
Carmen ESPINOZA (2,4),ván SÁNCHEZ (1,2)

(1) Physics Department, Universidad del Bío Bío (UBB), Concepción 4051381, Chile
(2) Grupo de Investigación en Didáctica de las Ciencias y Matemática (GIDICMA), UBB, Chile.
(3) Physics Department, Universidad de la Frontera, Temuco, 4811230, Chile.
(4) Didactics Department, Universidad Católica de la Santísima Concepción, Concepcion, Chile

Abstract. We explore how educators interpret classroom sociograms and use their network related ideas to inform pedagogical decisions. A workshop titled CLASSNET was designed upon network research evidence in education and collaborative learning techniques (CLTs). CLASSNET was implemented during 2022 and 2023 on a sample in-service (43) and pre-service science teachers (136). Qualitative analysis of their pedagogical decisions during 2022 led to the revision of CLASSNET's content in 2023, where we added CLTs and group-level activities. Results highlight the need for network-based protocols for group formation, and the tendency for posing prescribed teaching methods while overlooking the classroom social ecology.

Introduction

Active learning methods and group-level activities are nowadays commonplace in most physics and science curriculum. Student-centred teaching has shown beneficial cognitive gains and repercussions in the classroom social dynamics [1]. Furthermore, teachers design active group-level activities based on such cognitive benefits [2], yet these are rarely informed by the classroom social ecology aiming for an effective collaboration. Here we present a novel approach to elicit teachers' recognition of the social intricacies of a classroom-based classroom sociograms, and further explore whether pedagogical decisions for physics and science learning are made considering the collaborative nature of the classroom network.

Theoretical Framework

Teachers' behaviours have shown critical effects on students' social friendship and working ties, as well as the social norms of the classroom. Teachers who display supportive interactions and network-related teaching would model classrooms' norms by discouraging hierarchies grounded exclusively on performance [3]. Furthermore, in the face of group tasks, students struggle due to poor social skills, and the lack of teacher guidance [2]. The advances in physics education and the trends in student-centred teaching and collaboration fortify the need for designing formative opportunities for educators, aiming to strengthen their capacity to guide social processes by encouraging pedagogies that resonate with classroom norms and students' social ties.

Methods and Findings

Over a span of two years (2022-2023) we implemented a workshop titled CLASSNET (Classroom Social Network Analysis, see Fig. 1) grounded on evidence from social network research in education (e.g., social learning, information diffusion, etc.). 43 in-service physics teachers and 136 pre-service science teachers participated in the workshops. CLASSNET included activities for interpretation of classroom network visualisations, the recognition of social issues, and opportunities for posing pedagogical decisions. Through qualitative analysis we explored their responses aiming to check the degree to which their network-related ideas inform their pedagogies.

The 2022 evidence pertaining to pedagogical decisions lacked significant associations with their network interpretations, and mainly included prescribed teaching methods (e.g., PBL). Furthermore, most participants listed group-level activities; these lacked a rationale for doing so, let alone a criterion for group formation (e.g., gender, abilities). Accordingly, in 2023 CLASSNET we added a first part addressing collaborative learning techniques (8 CLTs); prompted decisions for group formation; and participants addressed the workshop activities in groups rather than individually like in 2022. Results from 2023 show their network interpretations mostly informing strategies for group formation, rather than their teaching methods for addressing science curriculum. Finally, participants asked for opportunities to analyse their own classrooms' networks, aiming to develop informed-based protocols for group formation.

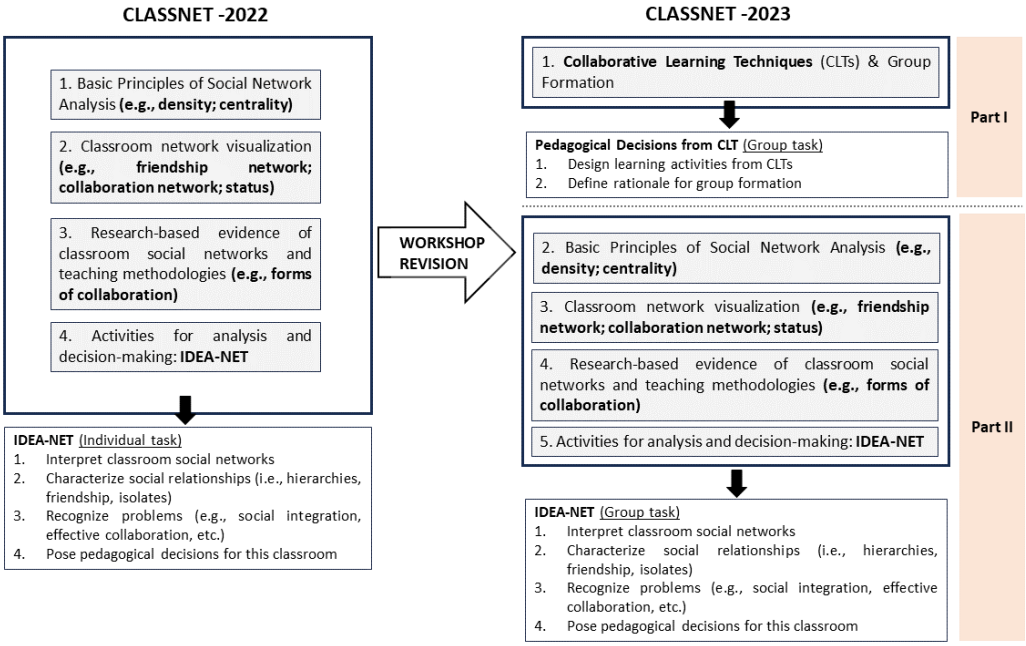

Fig. 1. Graphical depiction of the CLASSNET workshop design and related activities in 2022 and 2023.

Conclusions

Social network evidence and the sociograms become relevant tools for informing pedagogies in physic and science classroom. Considering the evidence, educators require lengthy and contextualised chances for reflecting upon the better ways to address scientific content while accounting for students' social ties (e.g., friendship, collaboration). Finally, we found an emerging need for network-based protocols for group formation, perceived as critical for organizing and optimizing students' social and cognitive development during collaborative processes in physics and science classrooms.

References

[1] K. Commeford, E. Brewe and A. Traxler, Characterising active learning environments in physics using latent profile analysis, *Phys. Rev. Phys. Ed. Res.* **18** (2022) 010113.

[2] H. Le, J. Janssen and T. Wubbels, Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration, *Cam. J. Educ*. **48** (2018) 103-122.

[3] S. Hymel and J. Katz, Designing classrooms for diversity: Fostering social inclusion, *Educ. Psychol*. **54** (2019) 331-339.