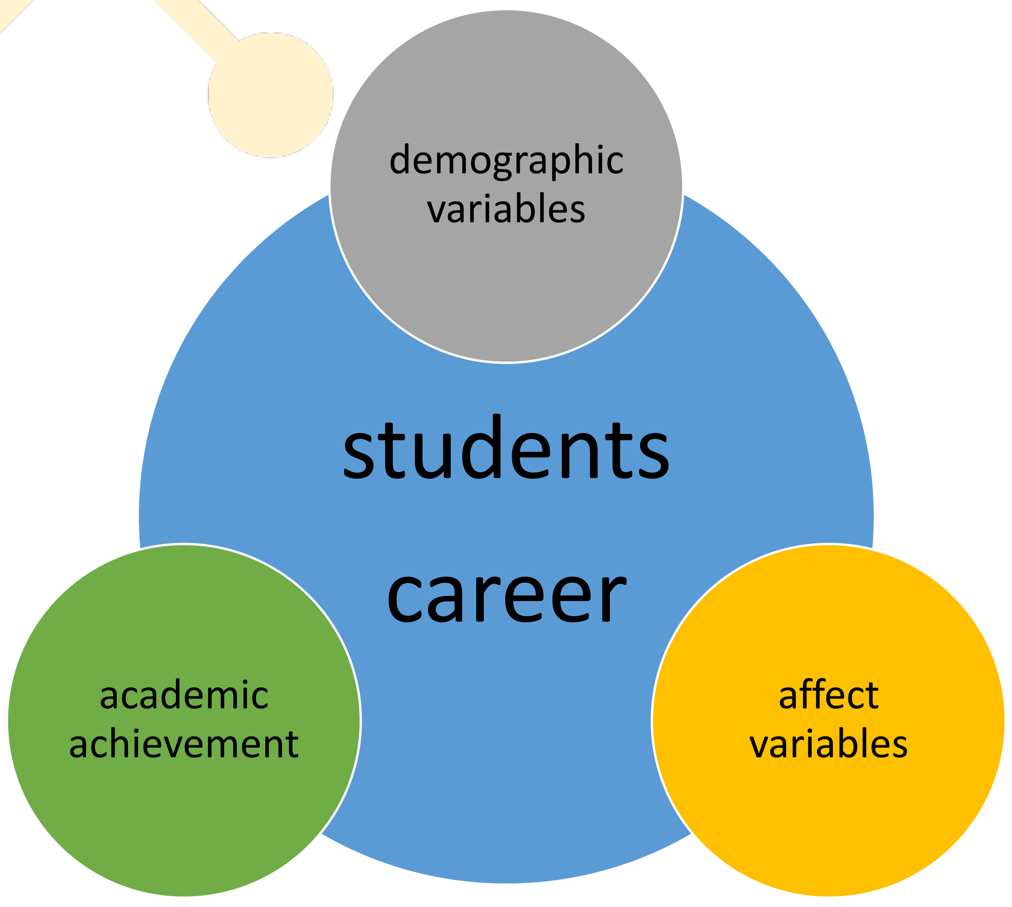
ID560 - **Community detection for undergraduate mathematical views**

Domenico Brunetto[1], Michela Tassone[2], Ester Cravero[2]

[1] Politecnico di Milano, Italy. [2] Università di Torino, Italy



Research topic:

analysis of undergraduate students' achievement in relation to affective and demographic variables.

Gender is an example for demographic variables, students' views of mathematics is an example for affective variables.

We focus on the **undergraduate students' achievement at the end of** bachelor degree in mathematics to see if there has been a change with respect to the first days at university.

process-oriented (P) represents mathematics as a creative activity consisting of solving problems using different and individual ways.

application-oriented (A) represents the utility of mathematics for real world problems as the main aspect of the nature of mathematics.

formalist (F) represents mathematics as characterised by a strongly logical and formal structure.

schema-oriented (S) represents mathematics as a set of calculation rules and procedures to apply for routine tasks.

views of mathematics (Grigutsch et al., 1998)

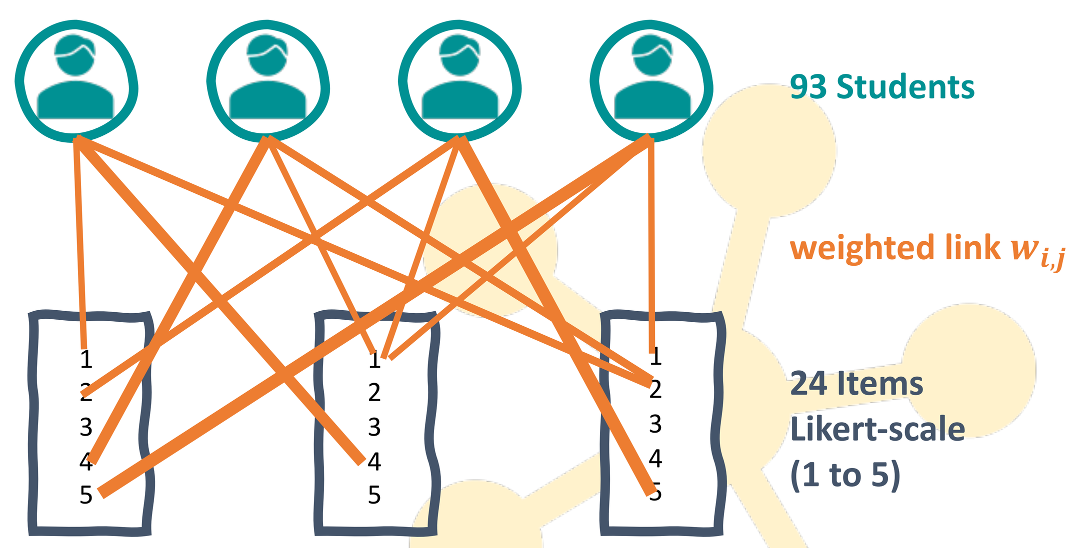
Beliefs are propositions that are true in the eyes of the beholder (Philipp, 2007), and tend to **cluster** forming coherent families of beliefs (Green, 1971).

Belief clusters can be understood in terms of **views of mathematics** (Grigutsch, Raatz & Törner, 1998).

Erens & Eichler (2019) operationalised the definitions of these four views into a Likert-scale questionnaire made of 24 statements, each one assigned to a specific view.

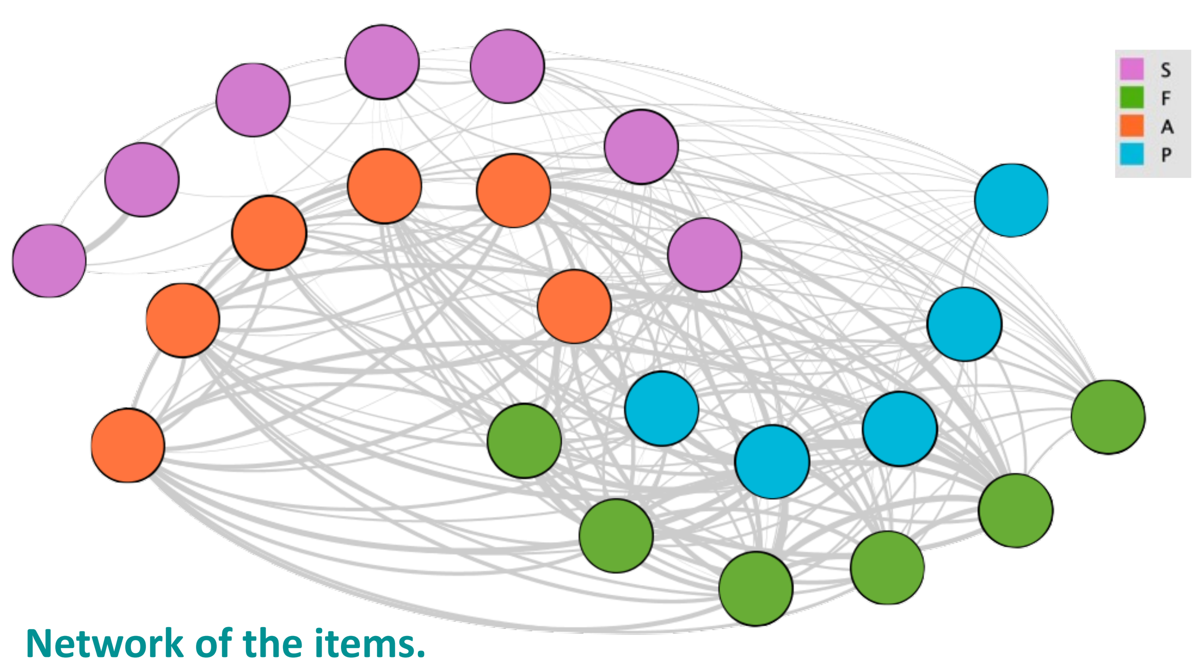
Cluster Analysis

The cluster analysis is based on **network analysis, avoiding** particular metric definitions. In particular, clusters were identified using a technique of **community detection.** Namely, the Louvain method, which is based on the optimisation of the modularity (Q). (Newman, 2010; Brunetto, 2017).



A bipartite network is made up of two distinct classes of nodes V and U, and links can only connect nodes of different classes, that is $L \subseteq V \times U$.

A student-node is connected to an item-node with an edge weighted 1,2,3,4, or 5 depending on the rank assigned to it on a **5-point Likert scale.**



Network of the items.

Created as projection of the bipartite network.

Two item-nodes are linked if a student agrees to their statements.

The more students agree about items i and j the stronger is the link $a_{i,j}$.

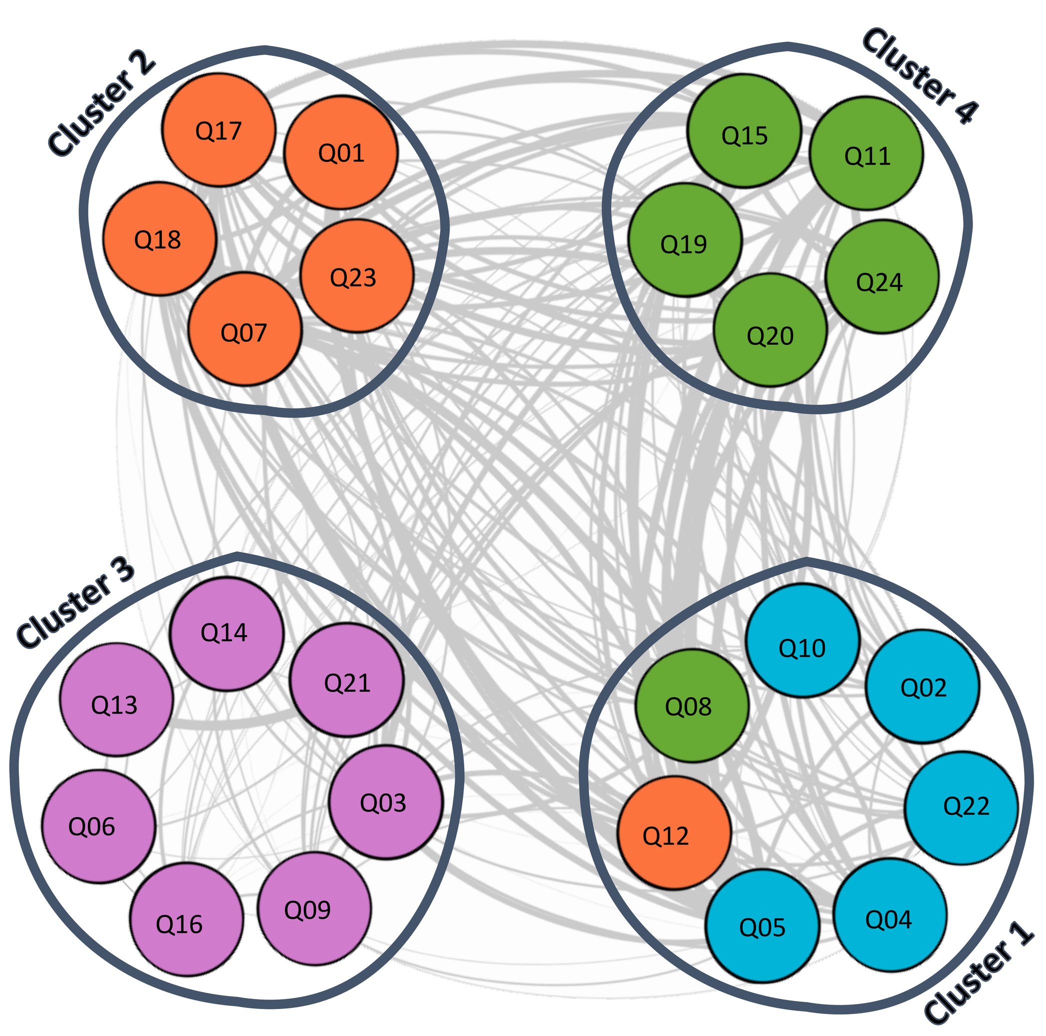
The strength $a_{i,j}$ is computed as the sum of the product of the normalized weights $w_{i,j}$ (with respect the average score of each item). Then the negative values of the strength, were set as zero value.

Results and implications

list of 24 items

http://tiny.cc/24IMV

The cluster analysis **confirm** an almost perfect **correspondence between the** ***a priori*** **classification** by Erens and Eichler (2019), **and our** ***a posteriori*** **investigation** on a sample of undergraduate mathematics students.



Precision & Recall

	A	F	P	S
Cluster 1	14.3%	14.3%	71.4%	0%
Cluster 2	100%	0%	0%	0%
Cluster 3	0%	0%	0%	100%
Cluster 4	0%	100%	0%	0%

The community detection on the 24 items network identifies 4 "communities" (i.e., clusters) of items. According to the Precision & Recall table, the **matching** with the a priori classification **is almost perfect**.

Cluster 1 contains 2 "outliers": Q08: *"Abstraction and logic are integral constituents of calculus (mathematics)"*. Q12: *"The ideas of calculus (mathematics) are of general und fundamental use to society"*.

However, we can argue **there is no contradiction,** because the community detection identifies cluster according to the **students' agreement (positive/negative)**.

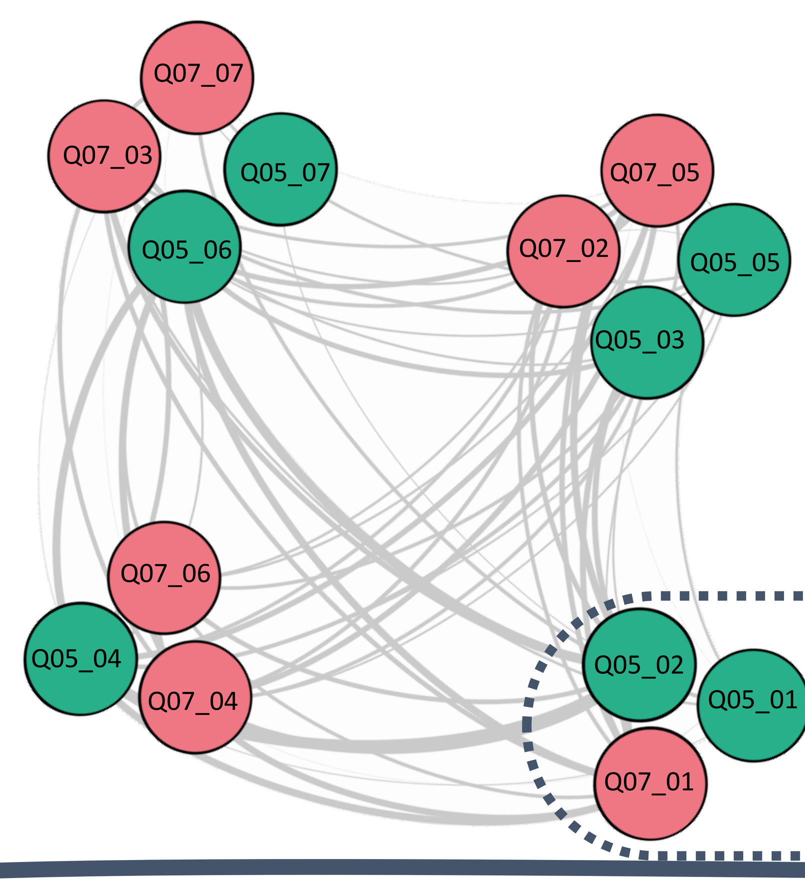
Therefore, Cluster 1 suggests that the disagreement on items Q08 and Q12 can be used to identify process-oriented views of mathematics.

Beyond the views

We further extend clustering to other aspects of mathematics teaching and learning at tertiary level.

The questionnaire contains further 14 items related to the teaching and learning aspects (needs and issues)

The community detection identifies 4 clusters according to the aspects under investigation.



Q05_01: Engaging students (by professor)
Q05_02: Stirring up student's attention and curiosity (by professor)
Q07_01: Classes are boredom because are similar to the textbook

References

- Brunetto, D. (2017). MOOCs and active learning in mathematics: Educational and Mathematical modelling for classroom practices [Unpublished doctoral dissertation]. Polytechnic of Milan.
- Erens, R. & Eichler, A. (2019). Belief changes in the transition from university studies to school practice. In M. Hannula, G.Leder, F. Morselli, M. Vollstedt, & Q. Zhang (Eds.), Affect and mathematics education (pp. 345-373). Cham, Switzerland: Springer Nature
- Green, T. (1971). The activities of teaching. New York, NY: McGraw-Hill.
- Grigutsch, S., Raatz, U. & Törner, G. (1998). Einstellungen gegenüber Mathematik bei Mathematiklehrern. Journal für Mathematikdidaktik, 19(1), 3-45.
- Newman, M. (2010). Networks: an introduction . Oxford, UK: Oxford university press.
- Philipp, R. (2007). Mathematics teachers' beliefs and affect. In F. Lester (Ed.), Second handbook of research on mathematics teaching and learning (pp. 257–315). Charlotte, NC: Information Age.