MATHEMATICAL MODEL OF STUDENT INTERACTION DURING CLASS ACTIVITIES

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Abstract

This research explores how students' opinions evolve during group activities in a mathematics classroom. Inspired by the study conducted by D. Brunetto and colleagues, we developed a mathematical model to understand student interactions. The model considers students' feelings toward their peers, reflected through the "I can - You can" framework, along with each student's level of understanding. In this study, we surveyed the opinions of ten fourth-year students during group work and conducted simulations of the model. The results are shown that the students' opinions tended to converge toward a consensus as they interacted. By running numerical simulations, we aim to better understand how student opinions change through interactions.

Methodology

The sample group consists of ten fourth-year undergraduate students from the Faculty of Science, majoring in Mathematics.

Step 1
Study the basic knowledge about Opinion Dynamics and mathematical modeling.

Step 2
Study the research on "Student interactions during class activities: a mathematical model."

Step 3
Data was collected through a survey on interaction during class activities, in which the sample group responded to the assessment using the statements “I can” and “You can”

Step 4
Create a matrix K,representing students' confidence levels in themselves and their peers.

Step 5
Compute matrix W and analyze the data to observe the trends in the change of students' opinions, and develop a numerical model.

Step 6
Write a report and verify its accuracy.

Codifying the students’ feelings

In the “I can - You can” framework,a student is characterized by two variables, which take values in the range [0, 1]. The situation can be represented on a coordinate system called the “I can - You can” diagram as shown in Figure 1. Four different profiles, that will be referred to as “traits”, can be identified:

1. Cooperative student
2. Isolated student
3. Obstinate student
4. Follower

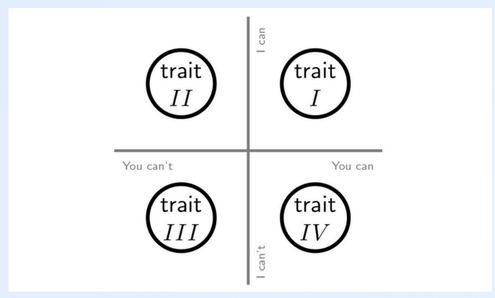

Figure 1: Schema of student traits on the “I can” - “you can” diagram.

$$K \in \mathbb{R}^{N\times N}, \qquad K = [k_{ij}]_{i,j=1}^{N}$$

- **"I can"** (k_{ii}) represents the confidence level of student i in their own abilities.
- **"You can"** (k_{ij}) represents the level of confidence student i has in the abilities of student j.

The attitude matrix (Correspondent Attitude Matrix, K) was obtained as follows.

$$K = \begin{bmatrix}
0.75 & 0.9 & 0.75 & 0.8 & 0.7 & 0.65 & 0.85 & 0.9 & 0.75 & 0.75 \\
0.95 & 0.7 & 0.95 & 0.95 & 0.85 & 1 & 0.9 & 0.95 & 0.85 & 0.85 \\
1 & 1 & 0.7 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
1 & 0.95 & 0.85 & 0.55 & 0.85 & 0.75 & 0.75 & 0.75 & 0.75 & 0.75 \\
1 & 1 & 1 & 1 & 0.7 & 1 & 1 & 1 & 1 & 1 \\
1 & 1 & 0.95 & 0.95 & 0.9 & 0.95 & 1 & 0.95 & 0.95 & 1 \\
0.85 & 0.85 & 0.7 & 0.75 & 0.75 & 1 & 0.8 & 1 & 1 & 0.85 \\
0.9 & 0.85 & 1 & 0.9 & 0.85 & 0.85 & 0.8 & 0.5 & 0.9 & 0.8 \\
0.8 & 0.8 & 0.8 & 0.8 & 0.8 & 0.8 & 0.8 & 0.8 & 0.6 & 0.8 \\
0.95 & 0.95 & 0.95 & 0.85 & 0.85 & 1 & 1 & 0.95 & 0.95 & 0.8
\end{bmatrix}$$

Results

We consider the changes in students' opinions as they interact during a classroom activity.
Let $x_i(t)$ be the opinion of student i in a group of N students, and let W be the confidence matrix of the group.The opinion dynamics model of the students is given by the differential equation:

$$\dot{x}_i(t) = \sum_{j=1}^{N} w_{ij}(t)(x_j(t) - x_i(t)),$$

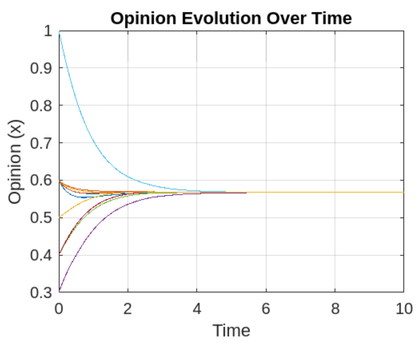

Figure 2: The dynamics of opinions of the 10 students

Calculate the confidence matrix (W) from the initial opinions of ten students:

$$x_1^0 = 0.6, \quad x_2^0 = 0.6, \quad x_3^0 = 0.6, \quad x_4^0 = 0.3, \quad x_5^0 = 0.4,$$
$$x_6^0 = 1.0, \quad x_7^0 = 0.4, \quad x_8^0 = 0.6, \quad x_9^0 = 0.6, \quad x_{10}^0 = 0.5$$

From these values, we obtain $W(0)$ as follows:

$$W(0) = \begin{bmatrix}
0 & 0 & 0 & 0.3110 & 0.2200 & 0.0387 & 0.2763 & 0 & 0 & 0.1539 \\
0 & 0 & 0 & 0.2810 & 0.1909 & 0.2199 & 0.1934 & 0 & 0 & 0.1148 \\
0 & 0 & 0 & 0.2731 & 0.2124 & 0.1948 & 0.1981 & 0 & 0 & 0.1216 \\
0.1875 & 0.1762 & 0.1403 & 0 & 0.0889 & 0 & 0.0720 & 0.1194 & 0.1114 & 0.1043 \\
0.1448 & 0.1499 & 0.1499 & 0.1021 & 0 & 0.0344 & 0 & 0.1722 & 0.1607 & 0.0858 \\
0.1576 & 0.1632 & 0.1445 & 0 & 0.0181 & 0 & 0.0709 & 0.1660 & 0.1549 & 0.1247 \\
0.1358 & 0.1406 & 0.1047 & 0.0865 & 0 & 0.0579 & 0 & 0.2022 & 0.1887 & 0.0837 \\
0 & 0 & 0 & 0.2970 & 0.2316 & 0.1412 & 0.1970 & 0 & 0 & 0.1331 \\
0 & 0 & 0 & 0.2626 & 0.2367 & 0.1327 & 0.2208 & 0 & 0 & 0.1472 \\
0.0979 & 0.1013 & 0.1013 & 0.1560 & 0.0897 & 0.1287 & 0.1000 & 0.1164 & 0.1086 & 0
\end{bmatrix}$$

Conclusion

The study employed a mathematical model to explain the dynamics of opinions in a student group during group work, considering factors such as “I can” (self-confidence) and “You can” (peer acceptance). It was found that in groups with high 'You can' values, the exchange of opinions occurred smoothly, and group members adapted their views. Conversely, students with high 'I can' values tend to express their opinions assertively and persuade others effectively, ultimately leading to a consensus.

References

[1] Brunetto, D., Andra, C., Parolini, N., Verani, M. (2018). Student interactions during class activities: a mathematical model. Dipartimento di Matematica, Politecnico di Milano, Milan, Italy, Received on 10 11, 2016. Accepted on 04 10, 2018.