Identifying Peers to Form an Effective Team in a Project-Based Course

Innovative Practice

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***Abstract*— *Science and Education* is an elective course for all undergraduates of Universidad de los Andes, a Colombian institution. This course is designed to promote a scientific mindset while learning how to teach STEM concepts. During the third week of the course, students must identify teammates for a 3-month project. Because the team lasts almost the entire term, it is important to be able to identify complementary teammates and work effectively. To address that need, an in-class activity called *Speed Grouping* was designed.**

This study aims to analyze what are the students' reflections about the *Speed Grouping* activity and their process of forming teams for the project. The students' perceptions about the usefulness of the *Speed Grouping* activity for working effectively as a team was revised. To address this goal, a qualitative thematic analysis was conducted, using students' reflective papers based on their own diary entries about teamwork. Categories emerged from data and were linked to effective teamwork literature to analyze the level of success in forming groups for the project.

The results of the thematic analysis showed that the Speed Grouping activity promoted peer selection for group effectiveness. In addition, reflections show a positive anticipation for teamwork during the project, highlighting the importance of interaction, team outcome, peers' personality and abilities, and articulation of team members.

Keywords—Teamwork; Group Identification; STEM Education; In-Class Activity

I. INTRODUCTION

Science and Education is an elective course for all the undergraduates of Universidad de los Andes, and it is aimed to promote a scientific mindset while learning how to teach STEM (Science, Technology, Engineering and Mathematics) concepts. The course has three modules, the first focuses on studying the epistemology of scientific concepts, the second on teaching and learning those concepts, and the third on designing a session for teaching a STEM concept. This last module consists on the design, pilot, and communication of a STEM unit, which is a long-term group project. Students must identify three teammates during the third week of the course as they are expected to work as a project team along the term. Teamwork is encouraged across this course as it is regarded as a cooperative learning strategy that, when properly accomplished, promotes "deep learning that occurs through interaction, problem solving, dialogue, cooperation and collaboration" [1, 2]. However, studies suggests that not all type of groups achieve effectively cooperative learning [3], in addition it has been challenging to study human behavior and team dynamics in order to improve teamwork [4].

Therefore, aiming to promote efficient teamwork, it is essential to provide students with an appropriate opportunity to identify possible teammates with whom they could complement each other and work effectively. To address that need, an in-class activity, called *Speed Grouping*, was designed for *Science and Education* course. The idea was developed from the popular *Tower of Cups* team building activity [5, 6]; however, a subtle modification was incorporated: participating groups were no longer fixed during the activity. Instead, members of each group had to vary across the different rounds similarly to a speed dating-like scheme. The objective of this rotation system lies in creating a space that encourage students to interact with as most classmates as possible and thus, be able to choose teammates in a more informed way.

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According to some studies, the speed dating-like model allows to perceive accurately some people's characteristics in a glimpse or short talk [1, 7, 8]. This phenomenon is referred as *thin slice* [9], which is defined as a "brief excerpt of expressive behavior sampled from the behavioral stream" [9]. In fact, thin slicing has been described not only in romantic relationship research but also in education research [10]. Studies have shown that, just based on ten second clips, people are able to identify how teacher's behavior may be different towards some of the students, behavior that finally matches properly with the actual teacher's evaluation of those students [10]. Considering the mentioned above, *Speed Grouping* was designed as a novel approach to expose students' attitudes and preferences towards peer identification and selection for group conformation. We expect this will lead to a better understanding of how the various elements involved in teamwork such as leadership, personality and cognitive characteristics [4], are taken into account during the process of decision making for group formation.

Since this is the first attempt to conduct this new methodology, the aim of this study is to analyze what are the students' reflections about the Speed Grouping activity and teamwork during project-groups formation and project planning. To address this goal, a qualitative thematic analysis was conducted, revising students' reflections about their teamwork posts in a virtual diary all along the course. Categories emerged from data and were linked to effective teamwork literature to analyze the level of success in forming groups for the project.

II. The Speed Grouping Activity

One of the learning objectives of the class in which the data was collected aimed for the students to be able to apply what they learned in the course to design a STEM teaching-learning activity. During three months, students had to work in teams for the project. As a first stage, they had to revise the epistemology of a STEM concept selected by them, so they latter would be able to design a unit for teaching that concept. As a second stage, students had to identify those pedagogical approaches they considered appropriate to teach the selected concept. During the third and final stage, they had to design a module aligned with the epistemology and pedagogy studied. For the activity design, they had to propose learning objectives, learning activities, and assessment activities aligned. Students also had to raise a research question related to the unit designed and propose a method for them to pilot the unit and answer the research question. At the end of the term, students had to present a final version of the unit piloted. They had to communicate their intervention, pilot, and research process using a poster, which included the results of the pilot. Due to the length of the project and its relevance in the course final grade, the selection of an effective group was crucial for the students to succeed in the course.

An activity was designed for them to be able to meet as much as possible prospective teammates "in action" in a short period of time. During one class session, students had to form groups of four with people they had not work with before. Then, they had to compete building the more efficient cup tower, based on a popular STEM activity [5, 6]. The efficiency was measured by the largest number of rows using the least number of cups and time. Groups had to use 6 cups, 5 minutes was the maximum time for them to build the tower, and goups had to follow five restrictions:

1) Cups initial position: All cups had to be placed in a corner of the table facing up.

2) Set up: Four strings had to be attached to a rubber band in each group. The rubber band was used for cup manipulation by pulling the four stings.

3) Manipulation of cups: No one could touch the cup ditectly. Students had to manipulate one and only one string attached to a rubber band. One rubber band with four strings were given to each group. When time was up all group members had to release the string and show the resulting tower.

4) Breaking the rules: In the event a group member had to break the rules (e.g. when a cup falled to the floor and a person pick it up) they had to locate the cup touched in the initial position.

5) Rotation: after the five-minute lapse, the students had 2 minutes to reflect about the group strengths and weaknesses. Then, students had to regroup forming a new team of four members. Each student had to choose a team with at least two members who had not work with them before. This procedure was repeated five times.

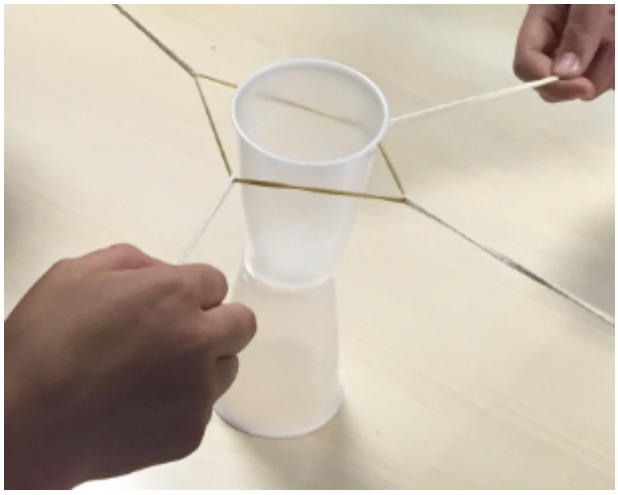

Image 1 Cup manipulation

At the end of the class, students had to write those strengths and weaknesses and any other reflection they considered important on their dairy. Those reports were evidence for them to use when writing a reflective document during the course.

III. Method

This study was developed under an interpretative worldview [11, 12] aiming to find an in-depth information for social dynamics when selecting colleagues. An interpretative paradigm allows to address the complexity of human behavior, which many times cannot be predicted [11]. A thematic analysis [13] was performed in order to identify emerging categories about what are the key elements to a successful group formation according to students' perspectives. For the analysis, an instance within students' reflective papers, that was explicitly related to the activity of *Speed Grouping* counted as theme; also, instances regarding selection of group members also were counted as themes. After an iterative revision of those emergent themes, a consolidated list of categories and sub-categories was stable, becoming the final theme schema for the analysis. The first reflective paper students submitted during the course was analyzed and considered the unit of analysis. An inductive identification was performed for the themes to emerge from the data.

77 students were part of the *Science and Education* cohort analyzed. The class was divided in two sections. Section one had 42 students, 21 of them (50%) were females; section two had 35 students, 21 of them (60%) were females. Among the two sections there were 29 students from the school of engineering, 12 from the school of economics, 10 from social sciences, 6 from the school of business, 6 from the school of architecture and design, 5 from the school of medicine, 4 from the school of sciences, and 5 from other schools. 16 participants (21%) were studying their first year, 25 (32%) were in their second year, 18 (23,5%) were studying their third year, and 18 (23,5%) had studied for four years or more.

Students' perspectives were collected in a class diary and used as evidence sources for two products the students had to submit during the term. These products were reflective papers about their own learning process during the period immediately before the submission. In the two reflections (approximately 1000 words each) students performed a metacognitive exercise in which they were challenged to observe themselves as learners and explain how the course had helped to shape their ideas and ways of thinking about science and about working collaborative in a project. These class' artifacts allowed to illustrate students' teamwork selection.

For coding consistency, only one coder was assign and performed the first iterations of the thematic analysis were new codes were emerging. The data was de-identified and there was no reference to student demographics for avoiding a bias based on gender, type of studies, or performance in class work. This study does not aim to find generalizations about how students select their peers to form a team; in contrast, it pursues to understand how students perceive an activity may facilitate team formation and which elements students, who were analyzed, consider are key for team success.

IV. Results

After the thematic analysis was performed, categories and subcategories emerged from students' perspectives. Their reflections connected the *Speed Grouping* activity with two different dimensions. A first dimension related to those elements they considered when selecting a group. A second dimension related to the activity itself.

The thematic analysis resulted in five iterations of data revision. During the first iteration, all reflective papers from students were collected and explicit references to the activity were extracted from the entire reflection. Among the 77 students on the

course, only 60 of them submitted the reflective paper that was analyzed. 18 of those students who submitted the document (30%) explicitly included some reference to the Speed Grouping Activity. Those students explained how this activity helped them to choose their teammates. The second iteration consisted in revise all the references to speed grouping highlighting those elements that students considered key for selecting a group. 59 instances containing key elements were identified. During the third iteration, the instances were broken down into codes that included a single concept or construct. This codification process resulted into 106 elements, categorized in 18 themes that became the final subcategories. For the fourth iteration, those themes were organized and categorized into 7 consolidated themes that became the final categories. Finally, a fifth iteration was performed for triangulating categories and subcategories with the literature, identifying two different dimensions that comprised all the categories. Table 1 illustrates the final categorization of themes found in the analysis.

The first dimension focused on the elements students highlighted as key elements when selecting peers to form a group for the project. This dimension is directly linked to the research question and the purpose of this study. In this dimension five categories emerged showing students' perspectives of the importance of interaction quality, alignment in product orientation, how peers complement each other, prospective teammates' personality, and knowledge of everyone's capabilities.

Interaction was the most overarching theme among reflections. Within this category 21 instances were identified within 4 subcategories. 14 of the 18 students reflected about the interactions experienced between them during the competition. In fact, 8 of them mentioned the importance of effective communication during the task for a positive result. Among those elements for an effective communication students mentioned active listening and frequency in the communication. They also mention that communication is necessary for organization, and that sometimes a negative outcome was caused for the lack of communication among group members. As part of interaction, 8 of the students with instances in this category mentioned the importance of having diverse point of views.

TABLE I. CATEGORIES THAT EMERGED FROM THE ANALYSIS

Dimension	Category	Subcategory
Group Selection	Personality	· Attitude · Affinity
	Product	· Outcome · Participation · Organization
	Interaction	· Communication · Points of View · Respect · Social interaction
	Individuality	· Self-awareness · Others' Abilities and weaknesses
	Complement	· Roles · Collaboration · Peer Support
Speed Grouping	Activity	· Interesting · Experience Gained · Knowing others
	Use	· Need of teamwork

In fact, they reflected about the utility in having different careers, contexts and ideas, because it allowed them to analyze different points of view and mitigate the bias of a unique perspective or solution. Two of them highlighted that diversity was possible due to the interdisciplinary nature of the group. Three students also mentioned the importance of respect when posting and listening their ideas, and two more mentioned that the communication had to start from social interactions probably apart from the activity, seeking for building confidence within the group and mitigation of future possible conflicts.

The second most overarching theme within this dimension was product. In this category 20 instances were identified within three subcategories. 13 students reflected about the importance of having a positive outcome at the end of each round of the competition. They identified winning the competition, or having an efficient tower, as being part of a successful team. In other words, students were product-oriented. In fact, 9 of the 13 students mentioned a positive outcome as an element for selecting their team. Likewise, 7 students mentioned that being organized was crucial for achieving a positive outcome; they measured organization in terms of group results. Finally, four students mentioned the importance of participation for being able to achieve the goal. Again, they assessed the quality of participation in terms of the outcome.

Another important element identified by students was complement. This category referred to the benefit of balancing individuals' weaknesses and strengths by working as an articulated team. In this category 19 instances were identified within three subcategories. In fact, 14 students reflected about having roles articulated and being collaborative helped them to organized their teams and tasks, facilitating a successful team. Six students mentioned advantages of having roles clearly defined. For instance, one student mentioned that having roles helped each member of the group being accountable for a specific task. Another student mentioned the importance of having a clear leader for others to follow, helping to be more organized and therefore effective. 9 students mentioned the importance of collaborating within the group for being an effective team. This subcategory is linked to several other categories and subcategories, according to students' reflections. They mentioned that a good communication allowed more organization, defining roles and tasks, and that pacification allowed all team members being actively involved, which some students defined as good collaboration. Also, as part of this category, a third category emerged as peer support. In fact, four of the students mentioned the importance of supporting other team members. Working in groups for having others to balance their weaknesses and strengths, and helping each other.

A fourth element regarding group selection was personality. This category refers to those elements for identifying a possible teammate related to attitudes and affinity between peers. In contrast with previous categories, this one depends on the relationship between peers, and not in the qualities of an individual of the result. For instance, one student mentioned selecting the group in which she felt most comfortable with others. within this category, 15 instances were coded within two subcategories. Among them, 10 students identified the importance of the affinity between team-members. Although they mention other elements for selecting a final group, these students highlight the importance of feeling good when working with another. More than explaining a specific quality or outcome, students refer to this element as having chemistry or being comfortable working with their peers. Likewise, this category refers to the attitude of others as an element for group selection. 5 students mentioned that the attitude of others helped to get organized, to mitigate bias or having a limited perspective. In fact, students explained the importance of being open to new situations, being proactive and in constant participation for being able to achieve the goals of the activity.

Finally, the least overarching category regarding to group selection was individuality. Although students were asked to write down the strengths and weaknesses of each group during the activity, only 6 of the 18 students mentioned explicitly this element in their formal reflections. These students considered important to identify those qualities of themselves and of others for choosing a proper team. In fact, four of them mentioned that knowing how others approach the challenge was crucial for selecting teammates. Also, two of them reflected on the importance of knowing own strengths and weaknesses helped to select an effective team.

The second dimension focused on the activity itself. The categories in this dimension were grouped separated because they did not answer directly the research questions; however, they were included due to the relevancy for validating the activity itself. Two categories emerged, one related to the benefits of the Speed Grouping activity, other related to the usefulness of working in groups. 15 of the 18 students referred to this dimension when reflecting about their learning process regarding to group work. For usefulness, no subcategories emerged. Five students reflected about the importance of working in groups, even though they had previous negative experiences or preferred to work individually. In fact, they acknowledge that they should learn how to work in groups due to the need of this skills in their future professional endeavors.

The second category that emerged within this dimension is related to the benefits of the activity itself. 20 instances within three subcategories were mentioned by 12 students. 7 of the reflections showed that students felt engaged during the cup-tower challenge, and mentioned that they found the activity very interesting. 7 students perceived the activity as a good opportunity to rapidly meet several classmates with different backgrounds and perspectives; they mentioned that the activity helped to achieve the goal of selecting an effective team for the project. Similarly, 6 students mentioned in diverse context how the activity helped to gain experience for choosing that effective team. For instance, one

student mentioned that the activity provided a space for anticipating future team relations and reactions, avoiding selecting a group based on uninformed judgments or stereotypes. Other students mentioned that repetition of the challenge within the activity helped them to gain experience with each iteration and new group formation. The repeating activity provided then with opportunities to gain experience about the challenge and being able to plan accordingly. With each iteration students felt more confident and were willing to take more risks than in previous iterations.

V. Discussion

Is remarkable to notice the several categories that appear in the students' reflections regarding the *Speed Grouping* activity. As shown in Table 1, 18 subcategories emerged from reflections of group dynamics with just a 5-minute interaction within each team for the cup-tower challenge. These findings are consistent with previous studies that have demonstrated how brief verbal and nonverbal interactions are sufficient to infer appropriate patterns or characteristics of other individuals [14,15]. This ability, also known as thin slicing, has been described and studied in diverse contexts such as room space analysis, racist behavior, sexual orientation, biased behavior in the classroom, and speed dating [14]. In fact, the attempt to develop the most rewarding and convenient relationships in such short periods, forces participants to assess interactions and predict future relationships in a more significant way within speed dating-like activities [14]. Therefore, thin slicing judgment could possibly account for the several and diverse emergent categories supporting the idea that *Speed Grouping* is a pertinent and useful tool to enable students to determine their project's workmates in a more informed manner.

Interestingly, the categories found and described in results could be grouped in two different dimensions: those that students considered as necessary to achieve successful teamwork; and those about *Speed Grouping* as an activity (Table 1). To start with the first dimension, it is noteworthy that almost all subcategories established (except recognition of other's abilities and weaknesses) can be classified in one of Pina Tarricone's *Key attributes* for successful teamwork [16] since they matched one or some of the author's descriptors. Essentially, this means that during *Speed Grouping,* students were capable of effectively identify those criteria that, according to literature [16,17], are considered vital for a successful teamwork.

For instance, all four subcategories that lie under the *Interaction* category (Table 1), could be associated with three of Tarricone's attributes: interpersonal skills, commitment and open communication. In the first place, *Communication* was mentioned several times by students as an essential requirement since it was necessary to coordinate the strings that enable them to move the cup. In fact, communication has been considered determinant to the success or failure of a team [18] as it leads to improved information flow and more effective interventions, encourages collaboration and fosters teamwork [19]. Perhaps the prominence of communication in the students' reflections is due to the attempt to reduce uncertainty and increase relational predictability considering this is one of the most fundamental communication behaviors [14]; being even more relevant in an environment such as speed dating-like activity, where people are being expected to rapidly assess their interactions in a more conscious manner [14]. Secondly, students highlighted the fact that speed grouping allowed them to discover new points of view, a consideration that high-performance teams value since diversity can be understand as a competitive advantage [20]. In addition, within this subcategory, some students look at *Speed Grouping* as an ideal setting for interdisciplinary; which means that this activity could build up a situation that encourages critical and creative thinking, the ability to make decisions and to synthesize knowledge beyond disciplines [21]. However, this confluence of ideas was not sufficient according to class reflections; some of the participants mentioned the importance of respect during work interactions. Some studies even suggest that when respect is absent in a group, other factors conducive to effective team behavior become irrelevant due to the importance of the first [18,20].

Interaction skills and requirements mentioned before are strongly linked to personality traits according to students. In fact, the most mentioned condition for teammate choice was having a good relationship among team members not in terms of a formal work-centered relation but in a more personal level; getting along with others during the exercise was perceived as an important requirement for

teammate selection. In general, special attention was given to agreeable relationships which could be explained in terms of social skills and their relevance in teamwork. For instance, social skills enable individuals to work in a more cooperative way, stimulating effective work coordination and conflict management [22]. Moreover, agreeable individuals are likely to be more selfless, cooperative, helpful and flexible; traits that notably improve teamwork [22]. On the other hand, another personality trait identified was the attitude towards the task assigned as it reveals commitment to it. Team members must be responsible for their contribution and awareness of processes, practices and new ideas [20]. This attitude should be conceived as a group and members should be committed to it since mismatch expectations about team objectives and products leads to inconveniences such as frustration and lack of trust [20].

Regarding complement category, the most prevalent aspect was collaboration. To a certain extent, this was an expected result considering *Science and Education* as a course intended to encourage collaborative learning where students' exploration and application of the material allows them to mutually search for understanding and meanings [23] of STEM concepts and the educational challenges related to them. *Speed Grouping* was therefore an appropriate scenario for students to realize how important collaboration is in a group task accomplishment. It is remarkable that from those ten students who identified collaboration as an essential issue, four described peer support as an important characteristic for teammate selection. In addition, role assignment has been also identified as an important feature for an effective teamwork. As a matter of fact, researchers have previously stated that "clarifying member roles, relationships, assignments and responsibilities" [18] facilitate team success; even more, they affirmed that synergistic integration of roles leads to a better team performance [18]. Also, team roles have been shown to be strongly associated with the strengths and weaknesses of team members [24]. In contrast, data collected showed that those students who identified roles as a key element did not identified others' abilities and weaknesses as a key element and vice versa.

Finally, product based category arose as an interesting theme since students assessed three different aspects of teamwork mainly based on activity's results. For example, some students considered that being able to effectively build a cup tower was a critical to determine whether a team was appropriate or not. This orientation towards product is consistent with previous studies where agreement upon common goals and success achieving have been stated as necessary to determine teamwork effectiveness [20]. In fact, in Tarricone and Luca's case study [2], cooperative-working relationships derived from shared common goal and focus on developing a quality final product that could out-compete other teams' results. Likewise, participation was also assessed by students based on the activity outcome; however, it is important to take into consideration that participation has been shown to be appraised differently according to Myers-Briggs Type indicator; "thinkers are primarily concerned with accomplishing the task, while feelers are concerned with how well people work together" [17]. Therefore, it could be interesting for further studies to determine if *Speed Grouping* could be an approach to make evident personality types and to evaluate how different types interact with each other during the activity. Last, some students considered that successful outcome during the activity resulted from an effective team organization. These observations are coherent with evaluation of successful self-managing teams where discussion about how teams organize and determine each of the member's contributions has been identified as a critical factor [25].

Regarding to the Speed Grouping dimension, data showed that students were interested in the activity. For example, students exhibited interest in the activity and its dynamics, and claimed that the activity was an engaging exercise to explore group interaction. These several statements become extremely relevant since interest and motivation have been identified as key factors for effective learning since several decades ago [26] as well as for development of different learning outcomes such as affective learning, understood as a specific type of learning involving confidence, self-efficacy, attitudes, preferences and dispositions [27]. Furthermore, nearly 40% of the group affirms that *Speed Grouping* setting provides an ideal space to know other people that otherwise would have hardly ever met or been considered as possible teammates;

which basically is one of the main objectives intended when the activity was designed. Noteworthy, this experience did not just take place towards the others, self-awareness was also enhanced according to two students that refer to *Speed Grouping* as an opportunity to identify self-skills.

Lastly, students acknowledge *Speed Grouping* as a useful approach to learn how to achieve effective teamwork in the future, highlighting cooperative work as an essential professional skill that need to be learnt. These results suggest that the activity encourage students to be more aware of the real-world complexity and to attempt approaching it from different perspectives, and considering diverse personalities [28].

VI. CONCLUSSION

In brief, some students considered *Speed Grouping* as an ideal approach to encourage teammates identification based on the key elements highlighted across this research. This novel strategy has been demonstrated as effective in making students more conscious about peer selection process giving them an appropriate space to interact with each other. Furthermore, thin slicing theory and its speed dating application studies strongly supports the idea that *Speed Grouping* enables participants to have a significant interaction with others during a competitive/cooperative activity. We firmly believe that *Speed Grouping* is a worth studying activity due to its potential learning outcomes in STEM education settings and beyond.

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