Formation of groups for collaborative learning: an approach based on profiles of individual self-reports

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Abstract— Forming collaborative learning groups without criteria generates problems such as disproportionate participation of individuals, demotivation and resistance to group work. Given this context, this work uses correlation and linear regression in helping to form groups for collaborative learning contexts. The research articulates, in addition to Statistics, knowledge in the areas of Positive Psychology and Collaboration Theories. From the analysis of the obtained results, through realized experiments, it is possible to form more effective groups for processes of collaborative learning, when one takes into account profiles of positive self-reports of the individuals.

Keywords—Collaborative learning; formation of groups; Positive psychological variables

I. INTRODUCTION

[17]; [12]; [8] consider that when work is done collaboratively, individual skills can be complemented by the knowledge and experience of other group members. In addition, interaction between people enables group members to identify inconsistencies and flaws in their thinking when encountering other points of view and understandings.

[6] emphasize that one way of supporting collaboration is to be concerned with group formation, which is considered crucial to triggering productive interactions between peers. For these authors, grouping carelessly can, for example, be the trigger for undesirable situations, such as the isolation of some students within a group. For this reason, it is essential to consider a group formation strategy to promote productive interactions and to ensure that such a strategy can be used to support collaboration.

[14] positive psychological variables such as subjective well-being, optimism, self-esteem, hope, self-efficacy, happiness and resilience. [15]; [13]; [5] emphasize that positive psychological variables are used to measure individual levels of human beings, their personal and academic potential.

Based on this contextualization, this work focuses its investigation of how to optimize group formations to enhance collaborative learning considering the positive characteristics of the individual. To guide such a study, the research is organized into five more sections. In Section II positive variables are described. Section III is reserved for research methodology. Results are brought through Section IV. Analysis and discussion are presented in Section V. Finally, Section VI draws conclusions and suggests future work.

II. POSITIVE VARIABLES

[4] present evidence of the implications of the positive variables hope, self-esteem, and self-efficacy in the individual's educational performance. [9]; [7]; [16]; [5]; [3] define hope as cognitions aimed at achieving a goal, composed of routes and agency. [2] emphasize that self-esteem represents an evaluative aspect of self-concept and consists of a set of thoughts referring to itself. It is, therefore, a positive (self-approving) or negative (depreciation) orientation to turn to self, and in this conception it is the personal representation of the general and common feelings of self-worth. [1] emphasizes that self-efficacy is the belief in the ability to gather cognitive, motivational and behavioral resources necessary to perform a task that is at the heart of the concept of self-efficacy (not reality itself).

II.I AUTORRELATING SCALES

Table I shows the levels of self-reported profiles of the individual as a function of the percentile ranges considering their positive psychological variables. This classification was validated by the Measurement Laboratory of the Institute of Psychology, Federal University of Rio Grande do Sul (UFRGS).

<table>
<thead>
<tr>
<th>Percentile range</th>
<th>Levels of self-reports of the individual</th>
</tr>
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<tbody>
<tr>
<td>(&lt; 30%)</td>
<td>low (B)</td>
</tr>
<tr>
<td>≥ 30% e &lt; 40%</td>
<td>medium low (MB)</td>
</tr>
<tr>
<td>≥ 40% e &lt; 60%</td>
<td>medium high (M)</td>
</tr>
<tr>
<td>≥ 60% e &lt; 70%</td>
<td>medium high (MA)</td>
</tr>
<tr>
<td>≥ 70%</td>
<td>high (A)</td>
</tr>
</tbody>
</table>

III. METHODOLOGY

As methodological steps, the sequence of steps described below was defined:

a) **Samples**: classes of undergraduate students, from the Computer Engineering course, from the State University of
Maranhão (UEMA / Brazil) were used. The Class A, with n = 36 students and Class B, with n = 45 students. Two experiments were performed using Class A. For experiment 1, we worked with Basic Discrete Mathematics. In Experiment 2, he worked on Advanced Discrete Mathematics. With Class B, we performed the experiment 3, working with the discipline of Advanced Data Structure. b) Measurement of self-report profiles: for the calculation of the profiles of self-reported hope, self-esteem and self-efficacy, as described in Table 1, was used the same methodology adopted by [11].

c) Preparation of the virtual room: the virtual learning environment (AVA) adopted for the accomplishment of the experiments was MOODLE. At AVA MOODLE, actions were taken, such as registration of students and teachers, provision of contents, formation of groups and provision of learning activities. At AVA MOODLE, students took advantage of the Chat tools and Forums.

d) Group formation: for the three experiments, the groups were formed randomly (by lot), free (students choose their own work pairs) and by the system (those performed by the teacher or the computer system).

e) Learning activities: learning activities were established as follows. For experiment 1, the teacher defined that groups of students should work on textual production. The activity was composed of three items: i) "research on the importance of the study of Discrete Mathematics", ii) "point out the main fields of application of Discrete Mathematics" and iii) "cite and describe basic concepts on Discrete Mathematics ". The text constructed by the students should contain structural elements such as introduction, development, conclusions and references. For experiment 2, the teacher used a list of exercises on the discipline of Advanced Discrete Mathematics, more specifically on graph theory. In experiment 3, the teacher defined as learning activities projects, which consisted of implementations of AVL trees. The projects were divided into three sub-activities (subprojects) of implementations of AVL tree algorithms. Students should deliver the implementation algorithms related to the three activities defined by the teacher and more textual production containing the theoretical foundation about each implementation on AVL trees.

f) Evaluation of group collaboration: to evaluate group collaboration, statistical techniques such as Correlation and Linear Regression were used. [10] emphasize that such techniques allow to describe and test the significance of relations between two (or more) variables when data are presented in ordered pairs (x, y), where x is the independent (or explanatory) variable and y is the variable dependent (or response). A scatter diagram can be used to determine whether there is a linear or non-linear correlation between two variables, so that we can determine the equation of the line that best models the data. This line is called the regression line and its equation can be used to predict the y values for a given value of x [10]. In the context of this research, the variables x and y are represented, respectively, by profiles of student self-reports (hope (esp), self-esteem (aes) and self efficacy (aef)) and PCGj (Group Collaboration Potential) and PMOA (in the Activity). Therefore, we have the ordered pair (x, y) = ((esp, aes, aef), (PCGj, PMOA)). This algebraic approach was the same established by [11] and reused in this work.

IV. RESULTS

Figure 1 shows the linear prediction graphs obtained between the dependent variables (or responses) PCGj and PMOA, as a function of the independent (or explanatory) variables, for the three experiments carried out.

V. ANALYSIS AND DISCUSSION OF RESULTS

When we adopted the statistical technique Correlation and Linear Regression, we sought to determine if there is a significant relationship between the dependent variables (or response) PCGj and PMOA and the independent (or explanatory) self-report profiles (hope, self-esteem and self-efficacy). One way to achieve such an analysis is to determine the best equation of the line that models the data. This line is called the real regression line. [10] point out that the square of r (correlation coefficient between the variables x and y) is called the coefficient of determination (R^2), which expresses the relation of the explained variation to the total variation. For example, if r = 0.90, then R^2 = 0.81. This means that 81% of the variation of y can be explained by the relation between x and y; The remaining 19% of the variation is unexplained and is due to other factors or sample error.

From the regression lines and R^2, shown through Figure 1, we have that R^2 (System-Formation - Graph B) > R^2 (FormationAlcatoría - Graph A) > R^2 (Free Formation - Graph C). This analysis confirms that the point dispersion diagram (PCGj, PMOA) around their respective regression lines is less accentuated in the group formations by the
system, demonstrating that this method is the most appropriate to assign students to the collaborative groups, as well as their probabilistic model of pair adjustments, that is, optimizations of the groups, since they can predict better results for the correlations between the PCGj and PMOA variables.

VI. CONCLUSIONS AND FUTURE WORK

This paper investigated how individual profiles of self-reported hope, self-esteem, and self-efficacy may best be combined toward high-performance collaborative groups.

The results showed positive evidences regarding the improvement of group performances when the formations of these happened by the system, in relation to the methods of random and free formation. This supports that it is possible to optimize formations of collaborative groups considering profiles of self-reported hope, self-esteem and self-efficacy of students.

The research demonstrated that the equation of a regression line allowed us to use the independent variable (or explanatory) student self-report profile to make predictions for the dependent variables PCGj and PMOA, thus knowing what kind of relationship (direction and significance) between these, through diagrams of dispersion of these independent variables around the linear regression model obtained when group formations are adopted by the system, random and/or free.

As future work, it is envisaged to deepen the experiments in light of Tuckman's Theory of Activity and Model. The first describes and explains the behavior of a work group, which is made up of few members and task oriented.

REFERENCES


