

ALTERNATIVE METHODOLOGIES FOR AUTOMATED GROUPING IN EDUCATION AND RESEARCH

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ABSTRACT

Education and research activities are now oriented on groups to solve complex tasks and develop collaboration skills. Agile Software methodologies, psychology and spirituality elements, information technology developments offer possibilities to create dynamic and efficient groups. In education, classical grouping strategies can't be used in e-learning environments where there's little or no physical interaction between parties.

We developed a web application that takes into account the alternative determined student - researcher typologies, according to the Enneagram methodology, and with a MBTI test. A simple and complex Enneagram test will determine the 9 base typologies. A psychological base test will determine the MBTI profiles. A correlation between enneagram and the MBTI typology is performed to generate and refine the grouping process in an automated manner. Case studies show that groups created using this method have an increased communication among the members and better practical results. This is due to the members' compatibility, which facilitates better collaboration in education and research.

Keywords

E-learning, enneagram, MBTI, web application.

1. INTRODUCTION

The Enneagram has an esoteric history based on ancient civilizations. It dates back before the mystic schools of Islam and from ancient Greek civilization using "Tetraktis" as a Pythagorean symbol. The Sufis, Greeks, Cabalists used aspects of the Enneagram in the spiritual development of initiates. The Enneagram defines how the 9 different typologies influence our orientation to the world. The Enneagram model is considered as focused to the positive or shadow aspects of personality based on an integrative or disintegrative evolution direction. As real applications of the Enneagram model we have orientations for education, business and self-development.

Myers-Briggs Type Indicator (MBTI) was developed in the early 1940's by Myers & Briggs that extended Jung's model. The model looks at the conscious functions of taking in information through

the functions of Sensing and Intuition and making decisions through Thinking or Feeling. MBTI model is very accessible and therefore most often practiced. MBTI literature focuses on the positive or neutral aspects of the types before considering a stress situation.

Alternative grouping strategies for students and research teams have been extensively studied in past years. Over time, many solutions were proposed to solve the unsatisfactory aspects of the grouping process. While most of these were often rejected, the traditional structure remained unchanged.

Considering new technological advances as, electronic supported learning and teaching we may analyze the new technological facilities in education against the traditional education.

In e-learning, the student has a more active role than in traditional learning, being involved in the lesson structure, while the teacher acts as a mediator. E-learning as cooperative learning facilitates group learning activities. By working in groups, students develop collaboration skills and they are easier to be managed by the teacher. Cooperative learning is effective when students work together to accomplish shared goals and when positive structures are in place to support that process [1]. Different grouping strategies have been proposed in literature.

A common strategy is based on the students' skills. In this case, each group uses an expert to minimize the knowledge gap between the group members.

Another grouping strategy consists in choosing the students that are more likely to accommodate a predefined role. For example, one student may be in charge of the design, another could do task management, and another may actually perform the specific activity.

Roles allow students to discover, exercise and develop individual skills, while the entire group benefits from the collaboration of its specialists. Other grouping strategies also take into account factors like relationships, power or dependence, [2].

Following, we present some methods that are closely related to our alternative approach.

Grouping based on Myers-Briggs Type Indicator (MBTI). MBTI [10] is a personality test that measures four aspects of people's personalities: Extroverted versus Introverted (E/I), iNtuitive versus Sensing (N/S), Thinking versus Feeling (T/F) and Perceiving versus Judging (P/J). Combinations of these aspects generate 16 different personality types. Many studies have investigated the use of the MBTI test in education [11, 12, 13].

Shen et al. [13] propose a grouping strategy based on 5 tiers. For example, Tier 0 contains the personalities that are most suited for team leadership: ISTJ – Inspector – pragmatic, detailed, organized; ESTJ – Supervisor – practical, realistic, decisive. Placing ISTJs and ESTJs within the same group, due to the inherent potential for a power struggle to develop, is not advised.

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Amato et al. [12] use Myers-Briggs personality profiles to evaluate the consistence and the progress of a group. She classifies groups containing similar personalities as compatible and groups that “blend individuals with different talents and preferences” as complementary. She finds that students with no prior group experience prefer compatible groups due to the comfort of such a structure, while students with experience prefer complementary groups where their talent is valued.

Grouping based on the learning strategy. F. Tian et al. [14] propose a grouping method based on a fuzzy analysis of student personalities and their learning strategies. They use an extension of Raymond Cattell's 16 Personality Factors [15] model to determine a student's personality and learning strategy. When grouping students, the fuzzy algorithm ensures that students with common learning characteristics are part of the same cluster. This way they can better collaborate and improve their skills.

This paper is based on our previous results [3], [16], but the difference consists in that we offer now a Web platform that allows a centralized dynamic grouping mechanism.

We named this application GAEM (*Grouping Application using Enneagram and Myers-briggs tests*).

The grouping mechanism is based in Enneagram and MBTI typologies that will be implemented considering a specific algorithm.

The administrator (the teacher, the project manager) is able to decide for each team if the grouping process will be accepted. For the education process the students are evaluated in two steps.

In the first part of the semester we observe and evaluate the students during individual practical activities.

The second part of the semester will consider the groups provided by the system for team-based projects. The new evaluations will be compared with the first part individual evaluations.

The goal is to divide the class of students into compatible groups and assign roles accordingly, in order to maximize the efficiency for team-based projects.

The grouping strategy we use is based on typology compatibilities, which are a result of the psychological interpretation of the Enneagram. Some typologies prove to show better progress if connected to their psychological complement. Members of such groups achieve better results than members of groups that don't take into account the personality factor or the compatibilities between personalities [5].

This paper is organized as follows: the next section details the personality factors considered for our solution, section 3 describes the proposed grouping strategies using a web application, results are discussed in section 4, while section 5 provides some conclusions of our work.

2. GENERAL PERSONALITY FACTORS

2.1 The Enneagram of Personality

The *Enneagram of Personality* (known as the Enneagram) is used in a variety of contexts, including business, psychotherapy, spiritual development work, art and education. It is an application of the Enneagram figure in connection with personality features, including nine main typologies (Fig. 1).

The points on the Enneagram figure indicate a number of ways in which nine principal types of human personality, called Enneatypes, are psychologically connected. Enneatypes are referred to by different names, or more general by numbers. These are some of the variations (Fig. 1 b):

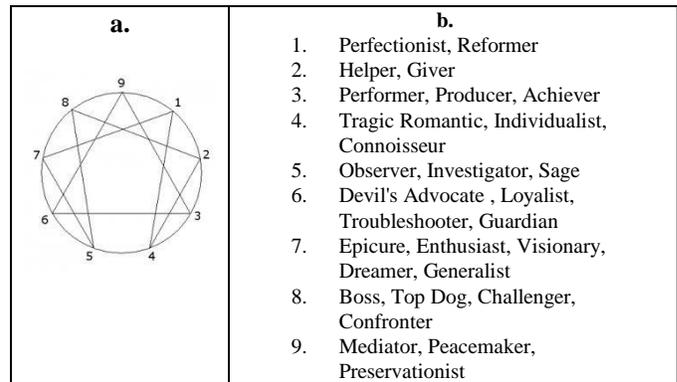


Fig. 1. Enneagram and Typologies

Each Enneatype (chief feature) corresponds to a distinctive and habitual pattern of thinking and emotions. The Enneatype of an individual can be determined using a RHETI (Riso-Hudson Enneagram Type Indicator) test, [4], which contains 144 paired statements, or our tests (short – long) provided by GAEM web application.

Based on the Enneatypes, different strategies can be considered to define working groups of students (or any other types).

Ideally, when all 9 Enneatypes manifest within a group, the members' evolution is more rapid. But it's possible to have a group with a limited number of typologies, less than 9. In this case, the unity, cohesion and communication are very important.

Our aim is to create a harmonious group where members with compatible Enneatypes can easily collaborate and obtain valuable results.

2.2 MBTI and Enneagram methodologies

The MBTI and Enneagram are two different personality typologies. As alternative methodologies they work well when are used in conjunction [17].

• MBTI is a psychometric questionnaire that measures psychological preferences of individuals with regard to how these people see the world and make decisions. The method was developed by Katharine Cook Briggs and Isabel Briggs Myers, based on personality typology theory developed by Carl Jung, published in *Psychological Types* (1921).

Defining personality indicators will be based on primary indicators in four pairs of opposites:

- **Extraversion - Introversion** (E vs. I) (focus attention)
- **Sensing – Intuition** (S - N) (incorporating information)
- **Feeling – Thinking** (F - T) (decisions)
- **Judging – Perceiving** (J - P) (relation outside world)

A mapping between MBTI typologies and Enneatypes

Different mappings from MBTI to Enneagram are presented in literature. There isn't a direct correlation accepted, but there are some things that may be typical however given the understanding that there is an exception to every one of these forced correlations. A possible correspondence can be [19]:

- Enneagram 1 and I* TJ
- Enneagram 2 and E* FJ
- Enneagram 3 and E* TP
- Enneagram 4 and INFJ

- Enneagram 5 and I*TP
- Enneagram 6 and ISFJ
- Enneagram 7 and E*FP
- Enneagram 8 and E*TJ
- Enneagram 9 and I*FP

Other more precise mapping should be:

Tabel 1. Mapping between Enneatypes and MBTI [20]

Enneagram Type	Associated MBTI Types
1-Perfectionist	ISTJ, ESTJ
2-Helper	ESFJ, ENFJ, ISFP, ESFP, ENFP, ISFJ
3-Performer	ENTJ, ENTP
4-Individualist	INFP, INFJ
5-Thinker	INTP, INTJ, ISTP, ISTJ
6-Loyalist	ISFJ, ISTJ
7-Enthusiast	ESTP, ENTP, ENFP, ESFP
8-Leader	ESTJ, ENTJ
9-Mediator	ISFP, INFP

Some authors and researchers have mapped this even more extensively than these limited correlations, [17], [18]. The correspondence between Enneatypes and MBTI types helps to refine the grouping process.

3. PROPOSED GROUPING STRATEGY USING A WEB APPLICATION

3.1 Grouping considerations

When creating groups of students we want to maximize the positive interactions between the group members. This can be done if we take into account the compatibilities between the group members. In other words, we want to have all nine Enneatypes to manifest as complementary aspects.

The manifestation of all typologies can be realized considering a limited number of members, less than nine, but with specific interactions. A group needs to have at least three members in order to achieve an optimum structure (the three's law).

One strategy may consider that the Enneagram is organized in three triads (Fig. 2), and the Enneatypes in each triad are thought to share similar characteristics. Rohr refers to these as the Gut, Heart, and Head triads [9]. Theoretically, one of these areas predominates in each of us. An optimal group structure needs to have at least one representative from each triad, but not any representative.

Gut-people are known to be direct, territorial, concerned with power, ruled by aggression. Their predominant emotion is anger and their mind may be troubled by ethical self-doubts and self-blame. They act instinctively, spontaneously and intuitively.

Heart-people are ruled by feelings. They are often concerned with what others think of them, seeing them as being for others and often believing they know what's best for them. Their

predominant emotion is anxiety, they dislike being alone, may feel sad and ashamed.

Head-people are methodical and orderly, detached from their emotions. They try to apprehend every situation, understand the pattern of events and their place within it. Their predominant emotion is fear.

The grouping process starts with identifying the Chief Feature. This can be a base Enneagram type (Enneatype), or a combination of two adjacent types, as, for example, Four and Five. This combination can be regarded as a *subtype*. The types on each side of the Chief Feature are called wings (Three and One are wings for Two). In case of a subtype, one wing is the weaker type of the two composing the subtype.

Each Enneatype is connected with two other types, in different triads. The connection is marked with a path (line) in the Enneagram representation. For example Nine is connected to Three and Six. These connections show how one Enneatype behaves under integrative (growth) or disintegrative (stress) conditions. The integrative / disintegrative behavior follows the directions shown in Figure 2. For example, under stress Nine will behave like a Six, while in growth will behave like a Three.

We considered in our research one base typology (Chief Feature), one typology on the integration direction and one typology on the disintegration direction, Fig. 2. In this way it is possible to define efficient groups using a general Enneagram test and an adequate interpretation. Such groups have a representative from each Enneagram triad, which complete each other.

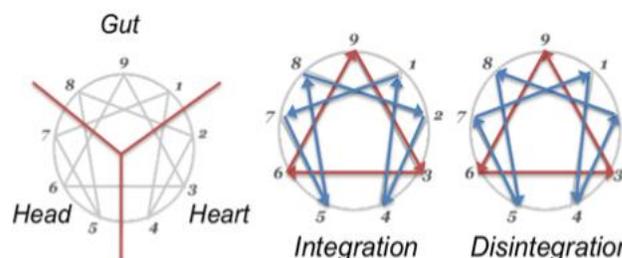


Fig. 2. Enneagram triads, integration/disintegration directions

The ideal group structure will have members with typologies 3, 6 and 9. Other possible grouping typologies are: (1, 7, 4), (2, 4, 8), (4, 1, 2), (5, 8, 7), (7, 5, 1), (8, 5, 2), using 1, 2, 4, 5, 7 and 8 as Chief Feature.

The use of Enneatypes for the group structure ensures the typology diversity. In this moment refinements were introduced based on mapping between Enneatypes and MBTI.

3.2 Proposal algorithm grouping

First step - test subjects with Enneagram and MBTI test

Second step - grouping students according to:

Alternative 1: Enneagram integration/disintegration directions grouping and MBTI refinement:

- Grouping based on the following typologies: (1,7,4), (2,4,8), (4,1,2), (5,8,7), (7,5,1), (8,2,5)
- Refinement by verifying if enneagram typology corresponds to MBTI typologies

(Example: 1 from Enneagram corresponds to ISTJ, ESTJ - MBTI typologies)

We establish three correspondence degrees.

Correspondence degree level	Explanations
Bigger than 67%	There are two correspondences with MBTI typologies, and a mapping may or may not correspond. Example: 1 correspond to ISTJ, 7 correspond to ESTP and 4 is regardless
Between 33% and 67%	The teacher determines whether to accept or not the team
Less than 33%	The default behavior of the system is to reject the team

Remark:

- GAEM have enough flexibility and the teacher can manually edit any grouping of the individuals in the team.

Alternative 2: Enneagram grouping in triads: Gut, Head, Heart and refinement with MBTI as Alternative 1 b).

3.3 Web application description

GAEM was created in order to easily group people according to MBTI and Enneagram test. The application was created using the PHP language and CodeIgniter, an open source Web Application Framework used to write web applications. Also the development process was realized according to RAD (Rapid Application Development)[6].

The web application is based on the MVC (Model-View-Controller) architecture, because this way the 3 major functions of a modern database-driven website are split up: the database functions (CRUD) – the model, the application logic – the controller and the presentation/interface (HTML) – the view.

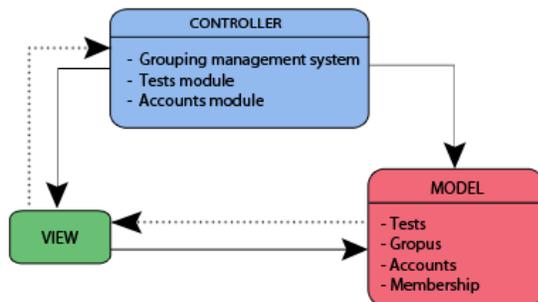


Fig. 3 - MVC application diagram

All the information is kept in a relational database (MySQL), used by the application to manage the user information, the tests and the groups.

Use case: A teacher needs to create groups of students to work on different projects. Using the web application, the teacher can distribute the students into groups. The teams are formed based on psychological factors, so that the students can give better results by working together.

The students will need to register on the website or the teacher will create dynamically accounts for his students. They will need to login and take the available tests: MBTI and Enneagram.

The teacher, who will have an account with admin rights, can see all the test results and using the Grouping Management Module he can generate the teams. The grouping mechanism is based on the algorithms described in the [3.2] section, so the teacher may choose one of these alternatives to form the groups.

The generated teams is displayed in an interactive interface, that will give teachers flexibility to manage the team members (with a drag and drop system). If the teams will be changed and the grouping criteria will not be met anymore, the user (the teacher) will be notified and will have the possibility to undo his change.

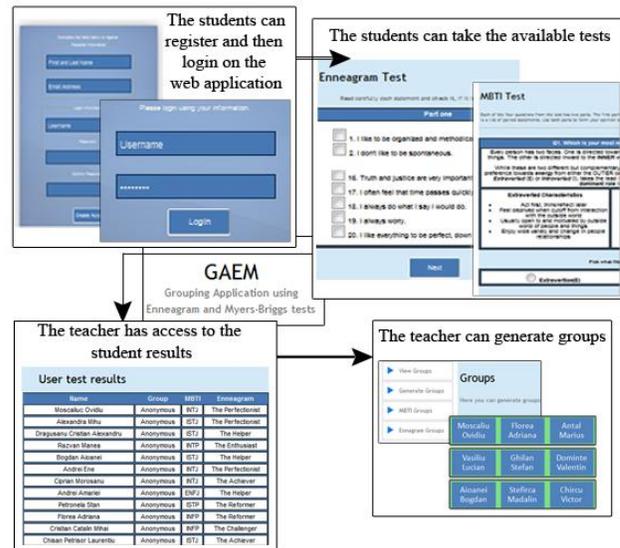


Fig. 4 – GAEM flow for the presented use case

We used this application to group our students and to obtain better results, which will be presented in the results section.

4. RESULTS

We developed in this year an application, GAEM, which allows an integration process of Enneagram and MBTI tests. The application offers an automation mechanism to generate optimal groups using results from these tests.

Case studies were conducted in a semi-automated manner over a period of more years with students in the first and third year of Bachelor of Science classes, and the students in the first and second year of Master of Science at Technical University of Cluj-Napoca, Romania and Alexandru Ioan Cuza University of Iasi, Romania. Students were observed during the practical activities of the *Basic Object Oriented Programming with C++* and *Software Engineering* courses for bachelors, and for *Advanced Elements to Develop Software in Telecommunications* and *Distributed and Concurrent Programming*, at the masters. Each practical activity class consisted of two stages: a documentation stage, when the students presented a summary of the theoretical aspects and a working stage, when the students put in practice what they learned.

The first part of each semester is dedicated on observing the students activity and an individual evaluation. At the middle of the semester, the students are tested concerning their personalities using the GAEM application. The GAEM application assigned the students to working groups, according to the proposed strategy.

Each working group is assigned to a project, which is evaluated at the end of the semester.

Each year, we apply this method on half the students, while the other half are grouped using the skill-based strategy (one expert in each group). These students are used as a reference to compare the results.

The first part of the group project consists in creating a “Task Planner” based on the initial specifications. Then, the group will divide the main tasks to each member and in the “External/Internal Reunion” the drawbacks will be clear specified and analyzed. The External Reunion requires the presence of the teacher, once by week and the Internal Reunion is between members of the group that could be often.

Any new proposed solution will not be rejected being criticized, and if possible, a new solution will be chosen in the meeting. This practice encourages the creativity and originality. The final result is a “Specification Results” and the implementation of the product.

Mental connections that are characteristics to new technical solutions development are not limited to the classical standard solutions. Group meetings are intended to stimulate brainstorming.

During their work on the project all the groups were suggested to use the brainstorming technique. Group brainstorming is effective when all members share their experience and creativity.

The total number of working groups observed during our experiments was 61 in previous years and 22 during this year.

At the end of the experiments, three aspects were relevant:

- Members of teams that were grouped based on compatibility typologies using enneatypes and MBTI showed better improvement, not in terms of acquired knowledge in particular, but in terms of learning how to combine knowledge with creativity. In about 25% of the brainstorming groups the evolution was spectacular (from the individual evaluation in the first part and from the group evaluation in the second part of the semester).

- Members of teams assigned using the proposed strategy proved to communicate more than members of classical teams. Communication featured brainstorming and all these aspects manifested in making the group more productive.

- The developed products were original, full of creativity and more reliable.

As examples of some projects topics developed by the 2010-2011 and 2011-2012 Master of Science students we mention: Organic computing, Workflow foundation based on Microsoft technologies, Workflow application - PassFlow with Oracle BPMN Suite, UML design, HMI based on biometry, Basic software testing, Software testing – new methodologies, HCI – FriendlyPC, HCI – SpeechInteraction, C++OX evolution, AGILE software methodologies, Cloud Computing etc.

We further illustrate the result obtained from evaluations performed for students in Cloud Computing class.

GAEM furnished us ten groups of students that were evaluated during one semester. In Table 2 we present the average marks obtained per every group, at each phase of evaluation (even initial the students are not involved in working teams). *Initial Evaluation* signifies the evaluation that was made in the first practical work class, with a test contained the fundamentals from distributed computing. *Individual evaluation* signifies the evaluation performed individual for each student in the middle of semester. *Final Evaluation* is the evaluation performed at the final of semester.

Table 2. Average evaluation per group according to Alternative1 of our algorithm

Alternative 1	Group 6	Group 7	Group 8
Initial Evaluation per Group	7	6.33	6.66
Individual Evaluation per Group	7.66	7	7.33
Final Evaluation per Group	9.66	9.33	9.33

For a better visualization of the result we depicted it in Figure 5.

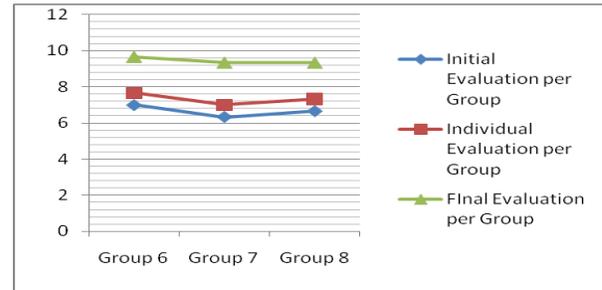


Figure 5. Graphical results of Alternative1 students evaluation

The results obtained using Alternative1 of our algorithm reveal us that grouping using Enneagram criteria and MBTI compatibilities refinements was a good choice for students’ progress.

Table 3. Average evaluation per group according to Alternative2 of our algorithm

Alternative 2	Group 1	Group 2	Group 3	Group 4	Group 5	Group 9	Group 10
Initial Evaluation per Group	7	6.33	5.66	5.66	6.66	5.5	6
Individual Evaluation per Group	7.5	6.66	6.33	6	7	5.5	6
Final Evaluation per Group	7.5	7	7.33	6.66	7.66	6.5	5.66

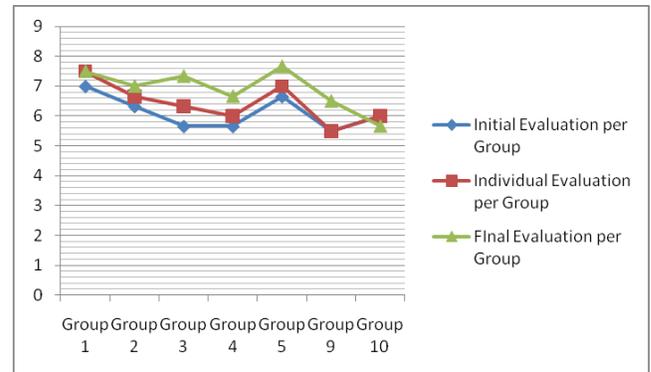


Figure 6. Graphical results of Alternative2 students evaluation

The results obtained using Alternative2 of our algorithm reveal us that grouping after triads: Gut, Head, Heart, and refined with MBTI works in major cases but we find exceptions, in our case (Group 10) and the evolution was moderate.

Finally Group10 does not respect the Alternative1 and Alternative2 of the algorithm and the application will consider it as a non-classified group. The students’ results were not relevant concerning the individual and group evaluation. In the next figure, Figure 7, are presented the marks obtained at the beginning of the activity, at the middle of the semester after an individual evaluation, and at the end, when the students were involved to develop a project in group.

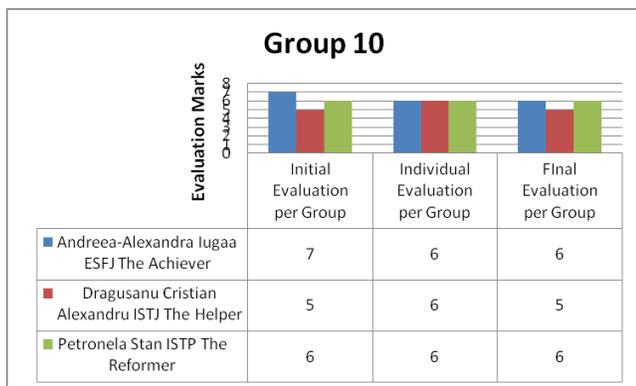


Figure 7. Results of the non classified group

We proved that our mechanism based on Enneagram and MBTI is consistent for group student classification, the exceptions cases will be analyzed using other groups of students and through the improvement of grouping algorithm (e.g. using MBTI as first mechanism of grouping, and make refinements with Enneagram).

5. CONCLUSIONS

In this paper, we propose a grouping strategy for e-learning environments and research teams based on psychological features. Effective grouping strategies take into account personality factors, which are hard to evaluate by a computer.

An original aspect of our work is the use of typologies, determined according to the Enneagram methodology test. A refinement is considered based on a MBTI test. The Enneagram and MBTI tests, with the classification process are determined in an automated mode using a web dedicated application, GAEM.

Groups are composed at least 3 members, of compatible typologies. Compatibilities are according to the integrative and disintegrative directions on the Enneagram. This also ensures that each group has a member from each Enneagram triad. The developed web application is able to manage the students/researchers and to group them in an efficient mode.

We conducted case studies to test our solution over more years, with students with different levels of group work experience. Our results show that groups created using this method perform better than groups that don't take into account the personality factor, in terms of self-development and group communication.

During the work on their assignment, all the groups were suggested to use the brainstorming technique. Members of groups that used brainstorming showed better improvement, not in terms of acquired knowledge in particular, but in terms of learning how to combine knowledge with creativity.

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