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Abstract

Asynchronous discussion fora are an important communication tool, supporting a large part of the distance education process.The goal of this research is the study of the educational techniques of Brainstorming and Snowballing to their utilization in the frame of a distance education forum, both as far as participation and creation of learning environment and also educational effectiveness are concerned. This research refers to computer teachers' training on didactics of programming within the framework of educational micro-worlds. As it is deduced from the data analysis and the study of the messages higher participation and improvement of critical thinking are noted when Brainstorming technique is used, while fairly less time is spent and less off-topic interventions are made when Snowballing technique is used. Meanwhile, Brainstorming is found to be more advantageous than Snowballing concerning the effectiveness both in primary level (trained teachers) and in secondary level of adaptation and knowledge impartment to the students (results of their students).

Keywords: Asynchronous Discussion Fora, Distance Education, Educational Techniques, Adult Education, Formal Languages, Coding, Programming Language.

1 INTRODUCTION

Distance education offers a "learner-centred" standard allowing to students to learn in their own pace and explore the educational material to the extent they wish (Collis, 1999). Given that the student often feels isolated (Barron, 1999; Tooth, 2000), the quality of offered education is based, among others, on the quality of the communication between the student and the teacher (Britain and Liber, 2000).

An important communication tool is the asynchronous discussion electronic forum, hereinafter called forum (plural fora). This study focuses both on the participation parameter and the creation of a learning environment as well as the educational effectiveness of Brainstorming and Snowballing educational techniques in their utilisation at a distance education forum using the open source LMS (Learning management system) Moodle (version 1.8.3), within the frame of training high school computer teachers on didactics of programming in the educational micro-worlds environment (StarLogo). It is worthy to note here that for this study it was utilized the previous practical and research experience within the framework of Hellenic Open University (HOU) and concerns, among others, previous projects related to HOU students attitude (Xenos et al., 2002; Xenos, 2004), as well as to the fora coding as a methodology of messages' interpretation (Patriarcheas and Xenos, 2009[a],[b] ; Patriarcheas et al., 2010).

The structure of this article is the following: Section 2, where it is presented the respective theoretical framework and a brief literature review; section 3 where it is presented the methodological framework of the study and comprises sample, method, activities, process and coding used; section 4, where there is the data analysis; section 5, where it takes place the respective discussion and section 6, where there are presented the results combined with the conclusions of relative studies.

2 THEORETICAL FRAMEWORK

There are numerous studies on educational techniques used in fora, some of which concern Brainstorming and others Snowballing. Indicatively, in relation to Brainstorming technique some (Pinsonnealt et al., 1999) adopt the term Electronic brainstorming (EBS) referring that "it has been proposed as a superior approach to both nominal brainstorming (working alone) and face-to-face brainstorming (verbal)", while others (Stenmark, 2007) adopt the term "IT-Supported Organisational brainstorming". There are studies which examine the productivity (Mullen et al., 1991) or the creativity (Michinov and Primois, 2005) in a web-based context of asynchronous electronic brainstorming groups, or try to particularise in subcategories of the technique, namely Camacho and Paulus (1995), refer to solitary brainstorming while others (Helquist et al., 2006) to "very large groups" of brainstorming. Other studies (Dugosh et al., 2000) examine the potential of cognitive stimulation in brainstorming, while others (Hymes and Olson, 1992; Offner et al., 1996) which explore the unblocking brainstorming and some others (Gallupe et al., 1994) which attributed the superiority of electronic brainstorming to a number of factors, including the technology's ability to reduce production blocking.

In relation to Snowballing technique Thomas and Carswell (2000) use it in their effort to assess the role of collaborative learning in a distributed education environment within the framework of a relative research of Open University of London, highlighting that it offers essential support for students studying at a distance, while others (Scarpellini and Bowen, 2001) use it when evaluating the role of the evaluation process in sustaining and developing quality distance education programs in collegiate aviation. Kember and Gow (1992) also evaluate it when studying the action research as a form of staff development in higher education, in attempting to improve their own teaching through cycles of planning, acting, observing and reflecting.

From the relative literature survey, it is concluded a gap as for the methodological approach which will be based on coding with the use of formal language and which will examine the two techniques in combination both in primary level (of trained people) and to secondary level of adaptation and knowledge impartment (results of their students at a chosen process). This research wishes to contribute to cover this gap. This research refers to adults training (computer teachers) on didactics of programming within the frame of educational micro-worlds (emphasizing on StarLogo language). At this point and before moving further down, it is advisable to slightly refer to micro-worlds environment. The term "micro-world" is not a new one; it has been used many time in the past to describe usually small-scale systems (for instance tiny ecosystems) which function almost unaffected by their immediate environment. Papert (1980), was among the first using this term so as to describe an educational environment in his description of Logo language. More concretely, Papert, he describes a microworld as: *"A subset of reality or a constructed reality whose structure matches that of a given cognitive mechanism so as to provide an environment where the latter can operate effectively. These concepts lead to the project of inventing microworlds so structured as to allow a human learner to exercise particular powerful ideas or intellectual skills."* (Papert S., Computer-based microworlds as incubators for powerful ideas, p.204).

Many micro-worlds (e.g. spreadsheet) are not manufactured for educational purposes (as Logo or Cabri are); they are often used, though, within this framework because they are appropriate for educational use. Consequently, programming micro-worlds may be used within the framework of a course introductory to programming (Harvey, 1985).

3 METHODOLOGICAL FRAMEWORK

3.1 Sample

This research was conducted during February to April 2009 in 4 Training Centres of Piraeus, Greece. The sample was constituted by 88 High School Computer Teachers and 1723 students of theirs, at the area of Prefecture of Piraeus within the framework of a training program of Ministry of National Education under the unity entitled "Didactics of Informatics". The training was conducted in order to

integrate within the Informatics lesson of 3rd class of High School the micro-worlds environment for introduction to programming from year 2010-11. All trained people were of the same level of knowledge and did have (until the program's beginning) no knowledge of the micro-worlds software and StarLogo language. There were evaluated the discussion thread on forum (in all 1527 messages), the results of the trained professors in 5 modules of the program (440 marks), as well as the students' results in a chosen activity after the experimental teaching of 9 hours.

3.2 Method

Trained teachers were grouped in 4 groups of 22 people which were endeavoured to be absolutely uniform as far as the members' education profile was concerned (level of studies, age, experience, sex etc.) Supporting material with the concepts to be presented, as well as a manual with the languages' commands were available via internet before the program's beginning; in addition, by the program's beginning, there were distributed from tutors to the trained teachers 8 subjects for the creation of lesson plans, which should be developed and applied by each one in their classroom within a duration of 9 hours. One hour was used for questions' resolution in each classroom. Moreover, it was agreed with the 88 teachers that after this procedure there would be given a chosen activity to the students of the respective schools as a test (in all 1723 students, approximately 19-20 per class). The participating schools are city neighbourhoods of Piraeus Prefecture and are of the same socio-cultural level.

Training was base upon Moodle forum, while there also took place seven (7) 3-hour advisory meetings in each group. Furthermore, after the end of each of the 5 modules of the program, a self-evaluation test was completed by the trained teachers. The aforementioned educational procedure is mainly applied by HOU in Greece.

3.3 Activities

The lesson plans distributed to the trained to be developed, should comprise: a) title for the hourly module b) the goals of the course (as for knowledge, skills, attitudes), c) sub-units, (parts into which teaching shall be divided) and time used for each one, d) educational techniques and teaching aids to be used for each sub-unit and e) justification of the above choices. The lesson plans concerned activities for the simulations' development due to the fact that this language uses graphic representations, animation and interaction between characters.

Indicatively, it is presented the activity agreed to be given by trained teachers to their students as a test (after the 9 hours teaching) and which concerned the creation of a simulation for "virus transmission" (Figure1) on the following assumptions: a) There is a focus of infection, consequently there is an area (within Starlogo environment) which represents the focus of infection (e.g. a chip) b) they are necessary many items which will play the role of beings to be infected (e.g. Starlogo's ingots) c) a rule is necessary by which an infection is transmitted d) It is taken that all ingots are uninfected in the beginning. For this reason all ingots should be painted white e) as focus of infection is considered a chip on the screen. So as to distinguish its position it shall be painted red and thus each ingot which will be infected shall turn red and f) if, while randomly walking, an ingot passes over a focus of infection then it gets infected.
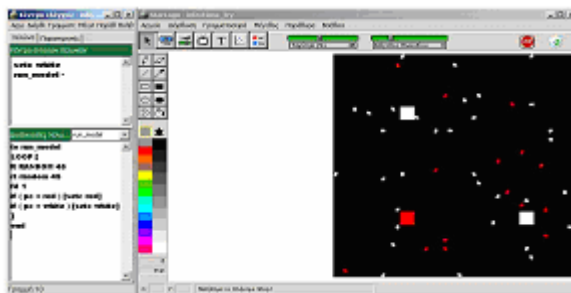

Figure 1.   *The Starlogo micro-worlds environment*

3.4   Procedure

During the asynchronous discussion on the forum it was decided to use the educational techniques Brainstorming and Snowballing. More specifically in two groups (1st and 2nd) Brainstorming technique was used while in the other two (3rd and 4th) Snowballing technique was used.

In the case of Brainstorming the procedure intended to the exposure of numerous sides of the issue of didactics of programming through the micro-worlds to the students of 3rd class of High School, the knowledge enrichment of the trained and finally the consolidation or change of their opinions. In particular, the procedure which took place exclusively through Moodle forum and was repeated in each course of the program was the following: a) They participated all in the same thread and each one was stimulated to express their own ideas in a spontaneous way even if their ideas seemed unrealistic at a first level without being necessary (at this phase) to explain them and without criticism on any of them b) The tutor codified all ideas and presented them in a uniform form c) Each trained was asked to explain or even modify (if they wanted) their initial placement d) At the end of the procedure, it was stimulated to compose the opinions and to reach conclusions as for the compilation of lesson plans, the educational techniques to be used by each one in their school, the supporting material to be distributed to the students etc.

Snowballing technique was chosen for the exchange of views in order to advance and expand the teachers' consideration as far as the didactics of programming concepts through micro-worlds to students of the 3rd class of High School is concerned. In particular, the procedure which took place exclusively through Moodle forum and was repeated in each course of the program was the following: a) The trained people had the opportunity to comment the issues of the concepts' teaching approach in micro-worlds environment they faced b) Then each trained person compared their comments to another (by creating threads of 2 people) c) The same procedure was repeated in groups of four and d) At the end of the procedure all the trained of the group participated (16) presenting all the views in a plenary session and they tried to compose their views and to reach conclusions, as they did in Brainstorming technique. At this point it is advisable to present the coding used.

3.5   Coding

Based on observations at HOU fora the following became evident:

a) There are two categories of communication actors: Tutors and Students

For brevity, tutors will be symbolised with a T and students with an E

b) As regards message types, these are distinguished into questions and answers. Hereinafter, symbolised with q and a respectively.

c) As to their content, messages are distinguished into those relating to (the respective symbols are given in brackets): i)the study of educational material (M), ii)questions/answers for exercises – assignments (X), iii)presentation of sample assignments by tutors (P), iv)instructions (I), v)assignment comments, corrections (F), vi)student comments on assignments (D), vii)sending – receiving assignments (J), viii)sending - receiving grade marks (G), ix)notification of advisory meeting (V) and x) non educational content (L)

Finally, the order in which above symbols will be written is: a) message carrier b) message type and c) the content of the category to which the message belongs.

Thus, we have a language which contains:

a) *Terminal symbols alphabet V_T,* where $V_T = \{T, E, q, a, M, X, P, I, F, D, J, G, V, L\}$

b) *Non terminals alphabet V_N,* where $V_N = \{u, r, y, c\}$, more specifically :

r: represents the message carrier (*T* for tutors and *E* for students)

u: represents a pair yc i.e. a message type *y* (whether it is a question *q* or an answer *a*) followed by its content category.
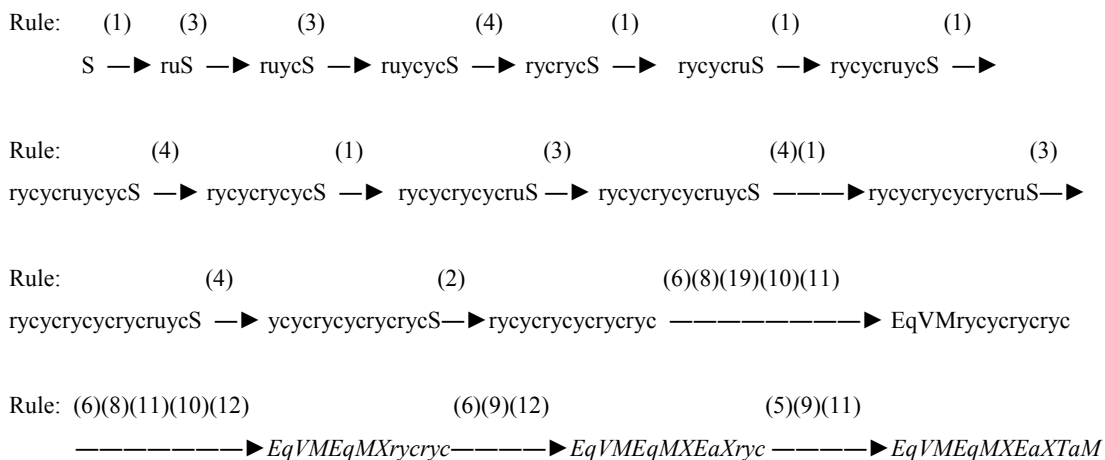
c) The grammar P

A set of rules of the form $\alpha \rightarrow \beta$, where α and β sequences containing *terminal* and *non-terminal* symbols and α is not an empty sequence, as follows:

1.S	$\rightarrow$	ruS	7. r	$\rightarrow$	ε	13.c	$\rightarrow$ P	19.c	$\rightarrow$ V
2.S	$\rightarrow$	ε	8.y	$\rightarrow$	q	14.c	$\rightarrow$ I	20.c	$\rightarrow$ L
3.u	$\rightarrow$	uyc	9.y	$\rightarrow$	a	15.c	$\rightarrow$ F	21.c	$\rightarrow$ ε
4.u	$\rightarrow$	ε	10.y	$\rightarrow$	ε	16.c	$\rightarrow$ D		
5.r	$\rightarrow$	T	11.c	$\rightarrow$	M	17.c	$\rightarrow$ J		
6.r	$\rightarrow$	E	12.c	$\rightarrow$	X	18.c	$\rightarrow$ G		

Where ε stands for an empty symbol

d) Symbol S where every sentence generated starts with this symbol.

An indicative example is presented that contains a series of messages represented by the sequence *EqVMEqMXEaXTaM*, which, according to the above, represent a discussion thread as follows: in the beginning is a message whose sender is student *E* who is asking a question *q* referring to forthcoming advisory meeting *V* and also concerning the study of educational material *M*. This message is replied to by student *E* who is asking a question *q* concerning the study of educational material *M* and also about the forthcoming assignment *X*. This message is replied to by other student *E* who is answering a about the forthcoming assignment *X*. In the end of discussion is found a reply from tutor *T* on the question concerning the study of educational material *M*. According to the above, the sequence *EqVMEqMXEaXTaM* constitutes a sentence of the Language because:

Rule: (1)   (3)   (3)   (4)   (1)   (1)   (1)

    S —▶ ruS —▶ ruycS —▶ ruycycS —▶ rycrycS —▶ rycycruS —▶ rycycruycS —▶

Rule: (4)   (1)   (3)   (4)(1)   (3)

rycycruycS —▶ rycycrycycS —▶ rycycrycycruS —▶ rycycrycycruycS ————▶rycycrycycrycruS—▶

Rule: (4)   (2)   (6)(8)(19)(10)(11)

rycycrycycrycruycS —▶ ycycrycycrycrycS—▶rycycrycycrycryc —————————▶ EqVMrycycrycryc

Rule: (6)(8)(11)(10)(12)   (6)(9)(12)   (5)(9)(11)

    —————————▶*EqVMEqMXrycryc*————▶*EqVMEqMXEaXryc*—————▶*EqVMEqMXEaXTaM*

As it is obvious from the example, while one content category corresponds to the 4th and 5th messages (*X* and *M* respectively), in the 1st and 2nd messages there are two content categories *VM* and *MX*

The above procedure can be represented schematically with the help of the following parse tree in Figure 2.
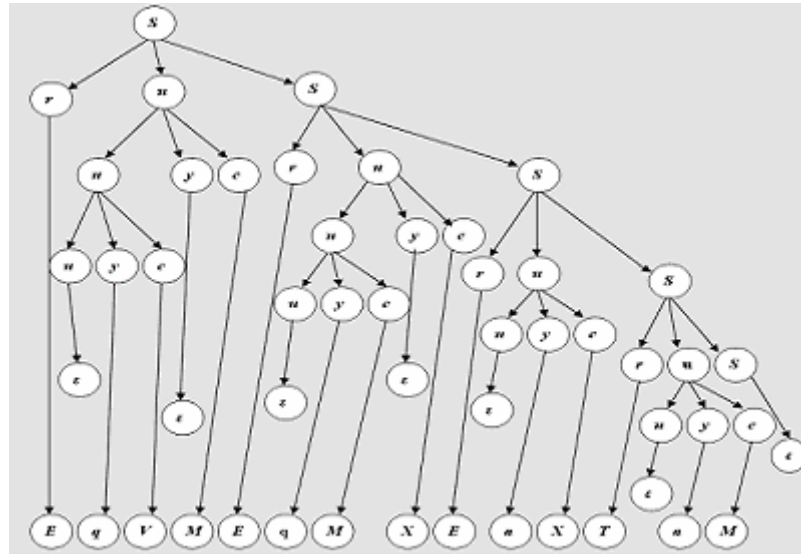
Figure 2.   Parse tree for sequence EqVMEqMXEaXTaM

As it is obvious this coding uses a formal Language. Additionally, it should be noted that for this Language it was used a syntax check algorithm, as well as a respective tool to automate this procedure by inserting threads from discussion fora and exporting the respective strings (Patriarcheas et al., 2010; Kotsiantis et al., 2010) .

4   DATA ANALYSIS

In groups 1 and 2, where Brainstorming technique was emphasized we received 843 messages; 68 were from the tutor and 775 from the trained people. Given that, according to the above coding, in each message more than one categories of content may be included (e.g. in the same message may be a question on study of educational material and on a project too), there were confirmed 1787 such questions. Respectively, in groups 3 and 4 where Snowballing technique was emphasized, we received 684 messages; 49 from the tutor and 634 from the trained people while, as far as content categories are concerned we had in all 1081 appearances. The above information is presented in Table 1.

	CC	AN		AN
groups 1 and 2 (Brainstorming)	M	418	groups 3 and 4 (Snowballing)	185
	X	501		228
	P	30		30
	I	38		27
	F	175		127
	D	244		163
	J	231		231
	G	23		23
	V	20		20
	L	108		46
	Total	1787		1081

Table 1.   Appearances number (AN) per message content category (CC) based on coding
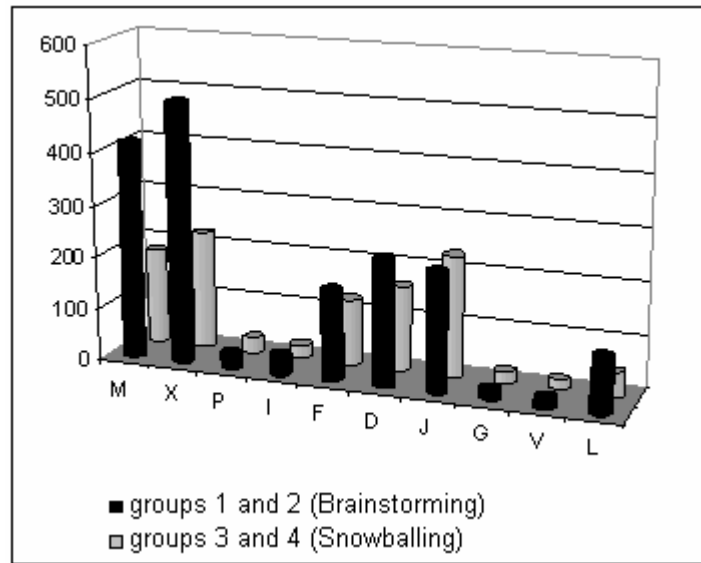
Figure 3.   *Graphic representation of Brainstorming and Snowballing techniques*

It is obvious (in Figure 3) the respective uniformity per message content category but in a different intension.

If we take into account only the trained people interventions, then we have 1211 appearances for Brainstorming groups. This comes if we deduce the tutor's interventions and the said "service type" of interventions, i.e. the categories presentation of sample assignments by tutors (P), assignment comments, corrections (F), sending – receiving assignments (J), sending - receiving grade marks (G), notification of advisory meeting (V) which function as separate variables according to the initial plan, as well as the tutor's interventions appearing on the rest content categories. The respective number of appearances for Snowballing groups are 563. The above information is presented in Table 2.

	CC	AN		AN
groups 1 and 2 (Brainstorming)	*M*	388	groups 3 and 4 (Snowballing)	155
	X	471		199
	D	244		163
	L	108		46
	Total	**1211**		**563**

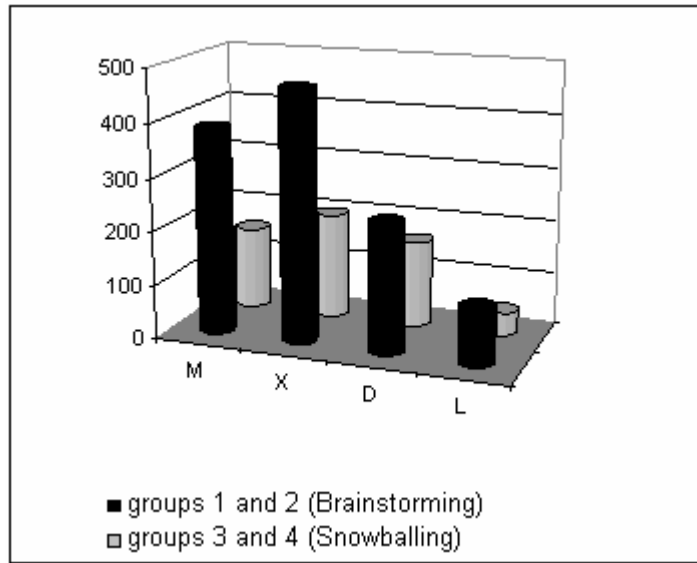*Table 2.*   *Appearances number (AN) per message content category (CC) without the tutor's interventions*

Figure 4. *Graphic representation of the distributions of Brainstorming and Snowballing techniques containing only the trained people interventions*

It is obvious (in Figure 4) the difference in participation increases when tutor's interventions are deducted.

As far as the trained people's performance in each test of self-evaluation at the end of each module is concerned, the collective data for groups 1 and 2 (Brainstorming) and 3 and 4 (Snowballing) are presented respectively on Table 3. For the estimation of the central tendency of the results, the three Pythagorean means and the average of interquartile range were taken into account. The three classical Pythagorean means are the arithmetic mean, the geometric mean, and the harmonic mean. As for the average of interquartile range (I.R.) there were taken into account the means i.e. (50%) without counting the highest and the lowest quarters of values (25% and 25% respectively). The means' choice (not only the average) was done so as not to "be affected" by exceptionally high or low values. On Table 4, there are presented the statistics measures of central tendency concerning the trained teachers' and their students' performance at the tests (of the chosen activity) after the 9-hour teaching.

Marks	groups 1 and 2 (Brainstorming)						Marks	groups 3 and 4 (Snowballing)					
	Course	1	2	3	4	5		Course	1	2	3	4	5
	61-70	5	0	0	0	0		61-70	12	2	3	0	3
	71-80	11	7	5	0	0		71-80	12	10	10	5	5
	81-90	10	15	17	18	4		81-90	8	16	17	16	14
	91-100	6	10	10	14	28		91-100	0	4	2	11	10

Table 3. *Marks of the trained teachers per module (excellent =100)*

mean	teachers				their students			
	Geom.	*Harm.*	*Aver.*	*I.R.*	*Geom.*	*Harm.*	*Aver.*	*I.R.*
group1	87.72	87.33	87.92	89.13	15.18	15.19	15.24	15.43
group2	87.91	87.64	88.18	89.11	15.22	15.21	15.27	15.39
Brainstorming	87.73	87.49	88.11	89.19	15.19	15.20	15.22	15.32
group 3	81.92	81.37	82.41	83.15	14.61	14.62	14.64	14.61
group 4	81.21	80.73	81.70	82.68	14.51	14.59	14.61	14.45
Snowballing	81.55	81.08	82.09	82.73	14.63	14.58	14.53	14.48

Table 4.   Statistics measures of central tendency concerning the trained teachers' and their students' performance (excellent=20) at the chosen activity

5   DISCUSSION

As it is deduced from the data analysis, in groups where Brainstorming was used, higher participation at forum is noted, compared to Snowballing both as for messages (843 against 684) and as for range of content categories (1787 against 1081). Furthermore, if from this number the content categories P, J, G, V are deducted, as well as the tutor's interventions, which in our case constitute separate variable, then the discrepancy (respectively) increases even more (1211 against 563). Moreover, even if we deduct the needless messages (L), then the discrepancy of participation (in educationally substantial categories) is 1103 against 517.

In Brainstorming case in relation to Snowballing, there is noted enforcement of the creativity and the participants' experiences; this finding arises from practical experience and messages' texts analysis and also from the fact that we have 418 against 185 and 501 against 228 for the categories: study of educational material (M) and questions/answers for exercises assignments (X) respectively. In addition, it is noted improvement of critical thinking (category: student comments on assignments (D): 244 against 163).

On the other hand, at Brainstorming technique it comes the phenomenon of more needless messages, i.e. off topic interventions (108 against 46). Despite the fact that it can be quantitatively proven, meanwhile the observation and study of messages' contents offers (in a quite small extent) a show of imagination by a smaller percentage of participants in Brainstorming technique, in contradiction to Snowballing technique. This may be explained given the fact the Snowballing technique is more "disciplined".

 As it can also be seen in Tables 1 and 2, a slightly uniform distribution to both techniques is noted, as far as where the attention is during the forum discussions, both throughout all the messages and also to those remaining if we deduct the messages functioning as separate variables. It becomes thus obvious that (*X)* category: questions/answers for exercises – assignments comes first (501 and 471 against 228 and 199) and it follows the (*M*) category: study of educational material (418 and 388 against 185 and 155).

As far as the effectiveness of the two techniques is concerned, it is obvious the advantage of Brainstorming against Snowballing, both in primary level concerning performance in self-evaluation tests of the trained people (average 88.11 against 82.09) and in secondary level concerning the students' performance at the procedure chosen to be the test (15.22 against 14.53) after the application of lesson plans, which were applied by the same teachers. This given is reinforced by the appearance of similar results among the groups (87.92 and 88.18 in groups of Brainstorming against 82.41 and 81.70 of Snowballing) and also (15.18 and 15.22 against 14.61 and 14.51 average student performance, respectively). The above assumptions are certified not only in relation to arithmetic means and geometrical, harmonic and arithmetic means of the interquartile range but also at trained teachers performance (in self-evaluation tests) as well as the respective students of theirs in the chosen activity.

Finally, at this point, it is worthy to mention that although the presented coding refers to asynchronous distance education environment, nevertheless, it can be applied also to synchronous communication environment.

6   CONCLUSIONS AND FUTURE GOALS

As it is deduced both from data analysis and also from the study of the text messages in Moodle forum, the groups where Brainstorming technique was emphasized show higher participation at the forum. Furthermore, it is noted a bigger enforcement of the participants' critical thinking. On the other hand, at Snowballing technique is noted that quite less time is spent and there are not off topic interventions in relation to Brainstorming. Meanwhile, Brainstorming is more advantageous than Snowballing concerning the effectiveness.

As for the high participation rate of Brainstorming, despite at first it may seem presumable, however it is not always like that, given that "a poorly crafted brainstorming input creates a cognitive load that consumes attention resources and may stifle the brainstorming process" (Helquist et al., 2006), while according to Michinov and Primois (2005) participation is encouraged "only when participants have access to a shared table facilitating the comparison among group members". As for the ascertainment of educational participation of Brainstorming in this study, it is at first in contrast to a respective study (Pinsonnealt et al., 1999) where it is highlighted that "the prevailing popularity of group brainstorming (verbal or electronic) in organizations may be explained by the perceived productivity" and that "these perceptions, which are at odds with reality, create the illusion of productivity"; but Camacho and Paulus (1995), who, despite ascertaining the same, however explain that "part of the productivity loss observed in interactive brainstorming groups may be due to the inhibited performance of individuals who are uncomfortable with group interaction"; Michinov and Primois (2005) are of similar opinion. This conclusion is also reached by a respective study (Dugosh et al., 2000) where it is noted that "the attentional set of the participant and the content of the exposure manipulation (number of ideas, presence of irrelevant information) affected its effectiveness". The conclusions of this study may be thus explained (as far as brainstorming effectiveness is concerned) and agree with relative study (Gallupe et al., 1994) that conclude that "electronic brainstorming groups were found to be significantly more productive" and likewise Hymes and Olson (1992), who support their opinion about unblocking brainstorming through the use of a simple group editor, as well as Stenmark (2007) who in one of his «three general pieces of managerial advice" eagerly urges: to «allow redundancy". Similar consideration there is about snowballing by Thomas and Carswell (2000), who for instance remark that "it is helpful if each sub-group to be given a different, but related task" which in other cases, e.g. (Scarpellini and Bowen, 2001) cannot occur due to the nature of the educational object.

Among others, as future research actions there are predicted long-term comparative studies of Brainstorming and Snowballing techniques in relation to HOU topics with studies focusing on other programming environments. Additionally, it will be more emphasized the central question, what reinforces the participation at fora and how this contributes to the educational process effectiveness by investigating side questions, such as how much it affects the person who starts the thread (teacher or student), how it starts, the period when the thread starts, how important is the time of response in threads, the groups' size etc. in combination with these two techniques, and finally, research of the presented coding in synchronous distance education environment.

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