

# The efficacy of homogeneous groups in enhancing individual learning

Yma Pinto\*

Department of Computer Science and Technology, Goa University, India - 403206

\* E-mail of the corresponding author: [yp@unigoa.ac.in](mailto:yp@unigoa.ac.in);

## Abstract

One possible enhancement to improving both the teaching and the learning process is an appropriate design of a learning environment. Collaborative learning, if appropriately used, has been one such tool that has been known to benefit learners. An issue that needs to be addressed, and one that can affect individual learning is the nature of the group composition in a collaborative environment. This paper analyzes the results of an experiment that was conducted on a module in a computer science degree course. The study sought to find the relevance of group composition to the amount of individual student learning. The underlying pedagogical approach for this activity is a collaborative learning experience through team work using heterogeneous and homogeneous groups. The analysis reveals a significant improvement in individual student performance in the year the groups were made homogenous.

**Keywords:** collaborative learning, improving classroom teaching, pedagogical issues, teaching/learning strategies, computer science education.

## 1. Introduction

An important and pertinent fact that requires noting is that besides the basic concepts of a discipline, effective learning methodologies characteristic to that discipline are relevant to knowledge delivery. Schroth et al (1999) have done a comparison of various pedagogical approaches and their results show that students experience more value, enjoyment and long-term influences of these activities as compared to taking exams and writing papers, which were viewed as neither valuable nor enjoyable. Thus, computer science education should also include within its curriculum design; processes, methods and models (Hansen & Ratzer 2002). One such approach to effective and sustained learning through cross-fertilization of ideas is the Collaborative Learning approach. This pedagogical technique helps refine multiple intelligences of the learner like Linguistic, Intrapersonal and InterPersonal (Gardner 2004) and Visuo – Auditory, while simultaneously exposing the learner to the higher skill levels in the Bloom's Taxonomy (Bloom et al 1971).

Theoretically, an important predictor of the value of a collaborative learning experience is the group's ability to understand, opine, share and construct new knowledge from the individual knowledge bases. Team members evolve after evaluating, assimilating and synthesizing both complementary and supplementary information and arriving at a common consensus. Rather than producing technology savvy individuals who lack flexibility and versatility, collaborative learning results in acquisition of a broader range of skills through interactivity with others, a pre-requisite for sustainable employability. It is a well researched and a known fact that a group performance is better than that of an individual (Hill 1982; Bradshaw & Stasson 1995; Richards 2009; Biggers et al 2009).

In a collaborative learner centric instructional delivery approach, groups of learners and their facilitator work in a more complex environment in comparison to a lecture-based delivery. They take on roles, contribute ideas, and critique each other's work, and together solve aspects of larger problems. There is a rich body of literature that points to benefits associated with this approach to learning (McWhaw et al 2003; Mentz et al, 2008; Muehlenbrock 2006; Palincsar & Herrenkohl 1999; Waite et al 2004). Cooperation with peers helps in deeper understanding and when necessary adapts the individuals' concepts. From an intuitive

standpoint, the knowledge that the group members bring to bear on the problem and how this knowledge is shared, understood, and further developed (or not) ultimately shape both the process and the product of the collaboration.

Barker et al (2002) forewarns that simply requiring students to work in groups does not necessarily lead to improved learning outcomes. Sometimes, the environment within a typical computer science classroom has been found to be defensive resulting in students who are reluctant to collaborate (Barker et al 2002). Other reasons preventing a positive attitude to group work include fear of plagiarism, freeloading, ego, effort, and communication overheads (Bell et al 2009; Bower & Richards 2006; Winn 2002). Further, assessments of group performance may lead to anomalies in individual assessment. On the strength of the above research, it is advisable that academicians use group work as a means of active learning rather than for assessments.

There are several factors by which academics can choose groups (Cohen 1994; Hoffman 2002; Rutherford 2001). Shaw( 1976) predicts that “groups composed of members having diverse, relevant abilities perform more effectively than groups composed of members having similar abilities”. Cragan et al (2009) state that the rich and diverse back-grounds of members in a heterogonous group make them potentially more capable of solving group problems compared to those in a homogeneous group. Relatively later researchers also reveal that heterogeneous groups will tend to function better than homogeneous groups (Barker 2005; Nicolay 2002). Other researchers (Braulche & Evans R 1998; Johnson D & Johnson R 2004) are not in complete concurrence over this fact. They show that sometimes homogeneous groups (regarding abilities, experiences and interests) tend to be better at achieving specific aims. An individuals’ motivation to help group mates depends on their perception of whether their individual outcomes are linked to those of their group mates. A study by Muehlenbrock (2006) also indicates that the combination of group formation based on student profiles and user context information can improve grouping quality. Other researchers (Braulche & Evans 1998; McConnell 2006; Nijstad & De Dreu 2002) favor instructor-chosen, heterogeneous groups which are segregated on the basis of their GPA, abilities and personalities.

Some studies (Lejk 2008; Shaw 1976) indicate that mixed ability groupings relatively disadvantage more capable students and tend to benefit below-average students. Later studies (Martin & Pardes 2004) combine collaborative learning with learning styles in order to use them as a main feature to select students in group formations. The parameter for homogeneity in this case is the learning styles itself, and activities need to be tailored for these groups accordingly for better group performance. These are suitable for web based courses that can be made self adaptable. The Australian Centre for the study of Higher Education (ACHE), states “when effective group management processes are employed, clear guidelines developed and communicated, and valid and fair grading processes employed, the likelihood of positive learning outcomes and student satisfaction can be significantly increased. Alternatively, if students cannot see the objective of group work, are unsure of what is expected of them, or believe the assessment methods are invalid or simply unfair, the educational benefits are reduced and tensions can emerge. The 'best' selection of group members, the 'optimal' roles and responsibilities that should be adopted and the 'ideal' conduct of group meetings will all depend on the purpose and function of the group” (ACHE).

Collaboration also influences the interpersonal skills important to team building, a much required skill in the modern workplace. A study by Webb et al (1998) indicates that high and low ability students had an increased teacher/student relationship which increases verbal interaction, whereas medium ability level students engaged in less interaction. Interactions of these students changed dynamically when placed in heterogeneous groups. These results are also indicative of the fact that group composition can affect individual collaboration and learning. Most of these studies indicate that groups composed of mixed achievers increases the knowledge base, the analytical and evaluator levels brought to bear on the problem, and consequently, the likelihood of a more optimal solution. This is notably true where the measurement is the consolidated overall group achievement, but what must not be neglected is the need to measure the improvement in learning, especially at the individual levels, which may not require the same group dynamics.

The research question that this study aims at answering is “Is there a statistically significant difference in

the individual amount of sustained learning among students if the group composition is made homogenous rather than if the groups were heterogenous? “ Here homogeneity is primarily based on earlier individual performance levels. The study also addresses intrinsic, though subjective, concerns raised earlier regarding issues such as:

- Did the group activity increase the level of enjoyment during the learning process?
- Did the individual learn more by working in the group rather than if he/she worked on his own?
- Did all team members contribute to the group work? What was the amount of individual contribution towards the group?
- Did the interpersonal and intrapersonal interactions within the group improve cohesiveness?

Computer Science Education should not only focus on the basic concept of the discipline, but also the processes and methods characteristic to that discipline (Zendler et al 2008; Hansen & Ratzler 2002). When a curriculum is first developed, its designers must articulate intended learning outcomes that align with competencies. Academic administrators must ensure that our academic programs deliver on the student performance in the expressed competencies. Some researchers (Burrill 1976; Fretwell & Lewis 2001; McDaniel 2005) make a mention that quality curriculum can only be created by linking curriculum design and assessments to the needs of the workplace.

Not all educational interventions are amenable to rigorous quantitative experimental research. This paper uses a mix of quantitative (relational research and a descriptive study) and qualitative research methodologies to analyze the data (Consumer’s Guide to Education Research). Conclusions to the questions enumerated above are drawn through an analysis of the feedback collected regarding the students’ attitudes and perceptions. The hypothesis stated above, is tested through a statistical analysis performed on the data collected from the evaluation and assessments performed on the learners over a period of three consecutive years by the same faculty. The results of this analysis could serve to inform and advise an instructor in selecting an appropriate facilitation strategy.

## **2. Designing and Implementing the Activity**

The purpose of the study was to explore the effect of homogenous groups in a collaborative learning environment for a post graduate course. The study made use of individual scores obtained from pre and post tests conducted on a specific module of the course. This component involves the analysis of business requirements and the subsequent design of a solution (the design of the application for the business). This activity is an ideal situation for collaboration and team work. The pre-test (consisting of sections encompassing all levels of Blooms’ taxonomy) was possible as the students were from the third semester of the course and had undergone an intermediate level course in an undergraduate degree program.

The faculty conducting this course has been facilitating a learner centric group activity for this competency over the last few years. The curriculum design and conceptual requirements being followed was taken from the framework (Pinto 2008). Teams are given the work of analyzing an application and presenting their design to their peers. After the deliberations within the group, the learners had to make a presentation that illustrated and explained the Entity Relationship Diagram which evolved from the given Case Study. The activity was observed, and it was noted that these deliberations brought in diverse opinions and solutions to aid in solving the problem. This helped the learners in improving their analytical skills and their skill to critically interpret and evaluate the work of their peers. It also enhanced their ability to collaboratively arrive at - and abide by - the groups’ consensus – an important requisite for a team to work harmoniously. Group work being a very crucial and important activity involving multiple skill sets from many contributors, these skill sets and ideas need to be harmoniously integrated before the entire team proceeds to the next stage.

The peer teams would grade the designs based on pre-determined parameters given by the faculty. The presentations are interspersed with questions, discussions and constructive criticism from the audience. This proves to be a very useful activity as the learners are made to note the pros and cons of a design choice

in different application scenarios. The learners also enhance their ability to synthesize and connect material to their existing knowledge base. This process of integrating information gives them a much deeper understanding of the subject. The faculty would then grade the reviews of the peer review teams to assess the evaluation skills of the teams conducting the peer reviews.

In the years preceding this quasi-experiment, the groups that were formed were heterogeneous in nature where the teams were composed of learners having different grade levels, but who were “friends”. Although the groups had members with different academic achievement levels, being “friends” they spent more time together as a “team”. The faculty observed that although the ‘team’ did well, the academically lower achieving individuals in the team piggybacked on their team members and did not enhance their learning substantially.

For this quasi- experiment, the pretest scores were used to form homogenous groups - students with similar academic performance levels were made part of the same team. The aim of the formation of the homogenous group was not to get the best output or design from all groups, but to get the maximum participation and productivity from the individual members within a group. The results show that the overall individual performance was better in this year as compared to when the groups were heterogeneous. The measurements and assessment strategies were kept standard across the years.

After the completion of the activity, the learners were given a comprehensive feedback form that sought to gain feedback on the clarity of the objectives and the effectiveness of the activity, the relevance of the case and the amount of learning that took place (as an individual and as a member of a team). The answers were sorted looking for common themes that arose from the subjective questions; percentages of students were calculated for the categorical answers. A summary of the feedback is shown below:

- This activity proved to be a better learning method: 97%
- Were able to obtain a deeper understanding of the subject and the design issues and could thus evaluate their peers effectively: 90%;
- Groups were cohesive: 75%;
- Equal contribution to the Group: 71% (the remaining 29% mentioned that their contributions were at a high level);
- The case study was at an advanced level: 40%.

A Qualitative Analysis captured through comments/suggestions includes: “We learnt to be more creative and reflect on our own work”; “We learnt to think logically”; “We learnt what went wrong with our thinking”; “We could clear our confusions and doubts”; “Discussions help us to understand and analyze the problem much better”; “Better subject understanding through a very interesting way of learning”; “We grew from weak to effective”; “We learnt how to meet our deadlines without being stressed – it was fun”.

What clearly stood out was the fact that there was an active participation of every learner in the session and the feedback revealed that each of the learners, even those who normally do not participate in the class, said they had gained immensely from this stress-free interaction.

As mentioned earlier, the only difference in the activity in the year this quasi-experiment was conducted was the homogeneity of the groups, which does not in any way bias the analysis of the collected data and which has been presented in section 3. After the completion of the entire group activity and allowing some time for assimilation, a post test (theory and skill evaluation) was conducted to find the amount of learning that took place at the group and the individual level.

### **3. Data Analysis and Discussions**

This section is structured by looking at the data analysis from two dimensions: Section 3.1 focuses on the analysis of the quality of the formative assessment method itself and Section 3.2 is devoted to analyzing the individual students’ performance at these assessments.

### *3.1 The Summative Assessment Strategy*

The instructional delivery, evaluation and assessment strategies that were followed conformed to Bloom's taxonomy (Bloom et al 1956) and the Component Display Theory (Merrill 1994). Bloom's taxonomy is a classification system of educational objectives based on the level of student understanding necessary for achievement or mastery of a subject. It contains six levels, with the principle that competence at a higher level implies a reasonable degree of competence at the lower levels. Instructional designers can use taxonomy concepts to guide the creation of the course content and the performance evaluation. The Component Display Theory proposed by Merrill classifies learning along the dimensions of content and performance. The theory specifies four primary presentation forms: rules, examples, recall and practice. Secondary presentation forms include: prerequisites, objectives, helps, mnemonics, and feedback. The theory specifies that instruction is more effective to the extent that it contains all necessary primary and secondary forms. The theory suggests that for a given objective and a set of learners, there is a unique combination of presentation forms that results in the most effective learning experience.

Section 3.1.1 deals with a discussion of the scoring rubric, followed by an analysis of the consolidated performance levels for the pre-test and post-tests using these scales. Section 3.1.2 is devoted to analyzing the quality of the assessment paper itself.

#### *3.1.1: The Scoring Rubric and the Consolidated Pre and Post Performance.*

Scoring rubrics are typically employed when a judgment of quality is required and may be used to evaluate a broad range of subjects and activities (Moskal 2000). By developing a pre-defined scheme for the evaluation process, the subjectivity involved in evaluating an assignment becomes more objective. The first step in developing a scoring rubric is to clearly identify the qualities that need to be displayed in a student's work to demonstrate proficient performance. The identified qualities will form the top level or levels of scoring criteria for the scoring rubric. After defining the criteria for the top level of performance, the evaluator's attention may be turned to defining the criteria for lowest level of performance. It is better to have a few meaningful score categories than to have many score categories that are difficult or impossible to distinguish (Brookhart 1999).

The questions in the assessment tests, designed to assess the DataBase Design skill set, were evaluated on a scale of 0 to 4 with the associated meaning as shown below. The following rubric was used as the students could easily identify with the scales and which would subsequently help them in the peer reviews.

0 - Doesn't know anything (most answers were guessed);

1 - Knows something but is very confused (cannot justify the answers properly);

2 - Knows something but some confusion still exists (answers may not be optimal, but can reason out the answer);

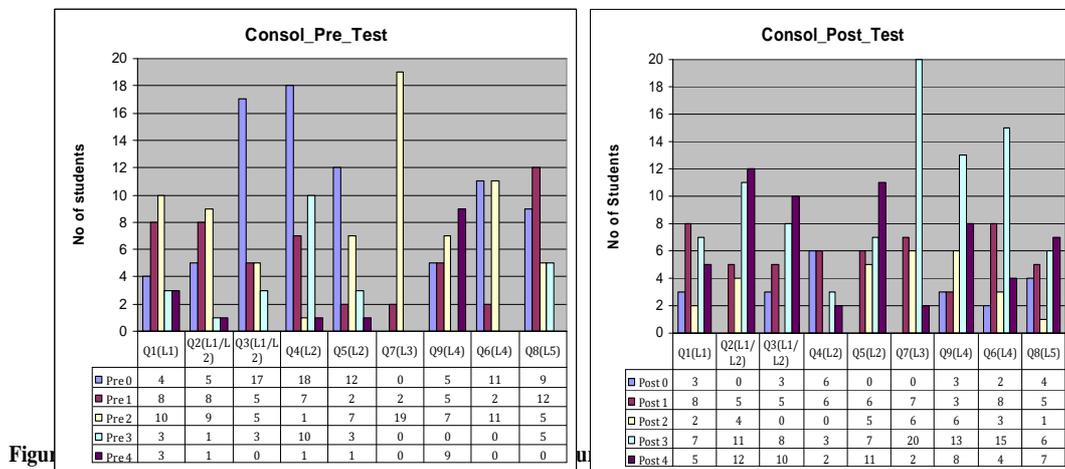
3 - Sufficient amount of knowledge (clear understanding with minimal errors; can analyze and identify optimal solutions)

4 - High Level of Knowledge and optimal solutions (can generate and evaluate multiple alternative and correct solutions).

The Question Paper itself was organized as follows: Questions Q1, Q2, Q3 and Q4 were at the Level of Knowledge and Comprehension; Question Q5 was an Application Level Question; Questions Q7 and Q9 were targeted at the Analysis and Application Levels; Questions Q6 had both an Analysis and Synthesis orientation; Question Q8 was a question that involved the highest skill set on Evaluation. Each of the above questions had subsections within them.

The result of the group activity conducted above was evaluated through Q7 and its impact can be seen from the Bar Charts shown in Figure1 and Figure2. The Bar Chart in Figure1 displays the total number of students who have scored various scale points at the different Question Levels at the Pre-Test; The bar

chart of Figure2 displays the same parameters but at the Post-Test.



An initial comparison of the graphs (Figure1 and Figure2) reveals the following points which are relevant and important to this study:

- (i) The amount of learning at the Comprehension level Questions Q2 and Q3 went up by a substantial amount. This is an expected observation after a series of formal lecture sessions
- (ii) Question 7, which was the question that evaluated the concepts after the group activity, had a maximum amount of learning in all respects. The pre-test (Figure1) shows that 2 students had a scale of 1 and 19 students had a scale of 2 and no student had achieved the higher scales of 3 and 4; the rest not having attempted the question. The Post-Test (Figure2) reveals that 7 students obtained a score of 1, 6 students obtained a score of 2, 20 students achieved a score of 3, and 2 students achieved the highest score of 4. What is also important to note is that a maximum number of students had the required jump in the performance grade from 2 to 3 (from a “level of confusion” to a “level of sufficient amount of knowledge”).

### 3.1.2: Analyzing the Question Paper:

To validate the quality of the assessment done, it is important to check the quality of the question paper itself (Rudner & Schaffer). One of the useful indicators is the discrimination power (DP) of the tests' items (Matlock-Hetzel, 1997). Discrimination describes the ability to distinguish between more and less knowledgeable students and contributes to the spread of scores of the examination. Easy questions are usually poor discriminators while the questions that assess the higher order knowledge levels are better discriminators.

The study revealed that the class conformed to the recommended pattern of learning and followed the Gaussian distribution for their grades. This check was necessary as most of the underlying statistical functions assume a normal distribution. The study, with a small sample size of 30, draws on the relational research methodology by using various statistical functions to reach a specific conclusion thereby establishing the empirical validity of the results. Statistical methods were chosen for the analysis of the data as they are characterized by the ability to handle clean data sets which are small in size. Standard deviation, being a mathematical formula measuring the average distance from the average, was chosen as the measure for verifying the discriminating power of the questions. Question Q8, which tested the highest level learning skill set, had the best discriminatory power. This was seen from the fact that the StdDev for Q8 was the highest.

An important observation relevant to this study is the StdDev for Question 7 - which is the lowest. This also

substantiates the hypothesis that the kind of group activity performed helped to bring all learners to a similar standard (which is a substantially high grade scale - scale level 3 - as seen from the bar chart in Figure2).

### 3.2 Analyzing Student Performance

Since the data being analyzed covered a period of 3 years, a check was necessary to ensure the results of the study were not affected by the variation in the quality of the teaching and the quality of the students itself. The same faculty has been teaching the course for many years and the methods (instructional delivery and activity) has been standardized for the past three years. Further, students are selected for admission to the MCA degree program based on merit at a common nation wide entrance test that assesses their general aptitude. This test evaluates the candidates' logical, quantitative, qualitative and Visio-spatial reasoning, high school mathematics, vocabulary, English comprehension and verbal ability.

To check that the quality of the students did not influence the study, an analysis of the internal consistency of the general aptitude scores of the students at the entrance test to the program was performed. The validity of the experiment can be verified by ensuring an acceptable standardization of the quality of the students. The Cronbach's test (Cronbach 1951; Bland & Altman 1997) was chosen over Kuder Richardson (KR) Formula as the test scores were scalar data and not dichotomous in nature. This test is used to measure the internal consistency or reliability in psychometric test scores for a sample of examinees. The formula to compute the Cronbach's alpha coefficient takes into account the number of components, the average variance for the current sample of persons, and the average of all co variances between the components across the samples. The higher the alpha value returned by the test, the more reliable is the test. The general acceptable alpha value is above 0.7 (Nunnally 1978; Gliem J. & Gleim R. 2003; Kromrey et al 2008). After subjecting the entrance test scores to Cronbach's test, an alpha value of 0.95 was obtained, ensuring the internal consistency of the data and the validity of the entrance test.

The next step is to ensure that there was not much variation in the quality of the students across the three years. To measure the diversity across the data samples, the standard quantitative statistical measures for dispersion could not be used. What was needed was a test that measures qualitative variance that satisfies the requirements of a categorical scale (Wilcox 1973; Kader & Perry 2007). The index of qualitative variation (IQV) is a measure of variability with an index value that ranges from 0 to 1. When the cases in the distribution are distributed evenly across the categories, there is a maximum diversity and IQV is 1.00 (Frankfort-Nachmias & Leon-Guerrero 2009). Gibbs & Poston's (1975) formula for IQV was used to measure the statistical dispersion in the samples. This formula takes into consideration the number of categories and the proportion of observations that fall in a given category before applying a standardization factor. The entrance test scores were categorized and the IQV for the 3 years was calculated and the values are as shown in Table1. The data analysis reveals a high level of diversity of the data in each of the sample

Year	IQV	cases and a negligible amount of variation across the three years.
Year1	0.874	This indicates standardization in the quality of the students which
Year2	0.856	would thus not bias the results of the experiment taking place over
Year3	0.867	the three years.

**Table 1: Index of Qualitative Variance for the three years**

#### 3.2.1 Comparing the Groups, Group Performances and Individual Learning Levels

The Correlation coefficient can be used as a measure of the strength and degree of the relationship between two variables. Correlational evidence can tentatively inform evidence based practice when quasi - experimental, relational research or descriptive studies are used (Thompson et al 2005; Centre for Public Education (CPE)). Although Correlation cannot be used to infer a causal relationship between the variables, it may be an indicator of a causal relationship (Somekh & Lewin 2005; Statsoft 2010). This statistical

measure will be used to answer the research question posed earlier.

To verify if a consistent and sustained amount of individual learning took place in the competency involving the group activity (referred to as C1) was actually more in the year the groups were homogenous, the students were once again evaluated at the traditional assessments conducted at an examination at the end of the year. The performance scales at this evaluation range from a grade level of 4 (lowest) to 10 (highest). A score below a grade scale of 4 implies a “failure” in the course. The correlation between the individual grades obtained at the end-semester examination that assessed this concept, and grades obtained in an assessment that evaluated the group performance was found. The relevant statistical evidence is shown in Table2.

Year	G Type	N	G Mode	G AvDev	G Var	I Mode	I AvDev	I Var	CoRel
Year1	Hetero	30	8	1.348	2.815	7	1.210	2.177	0.267
Year2	Hetero	30	7	1.115	1.970	7	1.308	2.650	0.234
Year3	Homog	30	9	0.825	0.936	9	0.744	0.751	0.310

**Table 2: Statistics for Group and Individual Score Performances**

(G and I in Table2 represent “Group” and “Individual”, respectively. N represents the number of students)

Year1 and Year2, which had a heterogeneous group environment, shows a weak positive correlation between the group grades and the individual grades; whereas the results for the Year3 which had groups that was homogenous in nature, display a stronger – though moderate – correlation between the group grades and the individual grades. Table2 also reveals the following pertinent findings for the Year3:

- The Average Deviation for the Homogeneous Groups and for the Individual Performances is the least.
- (ii)The Mode of the scores, both Group and Individual, is the highest for that year.
- (iii)The Variance in the scores is the least for the Individual scores when the learners formed a part of a Homogenous Group.

We need to further verify if the result achieved from the analysis of the data from the sample is a ‘real’ result or a result of ‘chance’. In order to determine the level of statistical significance, a function is needed that represents the relationship between "magnitude" and "significance" of relations between the two variables, depending on the sample size. In other words, that function would give the significance (p) level, and would be informative of the probability of error involved in rejecting the idea that the relation in question does not exist in the population (Statsoft 2010). Since educational research falls within the discipline of the social sciences, an alpha level of 0.05 is an acceptable value (Fisher 1922; Stallings 1985), although it still has a 5% probability of error. Specifically, since the significance depends mostly on the

Year	Group Type	p-values
Year1	Heterogeneous	0.08
Year2	Heterogeneous	0.115
Year3	Homogenous	0.05

**Table3: p-values for sample data**

sample size, the larger the sample, the smaller the difference needed to reach statistical significance (Somekh & Lewin 2005). The significance test (p-values) returned for the above sample data is shown in Table3.

Rephrasing the research question stated at the onset of the study as:

H0: There is no significant amount of individual learning in the case when the learning groups are Homogenous in nature.

H1: There is a significant amount of individual learning when the Homogenous learning groups are formed.

H0 can be rejected as the statistical significance (p-value) of the result is  $\leq 0.05$  (the acceptable alpha) in the Year3, when the group formations were homogenous. The study provides evidence to the fact that the improvement in the individual learners' performance did not occur by chance alone but was the result of the instructional intervention. This conclusion will be reinforced by the descriptive study that follows in the next section.

### 3.2.2: Analyzing the Retention Levels of the Individuals in the different Groups

Unlike the Post-test assessments which were conducted soon after the completion of the module, the assessments done at the end-semester examination evaluates all the modules completed in the course. The retention power of the individual can thus be observed for this activity based module vis-à-vis the other modules. The following Table4 shows some interesting statistics of the performance levels of the individual learner in all the modules conducted at the end semester examination vis-à-vis the competency module comprising the group activity. The examination at the end of the semester is a traditional assessment comprising questions from all the course modules and did not vary across the three years.

Year	Group Type	Average Overall Grade	Average C1 Grade	Mode Overall Grade	Mode C1 Grade	AvgDev Overall Grade	AvgDev C1 Grade
Year1	Hetero	6.517	6.034	7	7	1.220	1.210
Year2	Hetero	6.069	7.310	8	7	1.731	1.308
Year3	Homog	6.724	8.414	7	9	1.339	<b>0.744</b>

Table 4: Interesting Statistics of Class Performance for the three Years (C1 represents the competency module)

When there is a relatively small sample size, analyzing the individual elements of the data itself may throw a better light on the study. Table 4 together with Figures 3, 4 and 5 reveal some interesting statistics for the homogenous group environment in the third year emphasizing the fact that the homogenous group is an effective learning pedagogical strategy.

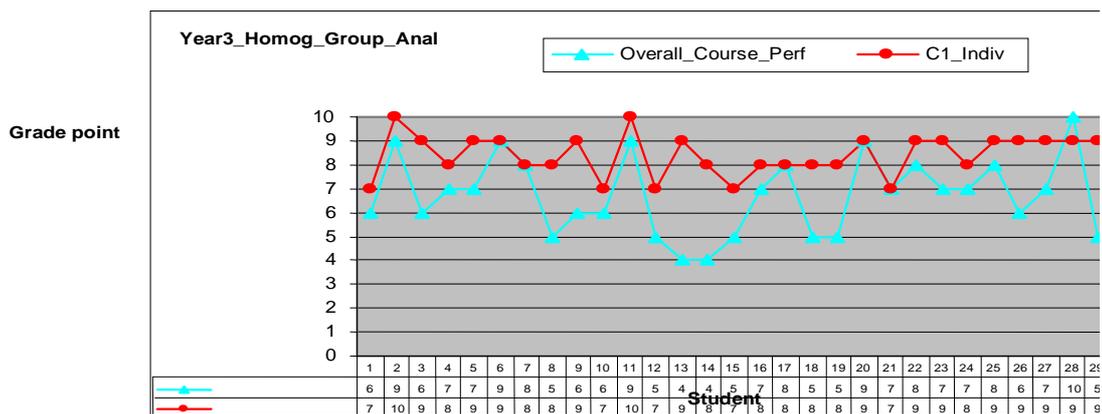


Figure 3: Graph of Individual (Overall Course and C1) Scores for Year3

The following analysis can be done for Year3:

- With the exception of a single individual, every learner had the C1 score grade higher than the

overall course score.

- The Average Score for the C1 is significantly higher than the overall course average score.
- The Average Deviation for the C1 score is significantly lower than the average deviation for the overall course score.
- The Mode for the C1 score is two grade scales higher than the mode for overall course score

For the Year2, the graph in Figure 4 below, shows that 20% of the learners had obtained a C1 grade lower than their overall course scores. Further, the Mode for the C1 score is a grade lower than the mode for overall course score. Figure 5 shows that 48% of the learners had obtained a C1 score grade lower than their overall course scores.

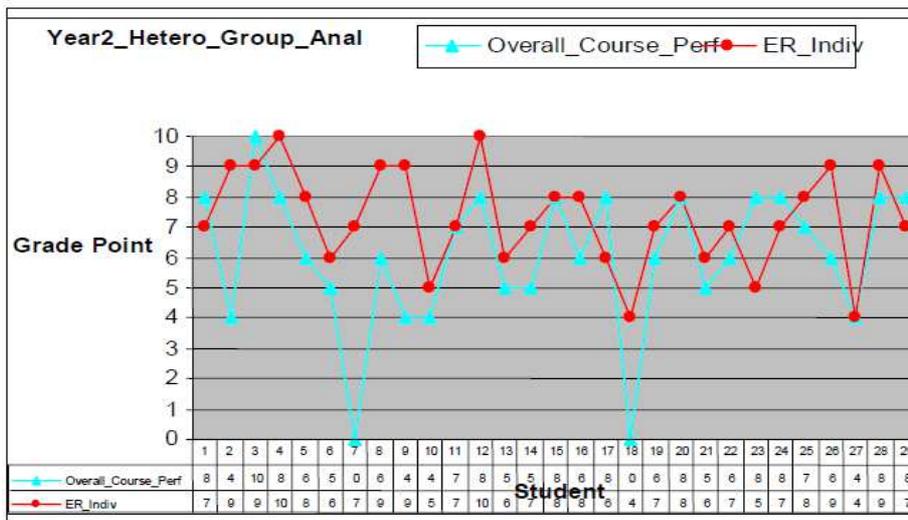


Figure 4: Graph of Individual (Overall Course and C1) Scores for Year2

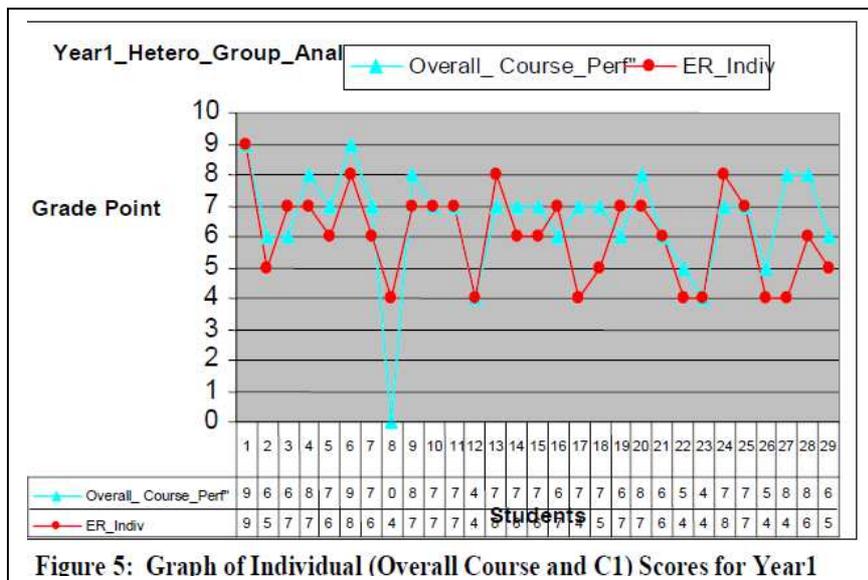


Figure 5: Graph of Individual (Overall Course and C1) Scores for Year1

From the above data, it is clearly discernable that the mode and the average for the C1 grades at the end-semester examination in the Year3 were significantly higher than the same for the previous years. Further,

the Individual Average Deviation for the C1 is the least for that year. Another important observation is that the individual C1 grades for a significantly large number of students in the earlier years (Year1 and 2) were lower than their individual overall grade - indicating that many of the students piggybacked on the grades of their team members when in heterogeneous groups; and their C1 concepts needed a comparable improvement. This data analysis is in agreement with the hypothesis H1 formulated in this study.

## 5. Conclusion

The general perception has been that heterogeneous groups are necessary for effective Collaborative Learning with the essence being the achievement of the group, and not necessarily the impact on individual learning. The results of this study reveal that, when the focus is on individual learning, heterogeneity in group formation is not a necessary condition. Although tentative, this study suggests that 'homogeneity' can not only improve the individual's learning ability, but also their levels of confidence. The lower achievers tend to work harder to arrive at their peer standards and cannot "piggy-back" on the higher achievers. The retention span also remains significantly longer for all learners in this learner centric activity.

Not only can group homogeneity/heterogeneity with respect to performance and academic intelligence be considered during the formation of a group, but also individual learning styles/skills for a more productive learning environment. The final aim would be to maximize the possibility of student success in an enjoyable learning environment.

## References

- Barker, L.J., Garvin-Doxas, K. & Jackson, M.H.(2002), "Defensive climate in the computer science classroom", *Proceedings of the 33<sup>rd</sup> SIGSCE Technical Symposium on Computer Science Education 34(1)*, 43-47. Doi 10.1145/563340.563354
- Barker L.J.(2005), "When do group projects widen the student experience gap?", *Proceedings of the 10th Annual SIGSCE Conference on Innovation and Technology in Computer Science Education (ITiCSE'05)*, 37(3), 276-280. Doi 10.1145/1067445.1067521
- Bell, T., Urhahne, D., Schanze, S. & Ploetzner, R.(2009), "Collaborative Inquiry Learning: models, tools and challenges", Research Report, *International Journal of Science Education*, 32(3), 349-377
- Biggers, M., Tuba, Y. & Sweat, M.(2009), "Using Collaborative, Modified Peer Led Team Learning to improve student success and retention in intro CS", *Proceedings of the 40th SIGSCE Technical Symposium on Computer Science Education*, 41(1),9-13 Doi 10.1145/1508865.1508872
- Bland, J.M. & Altman D.G.(1997), "Statistics notes: Cronbach's alpha", *British Medical Journal*, Feb 1997, 314:572
- Bloom, B.S., Hastings, J.T. & Madaus, G.F.(1971), *Taxonomy of Educational Objectives: The Classification of Educational Goals, Handbook 1, Cognitive Domain*. New York, McCay.
- Bower, M. & Richards, D.(2006), "Collaborative learning: Some possibilities and limitations for students and teachers", *Proceedings of the Conference for the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE'06)*, *ACM Transactions on Computing Education*, 9(1), 79-89.
- Bradshaw, S.D. & Stasson M.F.(1995), "Explanations of individual-group performance differences: What sort of "bonus" can be gained through group interaction?", *Small Group Research*, 26(2), 296-308.
- Brookhart, S. M.(1999), *The Art and Science of Classroom Assessment: The Missing Part of Pedagogy*. ASHE-ERIC Higher Education Report, 27(1). Washington, DC: The George Washington University, Graduate School of Education and Human Development
- Burrill, G. C. (1976), "Competency based curriculum design: An experimental model for social service workers", *Innovative Higher Education*, 1(2), 132-138, Doi. 10.1007/BF01079492
- Cohen, E.G. (1994), *Designing Groupwork Strategies for the Heterogeneous Classroom*, (2<sup>nd</sup> Ed.), New York: Teachers College Press.

- Cragan, J. F., Kasch, C. R. & Wright, D.W.(2009), *Communication in small groups: Theory, process, skills (7<sup>th</sup> Ed.)*. Lyn Uhl, Wadsworth Cengage Learning.
- Cronbach, L. J.(1951), "Coefficient alpha and the internal structure of tests", *Psychometrika*, 16(3), 297-334
- Fisher, R.A.(1921), "On the "probable error" of a coefficient of correlation deduced from a small sample", *Metron*, 1 3-32. <http://hdl.handle.net/2440/15169>
- Frankfort-Nachmias, C. & Leon-Guerrero A.(2009), *Social Statistics for a Diverse Society*, Sage publications, Chapter 5.
- Fretwell, D. H., Lewis, M.V. & Deij A. A.(2001),World Bank, "A Framework for defining and assessing occupational and training standards in developing countries".
- Gardner, H.(2004), *Changing Minds: The art and science of changing our own and other people's minds*. Boston: Harvard Business School Press.
- Gibbs, J.P. & Poston, D.L. Jr.(1975), "The Division of Labor: Conceptualization and Related Measures", *Social Forces* 53 (3): 468-476, Doi 10.2307/2576589
- Gliem, J.A. & Gliem, R.R.(2003), "Calculating, Interpreting and Reporting Cronbach's Alpha Reliability Coefficient for Likert-type Scales", *Proceedings of The Midwest Research to Practice Conference in Adult, Continuing, and Community Education, Ohio*
- Hansen, K.M. & Ratzler, A.V.(2002), "Tool support for collaborative teaching and learning of object-oriented Modeling", *ACM SIGCSE Bulletin*, 34(3), 146-150.
- Hill, G.W.(1982), "Group versus individual performance: Are N = 1 heads better than one?" *Psychological Bulletin*, 91(3), 517-539.
- Hoffman, J.(2002),"Flexible Grouping Strategies in the Multiage Classroom", *Theory into Practice*,41(1), *Promoting Thinking through Peer Learning (Winter 2002)*,47-52.
- Johnson, D.W. & Johnson, R.T.(2004), *Assessing students in groups: promoting group responsibility and individual accountability*, Thousand Oaks, Ca: Corwin Press.
- Kader, G.D. & Perry, M.(2007), "Variability for Categorical Variables", *Journal of Statistics Education*, 15(2) [www.amstat.org/publications/jse/v15n2/kader.html](http://www.amstat.org/publications/jse/v15n2/kader.html)
- Kromrey, J.D., Romano, J. & Hibbard, S.(2008), "Alpha\_CI: A SAS@ macro for Computing Confidence Intervals for Coefficient alpha", *SAS Global Forum, Paper 230-2008*.
- Lejk, E.(2008), *Management of cultural diversity in group assessment for learning*, Centre for Excellence in Teaching & Learning Assessment for Learning, CETL AfL, Univ of Northumbria., [northumbria.ac.uk/static/5007/cetlpdf/emmaleyk](http://northumbria.ac.uk/static/5007/cetlpdf/emmaleyk). (Nov 24,2008)
- Martin, E. & Paredes, P. (2004), "Using learning styles for dynamic group formation in adaptive collaborative hypermedia systems", *Proceedings of the First International Workshop on Adaptive Hypermedia and Collaborative Web-based Systems, AHCW*, 188-198 [www.ii.uam.es/~rcarro/AHCW04/MartinParedes.pdf](http://www.ii.uam.es/~rcarro/AHCW04/MartinParedes.pdf).
- Matlock-Hetzel, S.(1997), "Basic Concepts in item and test analysis", *Annual Meeting of the SouthWest Educational Research Association, Austin, 1997, San Antonio. ED406441*, [www.eric.ed.gov](http://www.eric.ed.gov), (Aug 2005).
- McConnell, J. J.(2006), "Active and cooperative learning: further tips and tricks (part 3)", *SIGCSE Bulletin* 38(2), 24-28.
- McDaniel, E., Roth, B. & Miller M.(2005), National Defense University, Washington, DC, USA, "Concept Mapping as a Tool for Curriculum Design", *Issues in Informing Science and Information Technology*, 2, 505-512. <http://www.informingscience.org/proceedings/InSITE2005/142f49McDa.pdf>
- McWhaw, K., Schnackerberg, H., Sclater, J. & Abrami, P.C.(2003), "From Cooperation to Collaboration: Helping students become collaborative learners", R.M. Gilles(Ed), *Co-operative Learning: The Social and intellectual outcomes of learning in groups*. London: Routledge Falmer.
- Mentz, E.,Van Der Walt, J.L. & Goosen L.(2008), "The effect of incorporating cooperative learning

- principles in pair programming for student teachers”, *Computer Science Education*, 18(4), 247-260.
- Moskal, B. M.(2000),”Scoring rubrics: what, when and how?”, *Practical Assessment, Research & Evaluation*, 7(3). <http://PAREonline.net/>
- Muehlenbrock, M.(2006), “Learning group formation based on learner profile and context”,. *International Journal on e-learning IJEL* 5(1), 19–26.
- Nicolay, J. A.(2002), “Group assessment in the online learning environment”, *New Directives in Teaching and Learning*, 91(Fall), 43–53. Doi 10.1002/tl.65
- Nijstad, B.A. & De Dreu C.(2002), “Creativity and Group innovation”, *Applied Psychology* 51(3), 400-406.
- Nunnalli, J. C.(1978), *Psychometric theory* (2nd ed.). New York: McGraw-Hill
- Palincsar, A.S & Herrenkohl, L.R.(1999), “Designing Collaborative Contexts: Lessons from three research programs”, In A.M. O’donnell & A.King (Eds), *Cognitive Perspectives on Peer Learning*, 151-178. Mahwah,NJ:Erlbaum.
- Pinto, Y.(2008), “A Framework for Competency Based Curriculum Design for IT Courses”, *Proceedings of the International Conference on Education, Research and Innovation, IATED, Nov 2008, Spain, ISBN: 978-84-612-5091-2, 107-124*
- Richards, D.(2009),”Designing project-based courses with a focus on group formation and Assessment”, *ACM Transactions on Computer Education*, 9(1), Article 2. Doi 10.1145/1513593.1513595.
- Rudner, L.M. & Schafer, W.D., *What Teachers Need to Know about Assessment*, Published by the National Education Association
- Rutherford, R.H.(2001), “Using personality inventories to help form teams for software engineering class projects”, *Proceedings of the 6<sup>th</sup> Annual Conference on Innovation and Technology in Computer Science Education, SIGCSE Bulletin* 33(3).73-77
- Schroth, G., Pankake, A. & Gates, G.(1999), “A Comparison of Pedagogical Approaches to Teaching Graduate Students in Educational Administration”, *Journal of Instructional Psychology*, Dec 1999.
- Shaw, M.E(1976), *Group dynamics: The psychology of small group behavior* (3rd Ed.). New York: McGraw-Hill.
- Somekh, B. & Lewin, C (2005). *Research Methods in Social Sciences*, Sage Publications.
- Stallings, W.M.(1985), “Mind Your p’s and Alphas”, *Educational Researcher*, 14(9) 19-20, *American Educational Research association*, <http://www.jstor.org/stable/1174554>
- Thompson, B., Diamond, K.E., McWilliam, R., Snyder, P. & Snyder, S. (2005), “Evaluating the Quality of Evidence from Correlational Research for Evidence-based practice”, *Exceptional Children*, 71(2) (Winter issue), Ms #076-70-r.
- Waite, W.M., Jackson, M.H., Diwan, A. & Leonardi, P.M.(2004), “Student culture versus group work in Computer Science”, *Proceedings of the 35<sup>th</sup> SIGCSE Technical Symposium on Computer Science Education, ACM SIGSCE Bulletin* 36(1), 12-16
- Webb, N.M., Nemer, K.M., Chizhik, A.W. & Sugrue, B. (1998), “Equity issues in collaborative group assessment: Group composition and performance”, *American Educational Research Journal*, 35(4), 607–665.
- Wilcox, A.R.(1973), “Indices of Qualitative variation and Political Measurement”, *The Western Political Quarterly*, 26(2), 325-34.
- Winn, W.(2002), “Current Trends in Educational Technology Research: The Study of Learning Environments”, *Educational Psychology Review*, 14(3), 331-35
- Zendler, A., Spannagel, C. & Klautdt, D.(2008), “Process as content in computer science education: empirical determination of central processes”, *Computer Science Education*, 18(4), 231-245.
- StatSoft, Inc. (2010). *Electronic Statistics Textbook*. Tulsa, OK: StatSoft. WEB: <http://www.statsoft.com/textbook>

Journal of Education and Practice  
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)  
Vol 3, No 3, 2012

[www.iiste.org](http://www.iiste.org)

Consumer's guide to Education Research, Center for Public Education,  
<http://www.centerforpubliceducation.org>.

Centre for the study of higher education, Assessing Learning in Australian Universities, *Ideas, strategies and resources for quality in student assessment, Assessing group work*,  
<http://www.cshe.unimelb.edu.au/assessinglearning>

This academic article was published by The International Institute for Science, Technology and Education (IISTE). The IISTE is a pioneer in the Open Access Publishing service based in the U.S. and Europe. The aim of the institute is Accelerating Global Knowledge Sharing.

More information about the publisher can be found in the IISTE's homepage:

<http://www.iiste.org>

The IISTE is currently hosting more than 30 peer-reviewed academic journals and collaborating with academic institutions around the world. **Prospective authors of IISTE journals can find the submission instruction on the following page:**

<http://www.iiste.org/Journals/>

The IISTE editorial team promises to review and publish all the qualified submissions in a fast manner. All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Printed version of the journals is also available upon request of readers and authors.

### **IISTE Knowledge Sharing Partners**

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digital Library, NewJour, Google Scholar

