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Research Paper

Improving the achievement of senior secondary students'in Greece school transfer of the geometric measurement of houses in a village on to paper with the help of peer- assessment.

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ABSTRACT
One of the basic tools recommended in this work on teaching the how to transfer the Geometric Measurement of houses in a village on to paper lesson is that of using a technique similar to peer-assessment. Students evaluate technological appliances created by their peers, while at the same time creating their own. In all three academic years covered by this work there is a common team of teachers to carry out the assessment. The article discusses the strategies that were used and implications arising from this process. The entire process proved a success since not only did the quality of the construction improve butalso the accuracy of the assessment itself, in comparison with the classical teaching methods used in geometry. Itseemsthatpeerassessmentis an effective toolin the ability of the students to transfer geometric shapes (such as houses) into a mock-up.

KEYWORDS: *Geometry, solid shapes to mock-up, measurements, peer-assessment, Senior SecondarySchool, model*

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I. INTRODUCTION

Numerous studies show that solving real-life problems requiring mathematical knowledge is very different from solving school mathematical problems that require similar mathematical procedures

This article presents research into the development of assessment tools that are effective in improving the teaching of lessons in the representation of solids such as houses in a mock-up.

Here we applied a technique similar to what is called 'peer assessment.' The necessity for a reconsideration of current practices of assessment has become intense, since the past twenty years or so have seen increasing recognition of innovative practices in assessment and the use of the results in the teaching process. An important place is held by formative assessment as a student learning tool [1]. The final aim of this is the improvement of teaching. Furthermore, the use of alternative assessment formats within the educational system involves significant reform of teachers' assessment beliefs and their perceptions as to the role of assessment in teaching and learning [2]. Peer assessment is fundamentally an interpersonal process in which a performance grade exchange is being established and in which the core activity is feedback given to and received from the students themselves[3]

Having measured a segment of the settlement, the students had to imprint these measurements into a mock-up using cardboard, glue and other materials. Through their participation in peer assessment, it was hoped that the students would gain substantially more knowledge because of the need to reflect critically on and evaluate the models of their peers.

In subsequent academic years, during preparation activities, students were exposed to a range of models from previous years and engaged in discussions about effective and ineffective models.

II. RESEARCH QUESTIONS

Through an evaluation of the students' work over 3 successive years (The topic was examined in the framework of peer assessment) we investigated whether we could bring the student to satisfactory results and specifically as to whether the student could createsuccessively better geometric constructions which transfer the Geometric Measurement of houses in a village on to paper.

In other words :

We consider whether each student who participates in the peer-assessment process in his/her effort to create a better quality construction, will try to achieve as good if not better results by effectively consulting the work of previous students. This results in the creation of better constructions that get rid of the disadvantages of the earlier ones.

III. BIBLIOGRAPHICAL FRAMEWORK

The bibliography is divided between the positive and negative aspects of peer assessment and what should be done to achieve an improvement in peer-assessment.

A. There are many supposed beneficial effects of peer assessment. Peer assessment is said to enhance student learning. More specifically, using peer assessment helps students to develop certain skills in the areas of, for example, communication, self-evaluation, observation, and self-criticism (Dochy& McDowell, 1997). [4].

In assessment literature it is argued that students who are actively involved in their learning as well as in the assessment process are more motivated, and therefore show more learning gains than passive students (Topping et al., 2000).[5]

Important work on peer assessment has been carried out by Zevenbergen, [6] (2001), and Burke, [7] (1969) who found that peer assessment was more reliable than self-assessment in the selection of high- and low-performing students. Important works of Conway, Kember, Sivan and Wu [8] have also documented the importance of peer assessment.Of course they maintain that when peer assessment is carried out by individuals with experience of it then we can arrive at very good results.

B. As regards the disadvantages of peer-assessment, these are mentioned in the worksof Falchikov [9] where they refer to various problems that might arise given the social context of peer assessment, such as a lack of trust in the self and others as assessors, and friendship marking through which groups or individuals rate their peers. Value diversity is defined as a difference in opinion of what a team's task, goal or mission should be [10].

Literature reviews by Dochy,Segers, and Sluijsmans [4] indicate that although various studies seem to have found positive effects ofpeer assessment on learning, the results are still inconclusive.

How do students feel when they are involved in peer-assessment? Initially we must refer to the opinion of [11who reported that students felt that peer assessment was criticism of one's friends and colleagues. These authors all maintained that while students may be resistant to peer-assessment, the learning outcomes for the students were found to be significant. A further disadvantage is shown in important studies which consider that peer assessment confuses objectivity [12] [6]

Freeman (Freeman 1995) [13] raised concerns about the certification process and how important it is that peer assessment should reliably reflect student learning. Because peer assessment may not be as reliable as academic marking, Freeman suggested that the peer-assessment component should carry a lighter weighting ([13] [6].

As to whether or not peer assessment has a positive result as an assessment tool, it must be mentioned that because a student's future is closely linked to assessment outcomes, it is important that peer assessment involves validity checks [6] particularly when subjective assessment is involved, because such assessment "always involves making fallible human judgments" [14].

One of the great difficulties of peer assessment is that neither teachers nor students know exactly what it is. Teachers, indeed, lack the basic knowledge of evaluation since a course on Evaluation is not taught in all the University in Greece.

Often, therefore, the students understand the teachers' difficulties in Evaluation in general and specifically in peer assessment and they deal with the whole procedure with suspicion [15].

The selection of criteria also plays an important role in improvement. Some of the discrepancy in assessment may be due to the lack of clear criteria. Williams [11] and Zevenbergen [6] support the notion of clear guidelines for marking as this makes the task more objective for students and thereby reduces any feeling they may have that criticism is personal. Orsmond, Merry and Reiling (Orsmond, Merry and Reiling[16] extend this point and suggest that some of the discrepancy in marking may be due to different interpretations of the criteria, a point re-iterated by Boud[17].

Peters [18] maintains that the process of peer assessment can be improved and student resistance to self-assessment and peer assessment may be decreased if there is continuous assessment of students' work rather

than the students being subjected to cumulative evaluations. At the same time, however, there may be an improvement in the results of such assessment, since peer assessment allows for the evaluation of each student's contribution, and while the evaluation through peer assessment is not entirely unbiased, it can be noted that the subjectivity associated with mark allocations may also be influenced by the students. The issue of subjectivity and interpretation of grades remains an area of concern. Another subject that would improve results of peer assessment is that of the clarity of the objectives that are set. The clearer the task of how to achieve a grade or award becomes, and the more detailed the assistance given by tutors, supervisors and assessors, the more likely candidates are to succeed[19].

Explanations also assist with the improvement of results. We consider that this is due to the fact that the subjectivity associated with mark allocations is influenced by the students' different feelings as to what numerical score should constitute a pass. Note: Bearing all this in mind we created a form of teaching where it was clearly determined what each student should evaluate.

IV. Objective

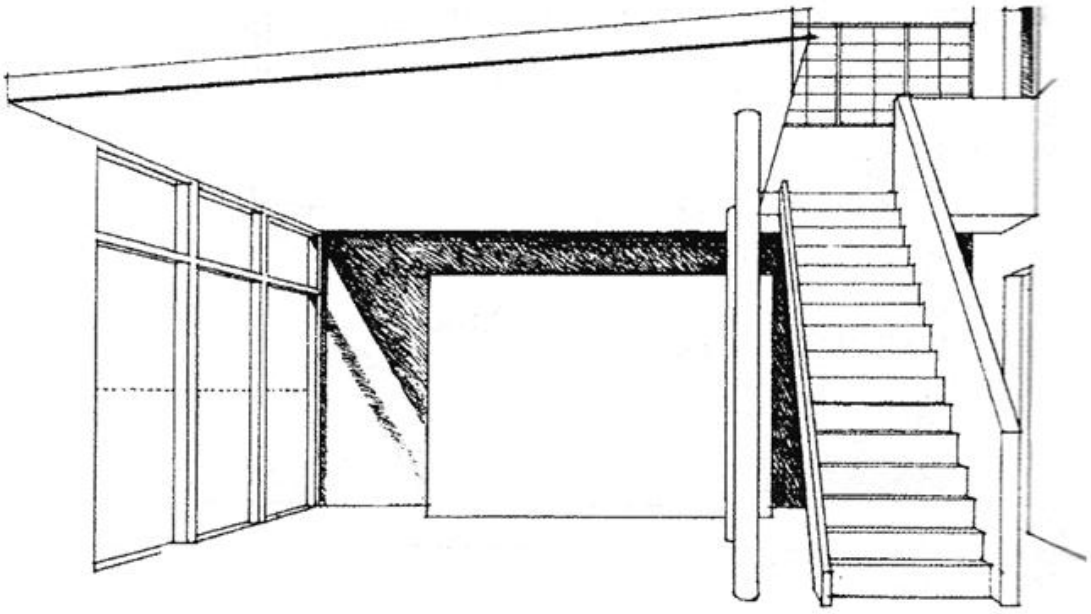
The objective of this work was to investigate whether learning experiences such as those in mathematics lessons may be seen to produce a better learning outcome using peer assessment.

- First, students would practice assessment.
- Secondly, through the construction of the models, students would learn to carry out the instructions for making the model.
- Through their participation in peer assessment, it was hoped that the students would gain substantially more knowledge because of the need to critically reflect on and evaluate the models of their peers.
- In subsequent academic years, during preparation activities, students were exposed to a range of models from previous years and engaged in discussions about effective and ineffective models. An analysis of what worked and what did not work provided a catalyst for identifying key factors in the construction of effective models. Students discussed criteria for the models, analyzedthe criteria, and, in particular, what each of the criteria meant [6]

4.1 Analytically for the constructed model.

The students were taken to a traditional island village where they attempted to record on paper the volume of a total of 5 houses in a village using a tape measure

Figure1: The first floor is shown as it was presented to the students on a sheet of A4 paper and they had to place it over the ground floor.



V. Participants.

This project evolved over a period of 3 years. The reason that the research had to develop over three years is that there were a limited number of students in this island region where the research took place. The school years involved were 2017-2018, 2018-2019 and 2019-2020 and in all three academic years there were 2 separate groups of students. One group worked in the classical way while the other group worked with peer

assessment. Each group was made up from two classes. The group which worked in the classical way was composed of 104 students in all three years (32 students in 2017-2018, 30 students in 2018-2019 and 42 students in 2019-2020). The other group which used peer assessment had 116 students, 36 in 2017-2018, 42 students in 2018-2019 and 40 students in 2019-2020.

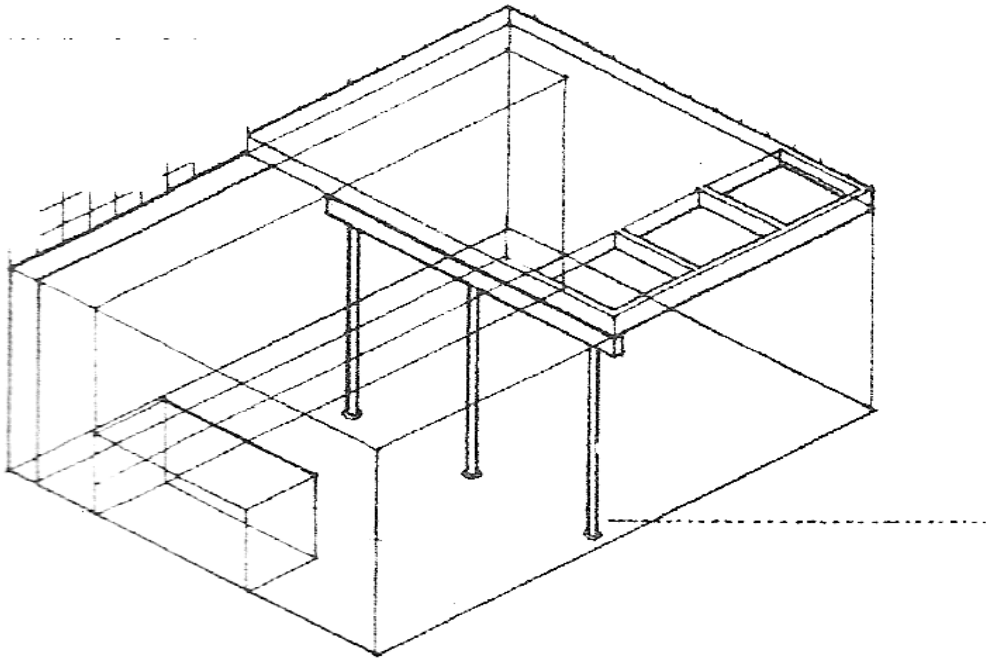
The students assessed themselves, and constructed their own model themselves. The two groups worked separately and each had the same model i.e. the construction of a two-storey house. My approach to peer assessment consisted of having students construct a model of a two-storey house as presented in figures 1 and 2. There could also be discussion in the classroom. This happened in each academic year.

There were 8 teachers and they would judge the works of the 116 peer assessment students, and they would also judge the work of 104 students separately.

The evaluation of the works created by the students took place in total when the students each completed their own work at the completion of the final academic year (2019 – 2020).

We also looked for teachers who came from the island so as to have the same ones through the three years of the research.

Figure 2: The diagram shows the ground floor as it was presented to the students on a sheet of A4 paper. The students had to construct a model on a wooden base 1.10 x 0.80.

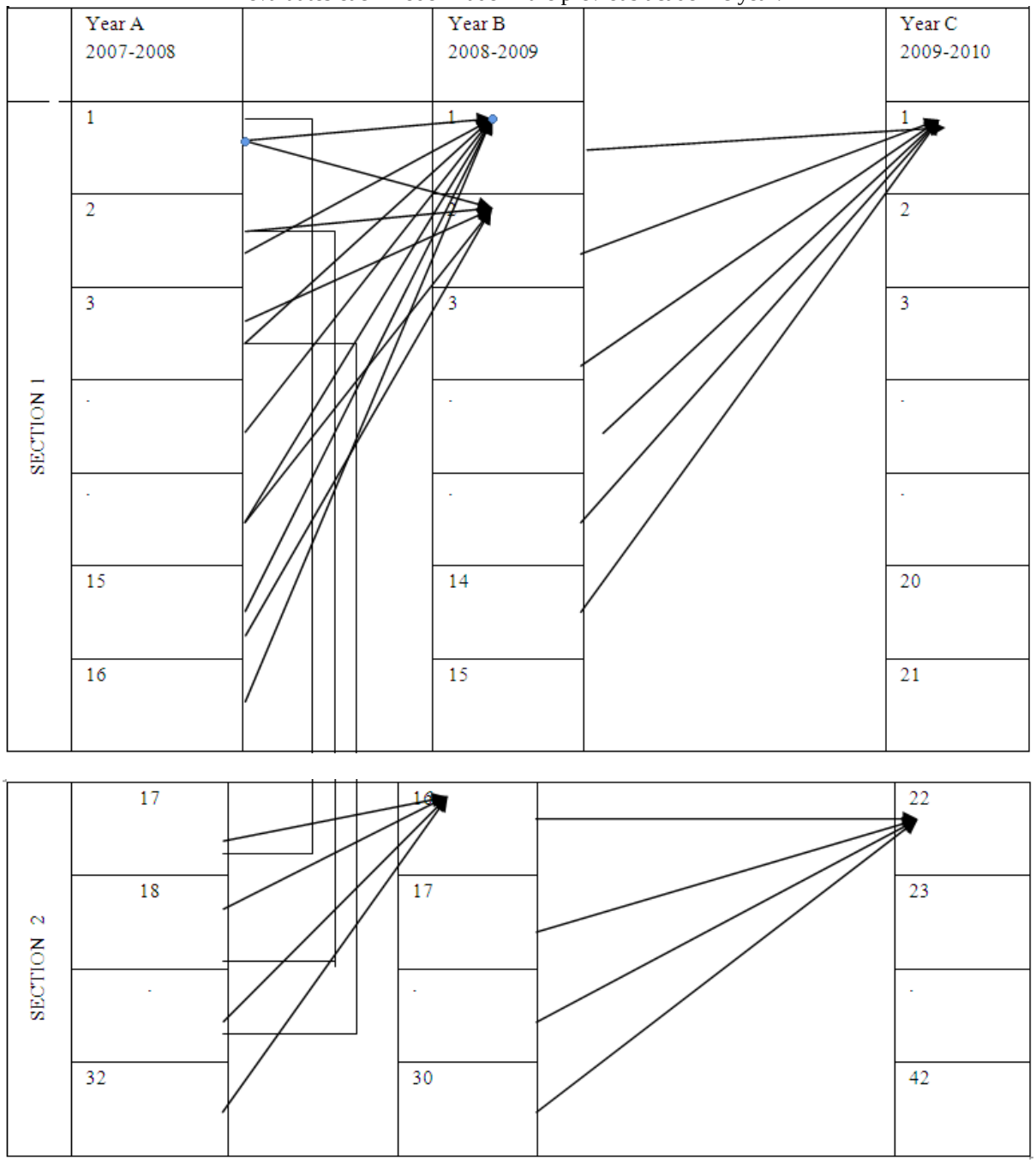


VI. PROCEDURE - GENERAL ASSESSMENT AND ASSESSMENT FOR THE MODELS.

They took measurements of height, breadth and length and made a model. At the same time a follow-up lesson was requested, with a discussion of technical information and the application of scientific methods**.**

The group which worked in the classical way attempted to put together all the necessary information required to construct the best possible model while the group using peer assessment worked as described in the graphic representation (figure 3). Each student worked separately to create his/her own construction and another student in each academic year would examine the construction of his/her classmate. For example the models of the 16 students in the first group would be examined by student 1 from the second group. The assessment process of the 16 tasks from the first section would be repeated by the 2nd student etc. (Graphic representation 3) and so on. Then the model that the first group constructed was demonstrated the following academic year (as mentioned above). This made it easier for groups in the following years to prepare and construct better models (this applies only to the group that carried out the peer assessment) The work of the 32 students in the academic year 2007-2008 was evaluated by the students (30 students) in the academic year 2008-2009 (figure 3).

Figure 3: Each student from the 15 or 21 in the academic years 2008-2009 and 2009-2010 respectively, evaluates each model made in the previous academic year.



Then the students in academic year 2018-2019 created their own work. The same process was carried out in the academic year 2019-2020. The students created their own work after having evaluated the work of their predecessors in academic year 2008-2009

Figure 4: The graphic representation shows the evaluations by academic year grouped by style and background font. The team of teachers evaluated the students' work after the students had completed it. The students evaluated the work of their schoolmates from earlier academic years (2008-2009 and 2009-2010) or from different classes (2007-2008)

Academic Years		**2017-2018**	**2018-2019**	**2019-2020**
Control Group		32 pieces of work created by 32 students (Divided into 2 groups of 16).	The students in the Experimental group are divided into two groups of 15. The Control group also consisted 15 students	***The students in the Experimental group are divided into two groups of 21. The Control group also consisted of 21 students***
Experimental	**PeerAssessment**	After the work was completed each of the 16 members of the group evaluated the work of the other group.	Group A evaluates 16 pieces of work from the previous year and Group B evaluates the 16 pieces of work from the previous year (2007-2008)	***Group A evaluates 15 pieces of work from the previous year and Group B evaluates 15 pieces of work from the previous year (2008-2009)***
	Teacher's Assessment	The 32 pieces of work of the students were evaluated when they were completed.	***The 30 pieces of work by the students in the experimental group are evaluated (by teachers from the same academic year 2008-2009)***	*The 42 pieces of work by the students in the experimental group are evaluated* ***(by teachers from the same academic year 2009-2010)***

Note:
A.The student groups in all three academic years were considered to be of equal ability levels.
At the end of the research the work of the students who had worked with peer assessment and those who had worked in the classical way would be judged by a team of teachers.
B. The names of the students who had constructed the models were covered so that they were not visible to the teacher or to the other students (for both groups). Although each student had the opportunity to evaluate the works of the other students, none of them knew to which student the work he/she was evaluating belonged to, since all names were concealed.
C. In order to check if there was then any differentiation between the marking of the teachers and the marking of the student, teachers were selected to judge the students' work when they had finished their constructions altogether after all the constructions had been completed. We felt that this would increase the reliability of the marks since in this way there would not be simultaneous interaction of the evaluation of the students who had evaluated the work of previous classes and the evaluation of the teachers which took place after the end of the whole period.

VII. Criteria

The student evaluator had also to justify his/her evaluation in a few written lines, giving the reason for the particular mark he/she had given. The reason for this being that in this way each student would pay greater attention to the mark he/she would give.

7.1 Measurement.

In each case the marking scale was from 1-10.

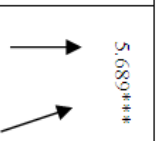
VIII. Results.

Wishing then to ascertain whether there was a differentiation between the abilities of the students who worked in the classical way in the Technology laboratory and those who worked using peer assessment, using Anova we made a comparison between the students in the academic year 2019-2020 who worked with peer assessment and corresponding students from the academic years 2018-2019, 2019-2020, who had also worked with peer assessment. Thus it can be observed that between the students from academic year 2018-2019 who worked with peer assessment and those of 2018-2019 and 2019-2020 who worked with peer assessment respectively $p=0.089>0.05$, and $p=0.07>0.05$ there is no statistically significant difference. But also between students from academic year 2019-2020 who worked with peer assessment and all the students from the same academic year who worked in the classical way, there is no statistically significant difference ($p=0.408>0.05$). Similar observations were made in the corresponding Anova comparison of the samples that worked in the classical way in academic years 2017-2018 $p=0.912>0.05$ and 2018-2019 where we have $p=0.733>0.05$.

Thus we conceive that there is no statistically significant difference. From the above it can be seen that we can consider there to be equivalence for the groups of students in all the academic years in which the research took place.

Then we attempted to compare the assessments made by the students who worked with peer assessment with the marks given by the teachers. As can be seen in Table 1 there is no year by year statistically significant difference (apart from academic year 2017-2018 where there is a difference between the marks given by the students and those given by the teachers. Thus also in academic year 2018-2019 (Teachers' assessment, sd=1.6 but the students' assessment was M= 4.98, Sd=1.98 t=2.28 p=0.043* <0.05 a statistically significant difference).

Table 1: Comparison of the assessments of student's work by teachers and by the students themselves (where peer assessment was applies).

Assessment by students who worked with peer			**Assessment by Teachers**					
Year when student assessment was made	**M**	**Sd**	**Year when Teachers' assessment was made**	**M**	**Sd**	**t**	**p**	**t (assessment by teachers)**
2007←2007	4.98	1.98	2006	5.083	1.6	2.28	0.043*	
2007←2008	5.833	1.403						
2008←2009	6.4167	0.79	2007	5.916	0.99	1.48	0.166	
2009←2010	7.00	1.78	2008	6.916	0.79	5.69	0.056	

Note 1: p<05*, p<0.05**, p<001***
Note 1: The assessment was carried out on a ten point scale.

In order to discern the differentiation in achievement between the students who worked with peer assessment and those who worked in the classical way they underwent assessment of their achievement by giving them the task of constructing a simple structure. Table 2 shows the marks given by the teachers to the students who worked with peer assessment and in the classical way. For example in academic year 2007 the average student achievement was M=4.7 Sd=2.8 (in the classical way of working) while the mark given to the students who worked with peer assessment (M=4.2 sd=1.2).

In this academic year there is no statistically significant difference. And also in the following academic year 2017-2018 there is no statistically significant difference (p=0.06>0.05) (Table 2).

Table 2: Results of the teachers' assessment of the two groups (peer assessment group and assessment of group which worked without peer assessment).

Students who worked in the classical way			**Students who worked with peer assessment**			
Year of assessment students	**M**	**Sd**	**M**	**Sd**	**t**	**p**
2007	5.33	1.49	5.083	1.6	0.453	0.660
2008	4.25	1.13	5.916	0.99	3.35	0.06
2009	4.416	1.31	6.916	0.79	6.5	0.000

Note 1**: p<05*, p<0.05**, p<001*
***Note 1**: the assessment was carried out using a ten point scale.*

Looking at Table 2 however it can be seen that although there is no statistically significant difference (p>0.05) the assessment averages of the students' work through peer assessment is greater than the average of those students who worked in the classical way.

There is a statistically significant difference in the quality of the models produced by the students working with peer assessment where p=0.000 in the academic years 2017-2018 and 2018-2019. Thus while the average teachers' assessment for the models of the students who worked M=4.0 sd =1.6, their assessment of the students who worked with peer assessment was M=7.3 sd=0.4.

There is also a statistically significant difference between the teachers' first assessment of the students' work and their final assessment (t=5.689***).

IX. Conclusions

Clear evaluation criteria were used for each model (Falchikov 1995). The student, based on the documented evidence, evaluated the works of his/her schoolmates' models from earlier classes and tried to create something new. The basic reason for the documentation, however, was not that we should get the students' opinions on how they evaluated their schoolmates' work, but that they should document the advantages or disadvantages of the models created by their schoolmates so that they could then construct their own models in a way that corrected the disadvantages, but included any of their schoolmates' correct geometrical construction. Such an approach agrees with the opinion of Orsmond, Merry and Reiling[16] Dochyet al..[4] Falchikov[9] that because of the non-existence of ambiguity the positive results of the entire process were maximized. Apart from the fact that the final mark that counted was that of the researchers it was once more ascertained that the students' assessment approximated that of the researchers.

-We answered to the instructions of Williams [11] who supported the notion of clear guidelines for marking as it makes the task more objective for students and thereby reduces any feeling they may have that criticism is personal. Thus the students who assessed the work of their schoolmates were from different classes (2016-2017) or even from different years (2017-2018 and 2018-2019).

As Freeman mentions [13] results from many evaluators produce unreliable results, so to avoid this possible lessening of reliability, apart from clear criteria the assessments were made by the same teachers in order to increase the reliability of the results.

X. Discussion

Our study offers some contributions to academic knowledge. Firstly, the study shows that students, using peer assessment as a tool, can achieve positive results in Geometry – it is sufficient that this is accompanied by some general principles. (1) It can put students in a position to draw together elements from the works of their schoolmates, using question techniques to establish the sincerity and care they bring to their evaluations, and also to the displays that they themselves have created. After the collection of elements from the work of their schoolmates the students themselves can then create their own work, altering the disadvantages of the older works. There should be clear documentation of the construction of a Technological work, and at the same time the criteria should be the same as upon the statement that peer assessment will take place.

The second contribution of our study is that it demonstrates to the researchers that their students, by peer assessment, can improve their expectations regarding their ability to accomplish Technological tasks which significantly influence their learning.

Although there was also a group that was taught in the classical way, there was greater effectiveness in those who assessed the works of their schoolmates, learning peer assessment through this process.

Each student had to observe all the other constructions of his/her peers. The process of undertaking focused observation required students to consider the processes involved in model construction and this expanded their knowledge of effective model construction. The examination of other models compelled students to examine critically and appraise the work of others and consider the effectiveness of strategies used in displays. The process of peer assessment in this lesson is considerably facilitated by the use of the models of others since, by looking at them, the students can more easily understand if one construction is better than another.

Through this process (peer assessment) the student develops an effective, coherent and lucid argument to support and/or substantiate the hypothesis or topic under discussion. At the same time the student can substantiate his/her arguments with articles, scientific publications, brochures etc. and use available theories, concepts and evidence to validate and appropriate new knowledge. He/she applies new knowledge in appropriate situations to solve problems, and improve and enhance performance and this can be seen in the models. (See also http://www.usdla.org)

We consider that a form of peer assessment can have positive results if the student can see what he/she is making (as happens in Technology) and can attempt to do better than what has been done by his/her schoolmates. Also, we consider that a significant role in this type of assessment is that the criteria of assessment should be continuously communicated to both the evaluated and the evaluators. Even in the Technology class the results of peer assessment on the students were significant, since group discussion in previous years of the research programme indicated that the construction and assessment of the models was a novel experience that the students enjoyed. It broadened their awareness of those topics, broadened their knowledge of model construction technique and extended their knowledge of approaches to teaching this same content. They felt that the process contributed to their practical knowledge; that is, they learned how to construct models while simultaneously learning about one particular area of the technology curriculum.

These observations and the ensuing discussions highlighted problems and issues associated with assessment and the subsequent marking of students' responses. The project also created opportunities for students to discuss the process of assessment within their own particular setting as they realized the breadth and

quality of items submitted. This gave many students a better idea of how their own work compared to that of their classmates, and, perhaps as a consequence, there have been no student-initiated challenges to the marks given – an increasingly important issue within the current work environment [6]

The new reforms that dictate the implementation of cost-effective practices may facilitate the adopting of peer assessment as a perceived economically-viable assessment alternative. This project has provided evidence that peer assessment provides a valuable learning tool for students. By being compelled to undertake constructive criticism, students are provided with a forum in which they must critically view and evaluate the item according the same criteria that guided their own model constructions. Through the construction of models, students became more cognizant about assessment, model construction, and other aspects of mathematics teaching.

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