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The merits of peer group review as a component in the assessment of design and technology project work in higher education

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Abstract
With the expansion of Higher Education, a number of institutional and national initiatives have encouraged the development of flexible approaches to teaching and learning. Methods which are used for the assessment of student performance have increasingly become a focus of attention. An important aspect of these methods concerns the provision of effective and efficient strategies for delivering high quality feedback to students, communicating performance levels and supportive advice.

In Technology education, a well established research strand has focused attention towards the assessment of design and technology capability, particularly linked to school based activities and examination performance. This assessment has concentrated largely on orthodox, formal methods.

The work that this paper reports concerns a small scale investigation and evaluation of the technique of peer group review in the assessment of design and technology project work. A cohort of fifty first year undergraduate students of a course Industrial Design and Technology was involved in the assessment of four practical design coursework projects which they had submitted.

Two particular aspects of peer group review are considered: the validity of student assessment in relation to parallel judgements made by academic staff; the perceptions which undergraduate students hold regarding the benefits and difficulties of this system of assessment. The paper seeks to identify the potential contribution that the technique of peer group review could make towards more effective and efficient assessment of design and technology project work from student and staff perspectives.

Introduction
This exploration of the use of peer group review in the context of the assessment of design and technology project work was largely stimulated by two key factors: student learning; efficient use of staff time. As the investigation has progressed, so the judgement regarding the potential contribution that the technique could make towards these two factors has changed.

To illuminate a number of reasons for looking towards the use of peer group review as a potentially useful component within the learning process in design and technology it is first worth examining some common aspects of task based learning. In this paper these are directed towards the author’s experiences with design and technology students.

Design and technology can be a powerful learning experience, in which active learning plays a major role. Active learning suggests students engaging more with their learning rather than being passive, generating specific outcomes (CVCP, 1992). In defining assessment criteria to support active learning, considerable care is required to ensure two key features: learning goals are defined from the student perspective; learning goals are supported through the process of assessment.

When considering how to approach a task with which they have been presented, individual students may adopt different strategies, linked closely to how they go about learning. Two identified approaches can be classified as a deep approach and a surface approach (Entwhistle, 1988). From a design and technology perspective, features which define these two approaches could be summarised as follows:

Surface approach
Concentration on and focus towards assessment requirements
An early move to final prototype modelling on the basis of limited design decision making

The use of known materials and processes
The use of a simple, essentially linear methodology for designing

Evaluation of the design prototype largely on the basis of function
Limited reflection on design decisions
Deep approach
Concentration on developing a viable design
Taking considerable risks when exploring and developing ideas
The use of research strategies to expand knowledge of materials and processes
Using organising principles to integrate ideas
Evaluation of the process of design as well as the product throughout the project
Relating design decisions to evidence based on the requirements of the task

In the search for more effective design and technology teaching, strategies that lead students towards the deep approach offer considerable potential for effective learning. Assessment can be an opportunity for encouraging students towards adopting these deep approaches (Race, 1991). In particular, peer group review could provide students with a different perspective on their work, highlighting the need for a more substantive consideration of how tasks are approached. This may, potentially, lead to an improvement in the quality of decision making and hence the quality of design outcome in whatever form this might take, prototype, three-dimensional form model, drawing etc.

For many students the transitions between GCSE level, Advanced level and Degree level work frequently occur with a corresponding failure to assimilate the appropriate levels of achievement required and, importantly, the role of assessment in the learning process. The changing role of assessment in the learning process between these differing levels is often un-clear to the students, leading, in many cases to in-appropriate assessment submissions, poor marks and subsequent de-motivation.

These difficulties in making the transition between different levels of assessment ensure a lengthy period of adaptation and re-orientation when learning can be severely inhibited. Some students maintain an approach orientated towards satisfying simple performance goals, achieving specific targets or outcomes, similar to earlier levels of activity. Others take a more mature view of assessment, leading towards an approach characterised by the adoption of learning goals. This reflects a deep approach to learning as opposed to the surface approach of those students who generally show performance goal orientation (Weiner, 1992).

For many students considerable tension exists between a strategy that is likely to be effective in obtaining a good assessment grade and one that allows them space in which to learn about different approaches to designing. Increasingly, risk is a rare quality in the work of young designers: if the outcome does not match the assessment criteria, usually defined as indicators of specific, categorised performance such as planning, manufacture, evaluation, then failure is often the result, both in terms of the grade awarded by the tutor and the perception of the student. A degradation in self-esteem and peer group position will frequently ensue, actively encouraging the student towards less risk and a sharper focus on meeting the criteria for assessment. As these criteria are frequently linked to performance goals, deep learning is not positively encouraged.

In the circumstances described, many students find themselves in a position where the lack of actual progress and achievement result in overload: they simply cannot see how to match time requirements against their need or desire for more effective learning. The consequence of perceived overload is to reinforce the adoption of surface approaches to learning: many students adopt coping strategies which rely on the application of unthinking approaches in problem solving. As a result, students perceive their measured learning progress to be poor, reducing confidence and increasingly driving them towards matching their output to the assessment criteria in order to be seen to be achieving.

The technique of peer group review could contribute to the transition of student learning towards achieving a deep rather than a surface approach. It affords an opportunity for students to reflect and test their work singularly against a set of criteria, whilst receiving an assessment of their relative positioning in the class group (Moore, 1994). Most importantly, students are exposed to a wider learning experience:

- students see their work in relation to others, obtaining a view of their strengths and areas for development both in overall terms and with regard to specific phases within the design cycle;
- the observation and investigation of other styles of working is an intrinsic feature of this approach, encouraging reflection;
- the procedure of assessment is clarified to students, including the definition of assessment criteria;
- students are asked to make critical, qualitative and quantitative judgements about design and
practical work.

In addition to the potential improvement in learning, initially, it was envisaged that the more significant gain would be in developing an assessment framework and subsequent process that would be less time consuming and more effective from a staffing perspective.

Organisation of the study and methodology

Peer group review was used with four short individual projects completed by first year undergraduate students. Concentration was towards the assessment of two major elements: the design work; the practical outcome that had been generated. The year group was divided into groups of five students who were given the task of assessing five project submissions from their peers. Assessments for each piece of student work were made by the group.

The first of these project assessments was used by the author to highlight issues associated with organisation and interpretation. For the last three project assessments, the marks that were awarded by the groups were used to compare student grading to that of the two members of academic staff who had also assessed the work. A number of key organisational factors should be mentioned:

All students were divided into groups of five, using alphabetical lists. They were then asked to assess the individual work from a different group that contained none of their own submissions. In this way all the work assessed did not present potential difficulties caused by ownership within the group.

Criteria for assessment were clearly described to each person within an assessment group. Different levels of achievement for each of these criteria were specified in terms of statements that the students could refer to whilst making judgements. A mark band was indicated for each level of achievement.

All the materials were explained and discussed with the whole class prior to the assessment taking place.

A strict procedure was adopted for the process of assessment.

First, the work was placed in what the group considered to be the rank order. The judgement was concerned with the design and practical work, according to the general ‘feel’ for the work which the group discussed. This was a form of ‘gut reaction’ to the work.

Marks were then allotted and discussed by the group according to the assessment criteria and performance statements for each piece of practical work.

The design work was then divided amongst the group. Each student looked in depth at one piece of work. This work usually took the form of folio’s, logbooks, physical models and reports.

The design work of each student was then discussed, with the person who had looked at the evidence highlighting what they considered to be aspects that met the criteria for assessment. Both during and following this discussion marks were awarded for each piece of work.

On completion of the four exercises, all students who participated in the activities were sampled using a questionnaire to consider the reaction of the student body to a number of key factors. The questionnaire had been previously trialled with a small cohort in order to identify and eliminate as many interpretational and organisational issues on the forms used. The questionnaire is reproduced in Appendix A. It sought to address a number of key areas relating to the assessment mechanism and the extent to which peer review changed individual students approaches to work in design and technology. These can be summarised by the statements below.

The extent to which peer review affected the following personal factors:

- the setting of higher standards;
- individuals awareness of their own position in the rank order of the class;
- an improvement in overall performance when designing.

The mechanics of the exercise:

- clarity of assessment criteria;
- ease of allocating marks;
- ease of placing work in rank order.

Between five and seven questions were used to assess each of these key areas using an ordinal scale. As an assessment of reliability, positive questions were set with negative questions. Reliability was checked during the coding of the responses by inverting the grading applied to negative questions. Two students who showed unreliable responses were removed from the test results.
Results: Accuracy of numerical grading
The results of the peer group mark allocation and grading compared to the awards made by academic staff are shown in figure 1.

In the graph comparing percentage differences between mark allocations, two key points are noticeable (fig.1a). First, student marks were more comparable with staff when considering the practical outcome as opposed to the design work. This may be linked to a number of factors; most likely, that the experience students have of assessing practical outcomes and evaluating products is more extensive than their experience of evaluating and differentiating between different design work. The practical outcome can be immediately tangible, with little or no need to search for evidence to support the mark awarded. By comparison, assessing design work needs a more experienced judgement linked to evidence that may be obtained from sifting the design folio or log book. Second, the percentage differences between staff and student marks are noticeably different, especially in relation to design work but also regarding the overall score. Clearly, this range of error is not tolerable and highlights a key problem in passing assessment over to peer group review.

This latter point is highlighted by comparison of the grades awarded to individual work (fig.1b). Only thirty seven percent were within plus or minus ten percent of the overall mark and therefore equal in grade to that awarded by academic staff. If one takes a tolerance of plus or minus one grade then ninety one percent of the cohort are covered. Should this tolerance be acceptable within the constraints of the project and its significance within the assessment profile for the whole course, then some reliability can be demonstrated. Only four candidates were outside this one grade tolerance band. The one candidate who was marked three grades in error submitted work of a very low standard, graded by both staff and students as failure, but with widely differing actual grades.

Results: Questionnaire responses
In considering questionnaire responses regarding the personal contribution that peer group review made to improving their work the author looked for a positive or negative skew to the data collected. This data is presented in figure 2 overleaf.

The general response to the question of whether peer group review led to setting of higher standards for each student shows positive skew, balanced symmetrically between practical work and design work (fig.2a). This is encouraging, for whilst students exhibited initial reluctance towards the idea of peer assessment the learning benefits appear to have been significant. This assertion is supported by the graphs showing perceived improvement in overall performance in design and practical work (fig.2b). A strong, positive skew is evident in this data.

It was anticipated by the author that students would gain a better appreciation of their rank order position in the class through engagement in the assessment process. This was not confirmed by the data collected, a neutral characteristic being evident (fig.2c).

A similar trend, positive, neutral or negative skew was sought in the data collected regarding the mechanics of the peer review sessions to confirm student response to this aspect of the assessment. This data is presented in figure 3 overleaf.

It was encouraging to note a positive skew in the data relating to whether the criteria for assessment were clear to students during the assessments (fig.3a). Time was spent explaining this aspect of the work and it appears that the majority understood the assessment criteria.

The data regarding allocation of marks to both practical and design work also shows a positive skew, suggesting that the majority of students felt comfortable in dealing with this aspect of the assessment (fig.3b). However, by implication this does not confirm a correlation with staff assessments.

With regard to placing work in rank order, no positive trend is evident from the data presented (fig.3c and fig.3d). Neither overall, nor at the higher, middle and lower grades of achievement was there any indication that students found this aspect of the exercise relatively easy to complete. Indeed, especially at the middle grades student response shows a negative skew, suggesting considerable difficulty in discriminating between different pieces of work. This was surprising to the author, who had anticipated that during the assessment, an initial rank ordering of the projects would provide students with a easy mechanism to sort the work, leading on to a more detailed consideration and the allocation of marks.
Figure 1: Mark and grading performance - staff/student comparison

2a: Improvement in overall level of performance

2b: Setting higher personal standards

2c: Awareness of position in the group

Figure 2: Student perceptions of the benefits arising from the peer review activity
Figure 3: Student perceptions of difficulties within the peer review activity
Discussion

In terms of validity, this small scale study has shown that if a general grading system is required, with either wide grade bands or pass/fail categorisation then peer group assessment can provide a reliable indication of whether work submitted is acceptable or not according to stated criteria. In this framework, applying a numerical grading system could allow staff to focus on work that is near the borderline between pass and fail. However, where accurate judgements concerning relative levels of performance are required, peer group assessment cannot be expected to be reliable in comparison to assessments made by academic staff. This view confirmed that held by other researchers (Boud, Churches and Smith, 1986) working in similar, design related disciplines (see also Boud and Falchikov, 1989).

The move to peer group review and assessment can have positive effects on the quality of student learning. In particular, the evidence from this study would suggest that it encourages students to set higher personal standards for both practical and design work. Additional learning benefits that could be evident but which were not investigated include the encouragement of risk taking in a design project, moving away from a culture of achievement based on assessment criteria to one where the quality of the design outcome and student learning are the main foci.

Peer group review may encourage academic staff to allocate less time to assessment and more time to tutorial and personal support, developing student learning through verbal feedback and comment rather than the more conventional schemes of written comments and numerical grading. This is especially important in design and technology, where discussion related directly to a model or design folio provides an essential strategy for effective learning. Additionally, peer group review and assessment can be used to signal a different relationship between lecturers and students. This has the benefit of breaking the traditional pupil-teacher relationship that students associate with assessment in schools at GCSE and Advanced levels. A collaborative or partnership role is projected (Andresen et al., 1992).

In terms of validity and acceptability, it would seem desirable for peer group review to become part of the culture of a course, from the very beginning rather than as a later addition (Entwistle, Thompson and Tait, 1992). Students should be encouraged to use this method of assessment to develop a deep approach to learning, rather than concentrating on narrow performance goals or outcomes, giving scope for exploration of design methodologies, personal style, creative flair and imagination.

More work concerning the effectiveness of this technique in design and technology needs to be completed before any improvements in student learning strategies can be confirmed. In addition, student perceptions of this approach to assessment warrant further investigation. From the data collected in the questionnaire, it is clear that students experienced difficulties in making specific judgements. These were largely concerned with numerical mark allocation, a problem which is frequently evident in design and technology assessment given the often subjective nature of judgements concerning both product and process.

Issues arising from the response of students to the exercise needs to be addressed early in a course. In tertiary education this means the first term of the first year if a shift in culture is to be achieved. Answers to questions that students may raise linked to assessment methodology are straightforward to provide and rely on the effective management of the exercise by staff. More wide ranging discussions concerned with why this approach to assessment is being taken require more careful consideration. Indeed, students need to see the benefits of this approach before they firmly commit themselves to full involvement. ‘Peer assessment fatigue’ is also a potential problem that should be highlighted. Whilst the technique is useful, it is acknowledged that a course should adopt a balanced approach to assessment.

Conclusion

This work has convinced the author of the potential learning benefits that peer group review can engender amongst first year undergraduate students. In particular, it is felt that students can be presented with a series of design tasks which, when assessed, will encourage the adoption of a learning style that does not necessarily focus on tangible performance indicators or outcomes relating to specific assessment criteria.

Peer group review can certainly offer a significant opportunity for improvements in learning style. Correspondingly, it can involve staff in more preparation in order to manage the activity, whilst not necessarily reducing the marking load. The perceived reduction in the allocation of staff time to this style of assessment is not necessarily delivered in practice. Therefore, it is felt important to pursue the potential learning benefits of this approach to assessment, whilst developing more effective and efficient organisational frameworks that may, when
refined, effect a reduction in staff time

Students need to experience this approach to assessment early in their design course if they are to accept it as a part of the normal framework of assessment. In this culture, students would be more likely to take a deep approach to learning than if they were only exposed to traditional means of assessment. It is clear that further development and refinement will be necessary if the full potential of the approach to assessment is to be realised.

References

Please could you complete this short questionnaire to help with my research.
The information which you provide on the form will be confidential and will only be used for statistical analysis.
No marks for your projects will be changed as a result of your answers.

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Unsure</th>
<th>Disagree</th>
<th>Strongly disagree</th>
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Name

Time started

7th March 1994

Looking at other peoples work encouraged me to set higher standards for my own design work

The worst work was easy to place in order of attainment

As a result of the exercises in assessment I now understand which criteria are used to assess my design work

A wide range of attainment was evident in the work

I did not know why I was giving marks to the practical work, I just guessed

The best work was easy to place in order

I felt confident that I had given the correct marks to the design work which had been assessed

My design work was generally worse than the work which I assessed

Assessing practical work has not made me set higher standards for my own practical work

I found it difficult to decide which of the work was the best and which was the worst

The standard of my own design work has improved as a result of assessing other peoples projects

Assessing other peoples work has shown me how to improve my practical work

I did not find it easy to place the worst work in any sort of order of attainment

After assessing other peoples design work I still do not know where I rank in relation to the rest of my peers

I now set lower standards for my practical work after assessing other peoples practical work

It was easy to give marks to the design work because I understood what the marking criteria were

The standard of my practical work is higher than that of the majority of the group

The practical work was difficult to judge as I did not know what I was looking for in order to give high marks

Having marked other peoples work I now know why I sometimes get good marks for my practical work

I have not changed my standards of performance in design as a result of assessing other peoples work
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<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Unsure</th>
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<th>Strongly disagree</th>
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<tbody>
<tr>
<td>Peer assessment has taught me nothing about how to improve my designing</td>
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<td>As a result of assessing other peoples design work I now have a more realistic understanding of where I rank in relation to my peers</td>
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<td>It was difficult to assign marks to the different levels of design work</td>
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<td>Assessing other peoples work has not made me set higher standards for my own design work</td>
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<td>The work in the middle was difficult to place in order</td>
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<td>I do not know how my practical work ranks in relation to the rest of the group</td>
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<td>I found it very difficult to decide what I was looking for in the design work</td>
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<td>Looking at other practical work has made me set higher standards for my own practical work</td>
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<td>No difficulty was experienced in placing the best work in rank order</td>
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<td>Giving marks to the practical work work was easy because I understood what the marking criteria were</td>
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<td>As a result of assessing other peoples work I now set lower standards for my own design work</td>
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<td>I did not know why I was giving marks to the design work, I just guessed</td>
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<td>It was difficult to assign marks to the different levels of practical work</td>
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<td>My practical work is of a high standard in relation to the group</td>
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<td>The work at the higher level of attainment was easy to place in order</td>
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<td>Much of the work appeared to be of the same standard</td>
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<td>Practical work is assessed according to criteria which I now understand from assessing other peoples work</td>
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<td>My practical work will be no better as a result of assessing other peoples work</td>
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<td>It was clear which order the work in the middle of the assessment should be placed</td>
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<td>Whilst I was marking I knew what I was supposed to be looking for in order to give high marks to good design work</td>
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I found it difficult to decide where to place individual pieces of work in an overall rank order
I have learnt about how to improve my designing by looking at other peoples work during peer assessment
The standard of my practical work needs to improve in relation to the rest of the group
In the middle range of attainment it was difficult to place the work in order
It was not clear what I was supposed to be assessing in the design work
I felt confident that I had given the correct marks to the practical work
From assessing other peoples work the criteria which are used to assess my design work are clear to me
Work at the lower level of attainment was easy to place in order
Allocating marks to the design work was easy
My design work was generally better than the work which I assessed
Assessing other peoples practical work has shown me where I rank in the class
It was not clear what I was supposed to be assessing in the practical work
Allocating marks to the design work led to inaccurate results
Looking at other peoples practical work has encouraged me to set higher standards for my own practical work
When I marked the practical work I knew what I was supposed to be looking for in order to give high marks
Placing the whole set of work in rank order was easy to do
It was easy allocating marks to the different levels of practical work

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**Time finished**: 7th March 1994

Thank you for your help