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Keyword: group dynamics; random group quiz template; virtual groups, electronic voting system; eye-contacts; group

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Abstract

A quiz template is developed keeping in mind the group dynamics to engage and encourage group work activities among E&T undergraduates. The Microsoft® Excel VBA programming was used to create random instant virtual groups (IVGs) and to select random questions. Although the IVG quiz selects group members randomly, yet the programming enables "controlled" reoccurrence keeping the entire class in alert state (i.e. allowing previous members from other groups to reappear and regroup). During the quiz, a small group cooperatively engaged working towards solution and at the end of each quiz question each group member is peer assessed by entire class following pre-set rules of engagement. At the end of quiz, the analyses are auto-plotted showing individual and group contributions flagging out, the best, good and the poor performers. The developed quiz workbook can be easily adopted for the reuse in any group assessment activity by simply changing the attendance list and question bank. The quiz template was used in piloting an epistemological study of various taught modules at different programme levels in various pathways of MEng-BEng and MSc Engineering programmes. The results of a survey analysing the effectiveness of such IVG quizzes using Chi-square test predicted an overall 71% net positive student's responses with an average above 59% for various programme levels. Furthermore, the data analysis suggested that Level 4 and MSc cohorts comparatively need more tutor support in their group work as they have limited exposure to group dynamics. The significance of eye-contact and positioning of peers in-classroom randomised IVGs were also studied, which revealed that increasing separation between peers and their obscured locations obstructing their eye-contacts show adverse effects on group homotopy recommending maximum five members in an IVG creating effective cooperative communication. The random IVG quiz is tutor centred activity and mainly designed engaging students in-class active learning, and is suitable for small to medium class size of 30-35, nonetheless, large cohort size can be supported by splitting in batches.

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1. Introduction

Many Engineering & Technology (E&T) graduates having received better grades might face difficulties in real life demonstrating group or team related aspects mainly because they do not get enough opportunities in E&T institutes to engage with people acquiring experience of negotiation; arbitration; conflict

management and leadership qualities necessary for group work or teamwork. In addition, most employers in several job descriptions keep teamwork and/or group work on their top of the agenda and therefore E&T professional and accreditation bodies demand universities to equip graduates with these desirable skills. The Engineering Council UK, engineering professional bodies (i.e., IET, IMechE, RAE, InstRE, RAeS, etc) and leading industry employers insist upon promoting group work activities among E&T students. Recent government's initiatives on university education and sustainable employment can be seen as steps forward in bridging the skill's gap. These initiatives include, introduction of mandatory Degree Apprenticeship Programmes (DAP) levy; and voluntary teaching excellence framework (TEF). In both, DAPs and TEFs, the higher education institutions (HEIs) heavily support student's cause (Crawford-Lee, M. S., & Crawford-Lee, M. S., 2016). Despite some criticism, the TEF will evolve and emerge as a qualitative measure covering various parameters that students care about, including, enhanced quality engaged teaching, promoting collaborative and cooperative learning. In various E&T disciplines, group work activities are designed encouraging students to learn from and with each other in groups where both, students and staff involve in interactive stimulating learning environment. These can be resource intense activities but students truly explore various *group dynamics* enhancing their problem solving capabilities and developing team building characteristics. Group dynamics describe the way members interact with one another. It is a set of behavioural and psychological processes that occur (eventually and/or accidently) within a group or between groups, include various parameters depending on the nature of groups, learning environment, cultural background, development factors, interrelations with individuals and other groups etc. The positive group dynamics promote team ethos and the poor or negative group dynamics thwart the groupwork performance. Although groupwork and teamwork can be seen as two different entities from 'business' point of view[1] but since both these essentially have same impact on the industry, therefore, in most E&T academic exercises various group and team fundamentals are mixed and their learning outcomes (LO's) are assessed accordingly. Therefore, in this study the phrases group, team, group work and group-work, teamwork have been used interchangeably. Unfortunately, many E&T students do not comprehend the importance of group work and their dynamics in their programme of study but acquire such interdisciplinary knowledge from various group activities, assignment submissions besides achieving subject-specific intended LO's. Consequently, they suffer more when they get trapped individually, encountering confusion; isolation; demotivation; incoherence and learn more about group dynamics from their costly mistakes in

[1] A group may comprise three or more individuals becoming a distinct unit or department working independently of each other to achieve their organisational goals. The members have a shared knowledge of the group's objectives, but specific tasks or responsibilities are assigned to different individuals. In contrast, team members (may be of same size as group) collaborate together on a set schedule achieving the project aims. Teams are often formed for temporary assignments with one specific desired goal. Teams can avoid potential problems early on in a project because team members are actually experts from various departments. For instance, a team of only engineers may create a new product with basic feasibility study, but may not cover more sustainable business analysis (i.e. return on investment, ROI). Therefore, having a finance expert within the team will help the engineers to create an affordable sustainable product in the first place, saving time and resources. Teams can be very productive and rewarding as it involves people with different talents and ideas converting problems into opportunities for innovation. *Adapted from Web article by*: Robin Fritz, "Differences between group work & team work".

group work assignments.

This study presents the design and development of randomised 'Instant Virtual Group' (IVG) quiz template helping to engage E&T undergraduates in classroom activities to participate and practice various group dynamics without these being mentioned. The quiz generates real-time small random group(s), required number of questions from the given list and the group members cooperatively workout solutions. There is a common consensus on optimal 'small' size of a group such that under five will compromise on diversity and interpersonal interaction, whereas with more than eight members in a group, the contribution from some individuals may start declining (Taylor, A., 2011, & Dennick, R, 2004). In cooperative learning, a small group is provided a platform where learners actively participate, respecting each individuals, valuing each other's contributions and celebrating diversity. The members draw upon their past experience and knowledge, and expected to invest in their own learning. They work together rather than competing with each other. In such interactive environment, sometimes tutor becomes learner and learners sometimes teach. Nevertheless, it is crucial that aim and objectives should be clearly identified and used as a guide. The questions must be relevant, interesting and level appropriate to challenge students' learning targeting desired skills-set for resolving conflicts as these arise. The IVG quiz template uses a group of five but can be adjusted to any number[2]. The tutor invites selected IVG groups on their turns to discuss their subject specific knowledge and also demonstrating group co-ordination, communication and critical thinking skills. The peer assessment is conducted for each group member at the end of an IVG question session. Finally, towards the end of IVG quiz, the tutor concludes the IVG quiz giving the analysis of each individual's contributions towards their group achievements, highlighting importance of various factors affecting the group cohesion.

Although there are several offline/online virtual learning environment (VLE) software (i.e. Blackboard®, Moodle®, Canvas®, StudyNet® etc) and third party automated quiz assessment tools (i.e. QMP: TodaysMeet; Padlet; Mentimeter; Kahoot; Quizizz; ThatQuiz; GoConqr; ClassMarker; Edmodo; Scorative, Google-Flubaroo; etc) capable of developing customised professional random quizzes offering instant personalised assessment and feedback but these may not generate instantaneous random groups. The main strength of aforementioned type quizzes is based on pre-set groups and online/offline or in-classroom real-time individual marking and feedback analysis based on electronic voting system (EVS). These are very useful in individual assessments and feedback or statistical analysis of the surveys or comparative analysis of depth of knowledge of an individual. Some of aforementioned quiz tools can be used in simultaneous assessment of multiple groups within a class but it requires use of personal mobile phone devices, generation of serval codes, and above all the class-management requires more time, causing disengagement and class disruption. Furthermore, it is not possible to modify or adapt these commercially viable quiz tools for groupwork, engaging a small random group (i.e. five members) in an activity and simultaneously keep remaining (i.e. not participating) groups in state of readiness. Similarly, most of VLEs incorporated quiz

[2] There is no limitations with generation of the large numbers but the implementation in real class environment puts the bar (*for more details, see Appendix B3*).

tools can be very useful in collaborative learning activities, however, these cannot be used to encourage vulnerable students engaging them in 'face-to-face' in-class group activities.

Equally important is for staff to be more involved in developing and managing students in 'real-time' rather than just relying on resources, staff should get *interactively* engaged in cooperative learning with students since with the advent of live Internet messengers, automation technology, distance learning, on-campus/off-campus, management information systems (MIS) and VLEs are more likely to be integrated as 'all-in-one' product and therefore more courses and their groupwork assessments will be pushed into online 'cloud-based' environment creating fewer opportunities for physical meetings. This is evident from Google for Education, the College Level Examination Program (CLEP) and Massively Open Online Courses (MOOCs) type educational systems predicting a major shift in future E&T disciplines where students may not require to attend the traditional institutions on full-time basis but might physically attend only selected modules for onsite premises few contact hours per week. Many non-E&T institutions have started this migration and E&T institutes will follow sooner, rather than later.

Research suggests that both cooperative and collaborative learnings can be practiced in classroom environment for deep learning using multiple approaches (i.e. individual, group or combination of both). These bring positive results for individuals getting good grades, improved self-esteem and higher motivation. At the same time, cooperative learning helps students becoming actively and constructively involved in deeper understanding of content and take ownership of their own learning, resolving group conflicts, besides improving teamwork skills. Recent HEA survey on student academic experience[3], identified that the students value their *collaborative* and *educational relationship* with the university, and students want this relationship to be *personal* (Goold, A., Craig, A., & Coldwell, J., 2008). Therefore, it is crucial for E&T staff to engage students in real time 'face-to-face' small group activities preparing them for professional skills that are more difficult to learn remotely or collaborating online.

The randomised IVG quiz template is user friendly, easy to implement and does not require any complicated software for the operation or restructuring for any taught module. The tutor's input is the key to the delivery mechanism where students benefit from tutor's knowledge, skills and abilities. During the quiz sessions, tutor helps students to understand the importance of cooperativeness and collaboration within the groupwork, team's efforts and consequences of not contributing to the group. Such IVG quizzes were used by the author in an epistemological pilot study encouraging good practice of groupwork in various cohorts and pathways of different programme levels (i.e. Level 4 to 7) in Electronics and Communication systems Engineering (ECE) division. The quiz template was used in different teaching and learning sessions, including, induction week; introduction to module; tutorials on lectures and final revision tutorial for examination preparation, etc. A feedback survey and analysis are also presented in this study supporting the possible use of such quizzes in various taught modules promoting positive group dynamics in E&T students, whilst achieving intended learning outcomes.

[3] http://www.universitiesuk.ac.uk/blog/Pages/What-do-students-want-from-their-university.aspx

1.1 Literature Review: Group work Design, Assessment and Edutainment system

Several aspects of groupwork can be divided into two main areas. The first thing that any group would consider is 'the product' (i.e., what is the job to be done?). The second one is 'the process' defining how the group should work together. It is important that the group must act as one unit accomplishing all tasks to achieve desired learning outcomes (LOs). In E&T groupwork depending on the objectives of an assignment, both 'process' and 'product/service' related skills must be assessed, and finally the group performance can be translated into grades, -individual; -group; or -combination of both, respectively. For example, in a project or laboratory based groupwork, an assessment comprises of several components for fair and transparent distribution of marks (i.e., literature review, experimental design & planning, analysis/interpretation of results, technical discussions, besides considering personal individual performance, motivation, and communication factors, etc). It is important that the assessment criteria must synchronise all the parameters of three inter-dependent vertices of 'assessment triangle', e.g., cognition, observations and interpretation. Therefore, for any cooperative and/or collaborative type of groupwork, it is necessary to make assessment as a method of reasoning from evidence.

Besides designing the programme specific and level appropriate group activities, the academics have responsibilities to ensure stimulating environment for effective learning. The 'system theory' describes the behaviour of individual(s) within a system putting each individual under spotlight. However, it may not be possible to achieve all the positive group dynamics by just summing up the individual characteristics of each group member but one must address the potential issues associated with the methods of 'engagement' and 'learning', respectively. Furthermore, the sustainable learning involves cycles of 'action' and 'reflections', during which learners should feel accountable and must question their actions, reflecting on their assumptions, and committing to new actions (Wankel & DeFillippi, 2005). Designing *effective* group activities and composing a group with defined roles and responsibilities are crucial to successful product & service delivery (Edward et al., 2006; Palmer & Hall, 2016; Springer, Stanne, & Donovan, 1999). It is more challenging in E&T disciplines to design various interesting, stimulating, value added groupwork activities covering diverse range of applied E&T subjects. In most universities, the tutors, module leaders (MLs) and programme leaders (PLs) jointly develop various strategies and design group work activities and reuse the same developed resources next time around after internal/external moderation process (i.e. ensuing Quality Assurance procedures). It is possible that some tutors may exploit group work to reduce the overall 'labour' required in assessment and feedback, and such abuse can be discouraged if the group work is designed with approperiate assessment strategy, making overall process simple, fun and engaging.

It is widely accepted that the random selection of students in making groups inspires diversity where different cultural backgrounds, gender, expertise, skills, etc are *forced* to work together. Such random selection may comparatively benefit everyone achieving the desired set of specific LOs, besides developing strong bond with entire class, mastering communication skills (Colbeck, Campbell, & Bjorklund, 2000; Rienties, Alcott, & Jindal-Snape, 2014). However, some criticises randomised grouping concluding that few groups may function effectively whilst many may become dysfunctional due to poor group dynamics (Bussman, 2014; Mills, P, 2003; Lencioni, P, 2006). In worst-cases, the student's group leader and/or team members could easily cause potential poor group dynamics (i.e., jokes, bad attitude, distraction, irrelevant

talks, drift or diversion from agenda, monotonous activities, boredom, isolation, low self-esteem, etc). The poor group dynamics and their root causes are well known to educationists who develop strategies making a team functional and cohesive, however, the required level of efforts varies from one discipline to other. The author in Reference (Lencioni, P, 2006) and the *online team assessment product developer*[4] have worked on a model identifying five dysfunctions of a team, given in Figure 1. The authors concluded that because most group leaders (and managers) are not schooled in the *art of building teams*, therefore if small problems are left untreated then with the passage of time, these misconceptions further lead to conflicts, resulting in massive financial losses and business scandals.

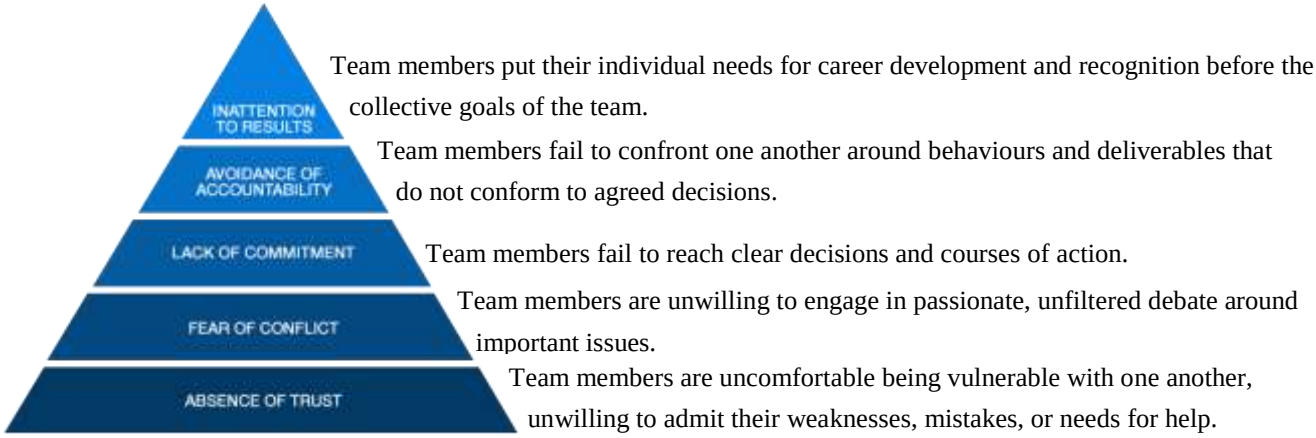


Figure 1. Conceptual model describing five dysfunctions of a team (Lencioni, P, 2006).

The full potential of randomised groups' activities can only be realised if the criteria of marking and assessment are made absolutely clear to both learners and assessor, as well (Council, N. R, 2001). Furthermore, the instructions and guidelines should be 'friendly', level appropriate and moreover the wordings used in the instructions must be andragogic and free from pedagogic jargon.

It is important for students to explore and evaluate their team's characteristics, such as: Strength; Weaknesses; Opportunities and Threats (SWOT). Such analysis helps undergraduates to recognise and convert their weaknesses into strengths by using available resources and opportunities whilst troubleshooting problems (Kashan, 2011; Fine, 2009). The SWOT analysis can best fit with various well-known group strategies enhancing the groupwork. The SWOT analysis can be broken down relating to the most commonly used team building strategy, given in the Reference of (Manktelow et al., 2015).

i. Know your team (SW)
ii. Tackle problems quickly with good feedback (OT)
iii. Define roles and responsibilities (SW)
iv. Break down barriers (OT)
v. Focus on communication (S)
vi. Pay attention (T)

There are several other useful analyses that may be used to define, planning; development and concluding

[4] https://www.tablegroup.com/teamwork

stages of a work (i.e., feasibility study, Gantt chart, etc) or to evaluate team's contributions, such as; 'Pareto's Principle' also known as 80/20 rule suggesting that for many events, roughly 80% of the activities yield 20% of profit. This is widely used in the analyses of contributions and decision making process where it is thought that the ideas within the group are always imposed by one or two individuals. The 80/20 rule may accept some deviation in favour of random partitioning variables such that the sum of two variable remains 100, for example; 90/10 or 70/30, etc (Lipovetsky, 2009). If these two variables are further extended to ratios 60/40 or 50/50 etc, then most of fundamentals will favour the SWOT analysis. These analyses, however are more useful in the final stages of a group work but students must be enlighten about such analyses in their group work in particular for their peer assessments.

Peer assessment involves students taking responsibility for assessing the work of their peers against set assessment criteria. This is more important in group work reflecting on individual's contribution affecting the overall team's achievement. In the proposed IVG quiz, a *formative* peer assessment is introduced encouraging students to explore 'assessment for learning (AfL)' skills, and drilling for their future summative peer assessments. There is enough evidence that such practices benefit most students when AfL principles are implemented in classroom environment (Panadero, E., 2017). With large group size in a classroom environment, the quiet students tend to get less airtime. The same could be true with the small groups if members are widely dispersed in the large cohort size, easily cause poor group dynamics. In such cases tutor should create suitable environment ensuring that every member gets equal opportunities for talking and being listened to. The tutor can easily achieve this during lecture or tutorial sessions by talking and walking through the partitioning space (i.e. gaps) in the classroom whilst uses wireless remote control pointer executing the slides show. Such responsibility is shifted onto 'group leader' for establishing effective communication within the group whilst focusing on the question. However, a group leader has limited freedom in classroom groupwork or meetings (i.e. cannot move away from the desk but can only twist and turn body or neck around) to establish contact with peers. This could adversely affect the group dynamics, in particular the group cohesiveness. The cohesion is an important factor in group work that is multi-faceted process helping to achieve bond between group members, mainly linked to social relations, unity and emotions. In addition, eye contacts and positioning of peers play pivotal role harmonising positive group dynamics. It is a universal truth that eye contact and interpretation of facial expression between two people establish a social link and a conduit for non-verbal interpersonal communication including salient and emotional information. This has been verified in a neuro-scientific study that these two features help synchronising thought process during a live eye-to-eye contact (Hirsch, J. 2017).

During the various trials on randomised IVG quizzes, factors affecting group cohesion were studied and some of these were linked to eye contacts, positioning and physical location of group members. Therefore, terms '*Homotopy'* and *'Homology'* were introduced in the group work analyses to further study their impact on individuals within and across random groups. Their fundamentals are subsets of 'combinational' algebraic topology, which deals with formation of space, shapes and their constructs due to interaction of members. Simply, homotopy can be defined as a *continuous transformation from one function to another*[5]. Two mathematical objects are said to be *homotopic* if one can be continuously *deformed* into the other. For

[5] Weisstein, Eric W. "Homotopy", http://www.mathworld.wolfram.com/Homotopy.html

example, the real line is homotopic to a single point. In IVG *group theory*, homotopy can be extended to characterise the individual efforts (i.e. contributions) to transform into overall group's performance. The term homology (or co-homology) in relation to homotopy can be defined as the *'degree of similarity' or 'having similar relation'*. In IVG analysis, this term was used considering that all members have had same '*homologous'* status and therefore each member in random selection is interchangeable, and therefore anyone can be randomly picked as group leader. Furthermore, leader has no supremacy but will still be assessed on the same marking criteria. This is further discussed in Section 2.4.1.

Engaging people in groupwork is challenging but at the same time it can be more rewarding and interesting if the learning activities are based on *edutainment system*[6], creating a system where learners are engaged in learning process without boredom and would still like to continue the process feeling like they were playing their favourite game. Making a teaching session like playing games, motivates students providing stimulating environment and furthermore it enhances their learning if they are offered immediate '*feed-forward'* type helping feedback. Such edutainment type groupwork helps those individuals who may not respond accordingly to pure pedagogical approach or instructions that they do not perceive as engaging.

Some approaches given in the references (Neo, M. 2009; Bodnar, C. A., 2016; Takyar, D. K. 2015) encouraged author to develop IVG quizzes employing constructivist learning environment, turning students into 'active learners' and experiencing various group dynamics. Most of the IVG quizzes can be delivered in classroom environment using multimedia screen projector, Microsoft Excel spreadsheets, electronic voting system (EVS) clickers and PowerPoint slides designed with TurningTechnologies®. The tutor and students are engaged as a team exploring domain of the given subject, offering students chance to use their knowledge, presentation skills, testing their abilities, and assessing their peers anonymously. Tutor effectively uses the break time (i.e. gaps) highlighting the importance of group dynamics affecting the team and individual performance.

2. Development and Structure of the IVG Quiz Template

Keeping in mind edutainment system covering most of the aforementioned factors involved in groupwork design and developing assessment strategies of E&T multidisciplinary groupwork activities, a simple IVG quiz template has been developed using Microsoft® Excel Visual Basic for Application (VBA). With little efforts, anyone new to VBA but with basic knowledge of Excel can develop, edit or at least easily run such IVG Quiz show by following the simple YouTube Tutorial videos and guidelines given in the reference (Takyar, 2015; Alexander 2016).

The VBA code for this IVG quiz (*see Appendix-A*) mainly uses random integer number generation command developing a simple algorithm selecting 'm' members for each instant group from a pool containing a list of attendance with number, 'n', such that the chosen members may not appear again in the same or even in the remaining groups. The 'N', total number of groups without repetition is given by $\frac{n}{m}$.

[6] The Walt Disney corporation created the term "*edutainment*" in 1948 in a documentary "True Life Adventure" combining both "*edu*cation" and "enter*tainment*", *Taken from*: Van Riper, A. B. (2010). Learning from Mickey, Donald and Walt: Essays on Disney's Edutainment Films: McFarland, Inc.

For example, a cohort size of n=30 students with m=5 members in each group results in N=6 independent groups. The same randomised algorithm can be applied to select/display the question(s). It should be noted that VBA code can be constructed with conditional format, for example; when a member of group or questions reach a set saturation level (or a set criterion) then any name(s) or question(s) can reappear randomly but in a controlled manner. In our case, any name or question may reappear randomly (i.e. not more than twice or maximum three times) in the entire quiz session but no duplicates within the same batch or group (*see Appendix B1*). The possible random reappearance of any previous group member into upcoming IVGs keeps the entire class active and in state of readiness. In IVGs, some randomly selected names will reappear in different group setup and capacity (i.e., may be as group leader or member). This helps students to explore their communication skills, abilities, personalities and leadership qualities within and across the group. It is interesting to see that in most cases, sections of the same group that frequently worked together in the same environment may produce radically different group dynamics (Anderson, D. L., 2017). Therefore, this 'break and make another' group system truly helps self-evaluation process. The number of members within a group and/or batch of questions in an IVG quiz can be adjusted depending upon the nature of the test (i.e. tutorial, revision practice, etc), type of the teaching module, programme level, cohort size and question bank. Furthermore, for an induction tutorial session, an active dynamic hyperlink can be included in VBA code to link the displayed topic (or question) pointing to the corresponding answer in the spreadsheet by just clicking the question with hypertext link the answer will pop-up in a window (i.e. functioning like an online electronic dictionary).

2.1 Operation of the IVG quiz

The IVG quiz template can be used in a traditional classroom environment (i.e. tutor centred with student's desks facing to tutor's desk and projector display) with a number of students in between 20 to 40 for different cohorts of programmes levels 4 to 7, respectively. The Figure 2(a) shows screenshot of a live quiz where Figure 2(b) gives a flowchart describing operational procedure to run that IVG quiz. There are clickable buttons on the spreadsheet 'Sheet1' to generate one group and options for picking question(s), reset, and save results, respectively. A randomised IVG group is generated instantly from the *Attendance list*[7] at a single click on the button named as "Generate New Instant Virtual Group". Similarly, random question(s) can be picked and displayed to the group instantly via a single click on corresponding button with a caution that another click will generate a new session (i.e. this caution is applicable to both group and questions as well). In addition to generation of a batch of random questions, another button (not shown in the Figure 2) can be used to generate a tailored sequence of questions from a smaller question bank in ascending sequential order (i.e. 5 to 10 questions, displaying one at a time in ascending order, instead of generating random questions). Such sequential quizzes are useful in assessment of a Tutorial session, where each group may already has worked the solutions. In such a sequential quiz students know the next upcoming task or question and the tutor can invite any member of the group to present the suitable solution. Appropriate Microsoft® Excel settings can be used to enhance the visibility attracting the audience (i.e.,

[7] For this study, all names and details of students are anonymised and the names appearing here in the 'Sample' quiz are the fictitious.

hiding gridlines; rows; columns; headings or formula bar, setting colour-scheme; font's size; adding eye-catching effects such as, colour-contrast; pictures; images; audio/video; animations, countdown timer, etc).

(a) (b)

Figure 2. The layout and operation of an IVG Quiz: (a) screenshot showing buttons and question's setup, (b) Flowchart describing the working procedure of the quiz.

Due to preset formulas encoded in the respective spreadsheet cells, the individual marked entries in 'Marks' column instantly produce statistics (i.e. group average marks and individual-group marks etc). The single click on large green button saves the generated data of the group in the destination sheet (i.e. in our case it is Sheet 5). Within the group, the name of the person appearing next to the question (i.e. in the same row) leads the group, initiating the discussion and finally concluding the session within allocated time as illustrated in Figure 3 (a) to (d). Only identified IVG members engage in working out the best model solution for the given question. The tutor awards the marks considering peer-to-peer assessment, not for just assessment of the technical knowledge but also considering the leadership, communications and engagement qualities of individuals. The criteria and the protocols are covered in more details in Sections 2.1 and 2.2, respectively, but for simplicity lets assume that the tutor manually enters these marks in the Excel sheet as reflected in peer assessment. It should be noted that 'structure', 'size' and 'display cell location' of the question can be set as desired. For example, question can be displayed in a popup window using message-box option in Excel, or the question can be displayed in the first top row of the Excel sheet as shown in Figure 2(a). In this sample 'Revision Tutorial' quiz, well-known short terms and single phrases from the subject review were randomly picked/ displayed as a 'flash-card' question to the group. Furthermore, these sessions can easily be saved after displaying individual group statistics and producing datasheet or showing comparison of group's performances. Some of these screenshots of similar quizzes are given in *Appendix-B1*. Such displays help providing instant feedback, making activity more stimulating

and turning into healthy competition.

The VBA script uses different *independent* 'sub' procedures and 'for-next' loops refreshing every time a button is hit, therefore all the buttons function independently, hence the same spread sheet can be used 'instantly' in variety of ways. For example, the same instant group can be asked a series of questions being generated instantly, one after the other. Single or multiple questions can be generated and displayed to individuals or to the group as whole, or new group can be generated asking same set of questions that was offered to previous group as illustrated in flowchart of Figure 2(b). The Figure 3 presents a session generating five members for each IVG quiz group and one question, respectively. It shows four selected 'cropped' screenshots from an IVG quiz session during a 'Revision Tutorial' used for a Level-6 module. It can be observed that some names reappear '*randomly'* in ten different groups, such as: Jackie, John, Norez and Vince (*for more details, see Appendix-B1*).

No.	Instant Virtual Group members	ONE (random) Question is:	Marks Q1	Group Av Marks	Indv-Group Av Marks
1	Vince	PCS	3	3.6	2.16
2	Jackie		4		2.88
3	Nickle		5		3.6
4	Moni		3		2.16
5	Rosh		3		2.16

(a)

No.	Instant Virtual Group memb	ONE (random) Question is:	Marks Q1	Group Av Marks	Indv-Group Av Marks
1	Jackie	TDM	5	4.6	4.6
2	Casper		4		3.68
3	Goldsmith		4		3.68
4	Norez		5		4.6
5	Ulux		5		4.6

(b)

No.	Instant Virtual Group memb	ONE (random) Question is:	Marks Q1	Group Av Marks	Indv-Group Av Marks
1	Olu	Burst Mode	4	3.6	2.88
2	John		3		2.16
3	Vince		3		2.16
4	Green		3		2.16
5	Tariq		5		3.6

(c)

No.	Instant Virtual Group member	ONE (random) Question is:	Marks Q1	Group Av Marks	Indv-Group Av Marks
1	Elmas	Bluetooth	4	4	3.2
2	Xio		4		3.2
3	Norez		4		3.2
4	John		4		3.2
5	Dolly		4		3.2

(d)

Figure 3. Four selected screenshots showing displayed IVG quiz session in the classroom environment: (a) Vince is leading the group discussion; (b) Jackie is leading the group discussion; (c) Olu is leading the group discussion; (d) Elmas is leading the group discussion.

This random selection with about a minimum 10% repeat option, keeps everyone attentive and prepared for more chances to review their technical skills (i.e., demonstation, presentation and communication etc). It is important not to let vulnerable 'shy and/or weak' students demoralised (*see for more details in Section 3.3 Student's comments*). Therefore, the IVG quiz displays statistics, plots and charts from the generated data encouraging their technical and group engagement activities. For example, bar chart statistics are auto produced displaying the analyses showing individual efforts invested in obtaining the group average marks. This is further explained with illustrative examples in *Appendices B1 to B3*.

This quiz template is specially designed for the tutors to share their groupwork, teamwork knowledge and experience encouraging positive group dynamics in students besides doing regular quizzes. The developed customised template can be reused for any other module by simply copy-pasting 'Attendance list' and 'Question bank' in corresponding spreadsheets (i.e. 'Sheet 2' and Sheet 3'). It should be noted that the attendance list should contain only the names of available participants taking part in the quiz test (i.e. by quickly taking class attendance and excluding absentees from the original cohort attendance list). Any late

arriving student can also be added to the Sheet at any time. The 'Instructions' and 'ground rules' can be included and displayed on the top row of the spreadsheet.

2.2 Rules of Engagement for IVG quizzes

In order to achieve all the positive group dynamics and programme specific learning outcomes, simultaneously, the students would be instructed to consider some useful guidelines while answering any question during the IVG quiz sharing their contributions with the team, For example;

i. Introduce yourself (communication, presentation)
ii. Define the Topic (subjective knowledge, self-expression)
iii. Explain the basic principle behind it, e.g., explain how does this work (fundamental/operation, storyboarding)
iv. Give practical uses (subject awareness/applications)
v. Historical background of topic and future aspects (evolution, trend analysis)
vi. If you do not know the answer then politely decline or ask for more clarity if you are not sure (critical appreciation, self-evaluation)

Individually, students would be expected demonstrating at least any two of the above six points to get pass marks. Other members of the IVG must carefully observe and listen to the speaking member and wait for their timeslot to interact (i.e. none should try dominating the conversation). The members waiting can raise their hands and group leader will invite them to speak in the next available slot. Once all the members have had their turns then the group leader may ask the group to conclude main findings, one-by-one. Each IVG member could give a very brief valid conclusion, about one line or short sentence. The overall time allocated per each IVG could be set as required, depending upon the total duration of quiz session and number of groups. A minimum 5 minutes for discussion/talk plus 60 seconds for concluding remarks was allocated to each IVG for this 'sample' quiz as indicated by the countdown timer (i.e. 6 minutes) in Figure 2(a). The next stage will be to mark each individuals after completing their peer assessment.

2.3 In-class Peer Assessment

The tutor vigilantly observers the entire quiz process where group leader and other members were expected to be engaged cooperatively working out conclusive answer. The tutor also ensures that the rest of the class maintains the set ground rules. At the end of each IVG question, the tutor invites the entire class to assess each group member by casting their 'multiple responses' votes using EVS clickers. In this peer assessment students consider two broad marking criteria, for example; has the member: a) contributed meaningfully to group discussions and following the rules of engagement demonstrated a cooperative and supportive attitude? b) used clear communication and time keeping? and how likely s/he will be welcome to my next group work.

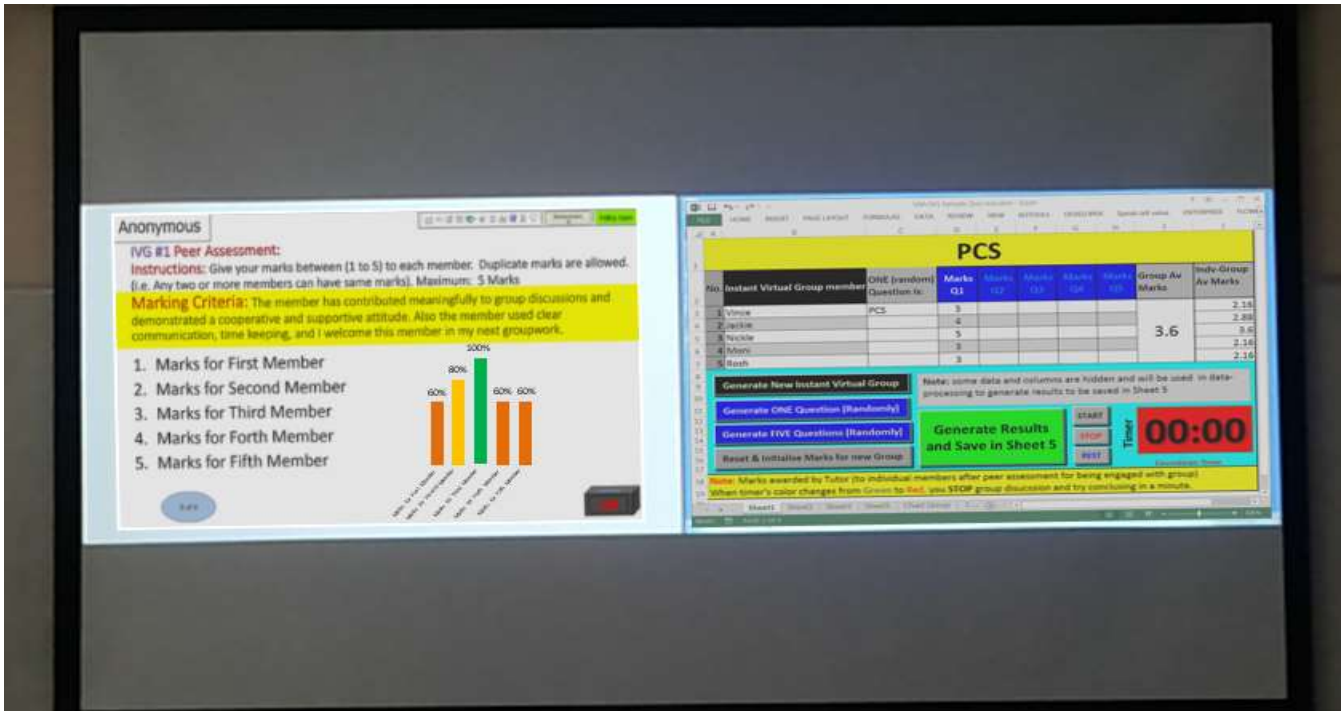
Briefly, the peer assessment includes appreciation of group's efforts related to the communication skills, ability to manage the given task within allocated timeslot. It is noteworthy to mention that instead of particular group members, the entire class participates in the peer assessment process. This *collective* peer assessment was thought useful considering the famous political statement "problems cannot be solved with

the same mind-set that created them". Therefore, those members who completely failed to achieve the desired LO's of the group work cannot self-assess themselves immediately after going through a disaster. The group needs to break up, step back, and individually self-evaluate themselves. In collective peer assessment, the entire class acts as a 'critical friend' and consistent peer assessment increases metacognition among students where vulnerable are advised to accept peer assessment results appreciating the majority's criticism.

The peer assessment involving entire classroom using EVS clickers took less than 2 minute2 per each group marking each member of the IVG group that were instantaneously and randomly selected using Excel VBA quiz. The tutor inputs these peer assessed marks in the Marks column onto the Excel Sheet 1. The tutor should not involve in arguments as there could be some situations causing nuisance or disturbance (i.e., jokes, laughs, irrelevant/funny remarks/talks, disability, discriminating factors etc). In these circumstances tutor takes control avoiding further confrontation and uses these opportunities converting the poor or negative group dynamics into healthy useful discussion spreading the awareness, highlighting the school/university's policy about widening participation, equal opportunities, gender discrimination, disability, diversity and the available support in the university. In addition, tutor records individual marks with simple handwritten comments in tutor's notebook, not showing to students. For example, tutor may not agree with the peer assessed score, hence it is important to avoid the arguments, saving time and maintaining quiz tempo. At the end of quiz session, tutor talks about these differences during feedback session explaining how an impartial assessment can make a clear, tangible difference to the progress of the student receiving genuine feedback.

Figure 4 shows the in-class peer assessment of a group using dual-windows wall-screen projector, each showing the IVG quiz and the EVS peer assessment. The screen projector control unit has several options to select from. After an IVG quiz, the tutor choose 'two windows' option, each showing desktop PC for MS Excel IVG Quiz and a laptop EVS peer assessment, respectively. The EVS peer assessment slides were set using priority ranking (i.e. multiple responses)[8] with duplication enabled, one slide per each IVG group number. It should be noted that the EVS collective score is displayed in percentages whereas the peer assessed marks were in between 0 to 5. Hence a quick conversion table is provided showing appropriate marks in the IVG spreadsheet vs EVS peer assessed scores.

[8] TurningPoint User guide https://www.albright.edu/itservices/media/pdf/Turning_Point_Clickers.pdf



Quick Conversion Table

EVS %	= Marks	EVS %	= Marks	EVS %	= Marks
100%	= 5.0	70%	= 3.5	40%	= 2.0
90%	= 4.5	60%	= 3.0	30%	= 1.5
80%	= 4.0	50%	= 2.5	20%	= 1.0

Figure 4. Dual window management displaying two screens on the wall display: Excel VBA-IVG quiz and the EVS peer assessment (also showing a quick conversion table for transferring EVS peer assessed results showing in percentages to IVG marks).

2.4 Implications for Teaching and Managing Students

There are numerous case-studies suggesting group work as essential skills for the graduates, however; the workload on students and staff can be over burden if group work is not monitored or scheduled appropriately according to landscape of the assessment (MY Jamro, 2015). As a matter of fact, a group work requires more time than individual work where a group must develop qualities of a team and finally the staff should assess each component of work accordingly. In group work, the role of staff changes from a tutor to facilitator and hence staff should be more accessible to students than normal. Additionally, the groupwork assessor (i.e. the tutor) should be trained 'psychologically' to handle 'stress' answering the diverse queries effectively during dialogues with various groups as any two groups of students might inquire different aspects and hence expected to respond differently to set pieces of work (Emmer E. T, 2001).

The randomised IVG quizzes were implemented in classroom environment with all participants being present, therefore the IVG groups cannot be compared with any online virtual groups or quizzes where there is no face-to-face interaction between students and the tutor. The IVG quizzes were offered as formative assessment tool exposing group dynamics to individuals (both students and staff) developing

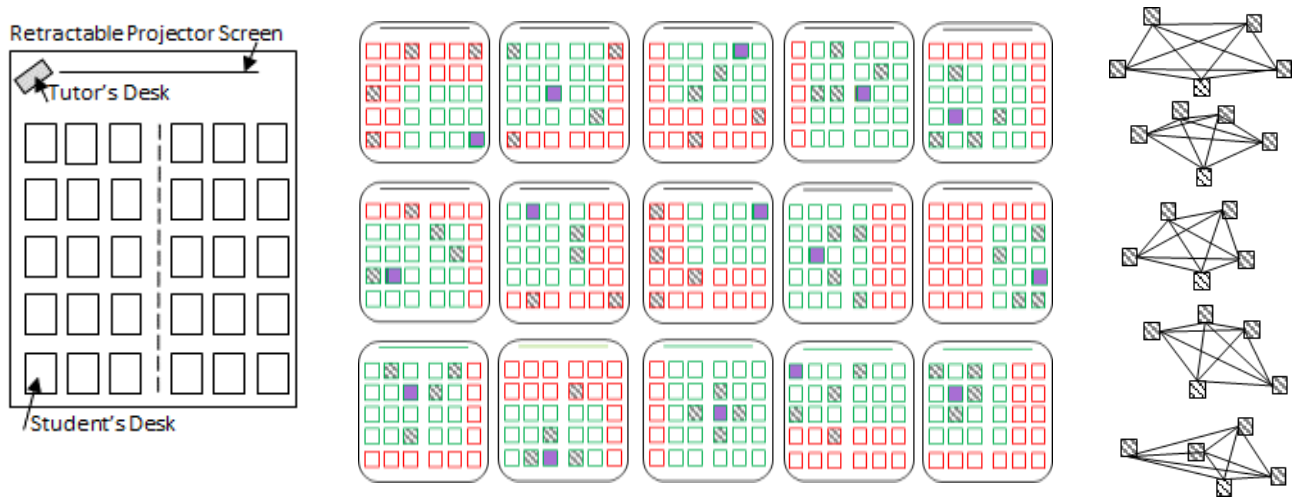
good practice for the future summative group work activities in the laboratory and/or online environment (MY Jamro, 2017). In most cases dealing with collaborative or online coursework submissions, the issues of *lurkers* (i.e. the individuals not actively participating) and *shirkers* (i.e. the individuals who may dodge work, duty, responsibility, etc) are more serious and should be taken care accordingly, otherwise they jeopardise all the group work efforts. It is important not only to identify these abstracted individuals but also to find ways bringing them back into the community as many of these would have been working on their individual 'brainy' ideas, and if inducted appropriately then these could contribute more and become useful part of the E&T business. The IVG quizzes can potentially identify these vulnerable students and pastoral care tutor can counsel them confidentially.

2.4.1 Managing random IVGs In-classroom Cooperative Learning environment

In a standard classroom environment, the size of a virtual group and their seating arrangement (i.e. floor plan) can play significant role in determining the impact on group performance. Most of these may be obvious and self-evident expecting to display known trends, however, since, the IVG quizzes focus on group dynamics, therefore it is important to study various parameters affecting students to share their subject specific knowledge, and pose challenges to judge and practice their communication skills and appreciate peers as 'critical friends'. Some useful information and predictable trends were observed confirming the positive group dynamics for effective communication within the group based on classroom management, and will be presented in this section.

The IVG quizzes were conducted within standard classroom arrangement with teacher-centred layout as shown in Figure 5(a) where tutor had freedom to walk through the partition (i.e. between two batches as identified by dashed line) approaching near to any student within 1-3 meters distance.

Figure 5(b) shows 15 different IVG layouts where group members were interacting in the classroom environment. The coloured borders show the effectiveness of group communication with green and red representing good and poor communication, respectively. The purple colour box represents the group leader where the shaded boxes show the members of that group. Figure 5(c) shows the possible line-of-sight (LOS) constructs of a group where each member can clearly 'see' each other (i.e. establishing effective eye contacts with everyone within the group), while physically located within a closed loop formation. This type of homology can be considered to follow the fundamentals of '*simplicial'* or 'simplicial complexes' (*see more details in Appendix-B3*).



(a) (b) (c)

Figure 5. Classroom Floorplan: (a) Standard floorplan for 30 students, (b) 15 different classroom IVG patterns each showing formation of a 5-member IVG, (c) Possible group LOS-homology patterns.

During the operation of IVG quizzes, it was observed that the group members at shorter distances without obstructions and closed to their leader with clear LOS homology exhibited better homotopy as compared to ones at longer distances (or nearby, but being obstructed) who faced some challenges in establishing effective communication. Some of the poor group dynamics were expected in most cases being identified with red bordered cluster of boxes that include, blockade due to disruption and shouting; frustration and aggression in asking to repeat; social loafing due to isolation etc. These ills were ultimately attributed to weak leadership qualities. These patterns were shared with the students during their feedback and reflection session at the end of quiz. It was recommended to students to stay close to each other similar to a roundtable floorplan for any 'physical' group work activity as suggested in the Reference (Brown, M., 2006). This study dealing with homotopy and homology is still under investigation and some of the early results are shared with groupwork enthusiasts in *Appendix B3*.

3. Comparative analysis of the IVG quiz survey

The IVG Quizzes were delivered within the classroom environment for several modules covering Level 4 to 7 of various programmes of study, including, Integrated Masters[9] (i.e. MEng and MSc) at Level 7 and BEng/BSc (Honours) Levels 4 to 6. It should be noted that UK universities intake direct entry students from national (or local), European and International at Level 5, 6 and 7, respectively. Most of Level 7 MSc cohorts are expected to be international students besides others progressing from previous levels. In fact, it takes time and efforts for the new entrants to adjust within the university system (exploring campus life, resources, learning new VLE and sorting accommodation etc). However, the progression to Level 7 MEng requires minimum upper 2nd class BEng (Honours) qualification to progress from Level 6, and also because

[9] Integrated Masters are the undergraduate programmes as per IET accreditation.

most of these may have successfully completed their Semester-abroad, Mini-Project module and/or Industrial placement years, therefore they possess thorough understanding and knowledge of the assessment landscape and group work requirements (MY Jamro, 2015). Therefore, in IVG quiz survey for programme, the Level-7 is split into MSc and MEng, respectively to consider their diversity, awareness and limitations.

3.1 Feedback Questionnaire and Analysis

All quizzes used in this pilot study were 'formatively assessed' sessions. There were at least three IVG quiz sessions with same cohort of students for each programme Level 4 to 7 (i.e. induction week, before commencing an assessed group work activity and finally one IVG quiz for the module revision tutorial near to closed book examinations). At the end of the last IVG quiz test (i.e. module revision tutorial) a survey was conducted with students using EVS clickers to reflect their likes and dislikes of the IVG quiz on five level Likert Scale from 'Strongly agree: 1', 'Agree: 2' to 'Strongly disagree: 5'and 'Disagree: 4', respectively, with 'Neither' in the middle with '3' score. There may be two possible ways to interpret the 'Neither' option, firstly, a student has no clear opinion and secondly, if this was not applicable to any of other choices (*see the questionnaire in section 3.1.1 and Appendix-C*). It was observed that some students did not cast their votes as if they were still either undecided or could not find any suitable option to choose from and made notes in 'optional comments' in additional box on the paper copy of the questionnaire. Nonetheless, all participants in formative IVG quizzes were altered via visible countdown timer included in IVG quizzes. In order to maintain anonymity of the EVS sessions, unregistered ResponceCard RF LCD EVS clickers were used in the survey quiz.

3.1.1 Open-ended Survey Questionnaire

Following eight questions were used in seeking anonymous student's feedback on the effectiveness of the IVG quizzes enhancing their programme specific intended learning outcomes (ILOs) whilst at the same time bringing awareness of group work and group dynamics.

Q1: I know the difference among Group-work, Group-Individual-work and Individual-work
Q2: Now I know my weaknesses/strengths and can decide my role within a group
Q3: I can easily introduce myself to the new members (i.e. even in randomised groups)
Q4: The IVG quiz helped me to gauge my communication skills
Q5: I prefer making a group 'ourselves' rather than random selection
Q6: The randomness of IVG quiz kept me active throughout the test session
Q7: More IVG quizzes with small summative assessment including feedback will help me
Q8: I understand 'group dynamics' more than last semester/year

3.2 Statistical Analysis of Survey results

The statistical analyses were carried on recent year's data. The statistical significance was calculated on five-point Likert Scale assuming that the students' responses were considered being positive (i.e. *Overall Agree* = Strongly agree + Agree) and negative (i.e. *Overall Disagree* = Strongly disagree + Disagree), excluding their neutral responses (i.e. Neither) after confirming the null-hypothesis by chi-square χ^2 test

given in the Reference (Comrey & Lee, 2006) using formula:

$$\chi^2 = \sum_{i=0}^{n_l} \frac{(O_i - E_i)^2}{E_i} \qquad \text{Equation: 1}$$

Where the terms, χ^2: chi square statistic, Σ: summation symbol, O: number of observed events, E: number of expected events, i: iteration, n_l: number of pathways or Levels.

The χ^2 test was performed on all 8 questions each for four different programme levels plus MSc cohort. The Table 1 shows contingency data for Survey Questionnaire, describing observed, expected and chi-square statistic for all programmes Level 4 to 7.

Table 1. Chi Square 'χ^2' sample data analysis for Questionnaire

Q. No:	EVS* Feedback	Observed					Expected					χ2 value	χ2 Test P-value
		Level 4	Level 5	Level 6	Level 7 MEng	Level 7 MSc	Level 4	Level 5	Level 6	Level 7 MEng	Level 7 MSc		
Q1	Neither	4	2	3	1	1	3.419	2.824	3.270	1.041	2.081	0.925	**0.598**
	O-Agree	20	17	20	6	11	23.000	19.000	22.000	7.000	14.000	1.569	
	O-Disagree	3	2	2	1	3	3.419	2.824	3.270	1.041	2.081	1.193	
	G-Total	27	21	25	8	15	-	-	-	-	-	-	
Q2	Neither	3	1	2	1	2	3.041	2.554	2.554	0.973	1.459	1.267	**0.570**
	O-Agree	21	19	20	7	10	25.000	21.000	21.000	8.000	12.000	1.336	
	O-Disagree	4	2	1	1	2	3.247	2.727	2.727	1.039	1.558	1.589	
	G-Total	28	22	23	9	14	-	-	-	-	-	-	
Q3	Neither	4	2	1	1	1	1.946	2.432	2.432	0.973	1.338	3.175	**0.659**
	O-Agree	13	18	18	7	9	16.000	20.000	20.000	8.000	11.000	1.451	
	O-Disagree	3	2	2	1	2	2.462	3.077	3.077	1.231	1.692	0.971	
	G-Total	20	22	21	9	12	-	-	-	-	-	-	
Q4	Neither	3	0	0	0	0	0.811	0.932	0.973	0.324	0.486	8.627	**0.563**
	O-Agree	17	20	23	7	10	20.000	23.000	24.000	8.000	12.000	1.341	
	O-Disagree	3	3	1	1	2	2.597	2.987	3.117	1.039	1.558	1.627	
	G-Total	23	23	24	8	12	-	-	-	-	-	-	
Q5	Neither	4	2	0	2	1	2.797	2.432	3.041	0.730	1.338	5.931	**0.807**
	O-Agree	21	18	24	6	10	23.000	20.000	25.000	6.000	11.000	0.505	
	O-Disagree	2	2	1	0	1	1.747	1.519	1.899	0.456	0.835	1.103	
	G-Total	27	22	25	8	12	-	-	-	-	-	-	
Q6	Neither	3	2	1	0	0	1.865	1.703	1.541	0.568	0.730	2.230	**0.870**
	O-Agree	21	22	18	6	8	23.000	21.000	19.000	7.000	9.000	0.528	
	O-Disagree	2	1	2	1	1	2.147	1.960	1.773	0.653	0.840	0.724	
	G-Total	26	25	21	7	9	-	-	-	-	-	-	
Q7	Neither	1	2	2	1	1	2.270	1.986	2.081	0.662	0.851	0.912	**0.831**
	O-Agree	22	20	21	7	8	24.000	21.000	22.000	7.000	9.000	0.371	

	O-Disagree	2	1	1	0	1	1.538	1.346	1.410	0.449	0.577	1.106	
	G-Total	25	23	24	8	10	-	-	-	-	-	-	
Q8	Neither	3	3	3	2	1	4.054	3.405	3.568	1.135	1.784	1.416	**0.152**
	O-Agree	19	20	20	6	8	25.000	21.000	22.000	7.000	11.000	2.630	
	O-Disagree	6	1	2	1	3	4.452	3.740	3.918	1.247	1.959	4.086	
	G-Total	28	24	25	9	12	-	-	-	-	-	-	
Total Attendees		**28**	**25**	**25**	**9**	**15**	-	-	-	-	-	-	

** Some respondents chose not to answer (i.e. remain abstain or were undecided and could not click any option and the polling was closed). Some students put their comments in 'optional section' given to them as a paper copy handout.*

O-Agree: Overall Agree, O-Disagree: Overall Disagree, *and* ***G-Total: Grand Total*** includes all the favourable and unfavourable respondents.

Each level's decisions were independent and the decision making in rejecting the null hypotheses was based on p-values with standard χ^2 distribution. A standard 5% predetermined level of confidence (i.e. $p = 0.05$) with 4 degree of freedom (df) was used in the calculation, e.g., $df = (n_l - 1)$, where 'n_l' represents 5 independent programme levels, e.g., Level 4 to 7 plus MSc as separate cohort. It can be observed that the calculated p-values for each question against all programme levels, were less than 1 (i.e. between 0.152 and 0.870) that is much lower than theoretical critical value (i.e. 9.49) for standard conditions, s*ee Appendix-D for more deails* in Reference (Comrey & Lee, 2006).

The data in Table 1 looks quite cumbersome at first glance, therefore to present the main data in a meaningful manner the *normalised* values in percentages were extracted to plot the trends for the questionnaire. The normalised value as 'net positive responses' being converted into percentage using formula given as under:

$$Net\ positive\ responces\ \% = \frac{(Overall\ Agree - Overall\ Disagree) \times 100}{Grand\ Total} \qquad \text{Equation: 2}$$

Table 2 provides the percentages of net positive responses of entire questionnaire (i.e. all 8 questions), which were derived as normalised values from their corresponding data using formula given by Equation 2.

Table 2. Net Positive Responses for all 8 questions

Q. No:	% Net positive responses					
	Level 4	Level 5	Level 6	Level 7 MEng	Level 7 MSc	Over-all
Q1	63%	71%	72%	63%	53%	64%
Q2	61%	77%	83%	67%	57%	69%
Q3	50%	73%	76%	67%	58%	65%
Q4	61%	74%	92%	75%	67%	74%
Q5	70%	73%	92%	75%	75%	77%
Q6	73%	84%	76%	71%	78%	76%
Q7	80%	83%	83%	88%	70%	81%
Q8	46%	79%	72%	56%	42%	59%
All Qs	63%	77%	81%	70%	62%	**71%**

Based on data validation using χ^2 test analysis, student's satisfactory trend for each programme level is plotted in Figure 6 showing overall positive responses for various programme levels. If a threshold level of 40% is assumed then it can be observed that all the questions scored 40% or above for all programme levels. However; Levels 5 and 6 were found more thoughtful appreciating overall quiz questionnaire attaining above 70% score for all questions. Students at both these levels know their modules, their expected learning outcomes very well and also familiar with the marking and assessment criteria of various components of their programme of study. Students are therefore keen to explore more, furthering their chances to achieve better grades in their degree programmes. It can be observed that Q1 to Q3 and Q8 show overall less confidence as compared to Q5 to Q7. Since Level 4 and most of MSc intakes are new to the university system and therefore showed overall low confidence in 'group work' activities mainly due to less acquaintance and awareness of available resources. Figure 6 also shows another analysis on the secondary y-axis showing programme of study level-wise average acceptance (i.e. taking the average of responses for same question number for various programme levels). Here Q1 to Q3 and Q8 attain average scores of 64%, 69%, 65% and 59%, respectively.

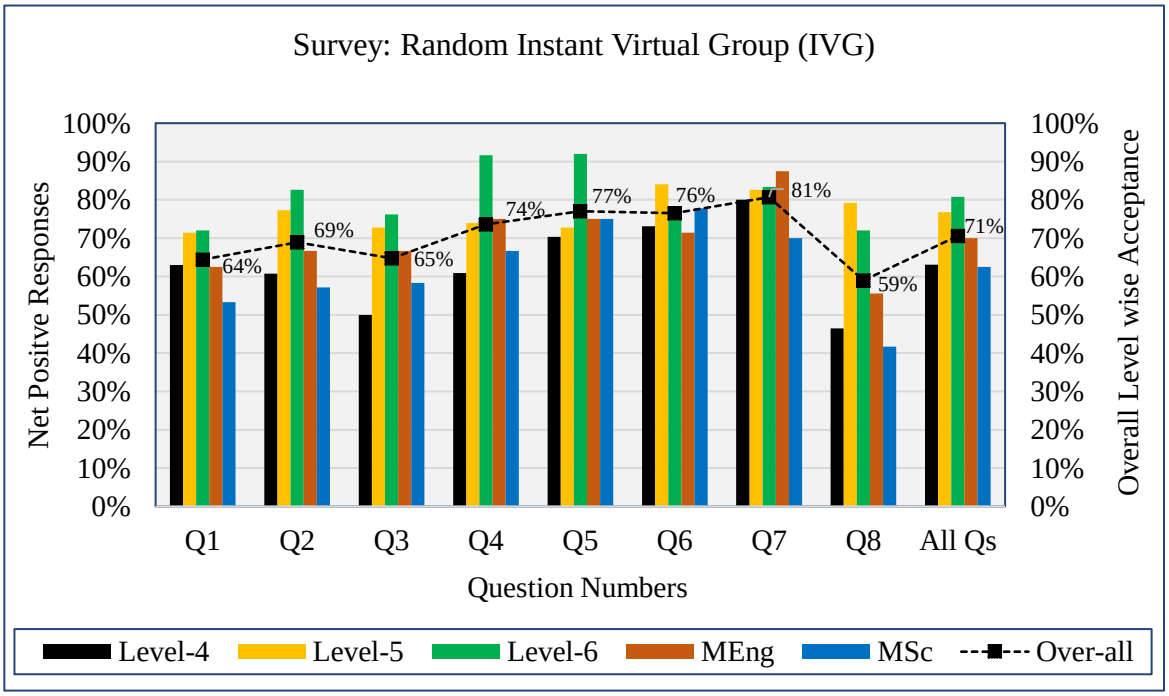


Figure 6. Feedback analysis on Instant Virtual Group (IVG) quiz for various Programme Levels showing Net Positive responses and level of acceptance.

The Q5 to Q7 attain higher average values of 77%, 76% and 81% respectively. The overall average level-wise acceptance for all eight questions remained 71% that showed positive attitude of E&T students towards such IVG quiz activity. The Q8 attained overall lowest average level acceptance score (i.e. 59%) that mainly resulted from Level 4 and MSc scoring 46% and 42%, respectively, who felt either over-assessed due to their more *demanding* weekly assessment landscape of all taught modules in the last teaching weeks of the semester (MY Jamro, 2015) or the scope of such IVG quizzes was not clearly understood. These two pathways (i.e., Level 4 and MSc) are more vulnerable and deserve some edutainment

to engage them in the group work activities. This analysis also does not include the number of absentees and their possible reason(s) to remain abstain in the quizzes assuming that they were not withdrawn from the course and attended their other regular modules. The main reason for being remaining absent may be related to the fact that some students do not give more importance to 'formative assessed' sessions or they could be occupied by other coursework due for submission within the same week. This was particularly true for some vulnerable MEng students who were doing their MEng Team project[10] and were not progressing accordingly due to either incoherent group work or leaving things to the last minute and thus accumulated more work towards the end stages of their MEng Team Project.

3.3 Student's Comments

In the anonymous questionnaire, students were asked to provide their 'optional' comments to help the programme and modules teams developing more support for cooperative and/or collaborative groupwork related coursework and lab exercises. Although students provided clear score on the questionnaire but their received comments are valued and can be categorised in three main areas: comments about communication skills of individuals within group and their handling; comments about staff and school in delivering and managing the groups; and third category includes mixed responses covering various topics related to assessment and feedback. Some selected comments from each category are presented here. Only spelling errors were rectified and corrected whereas some terms and names were x'ed to maintain anonymity or student's natural prejudices.

Comments from Level 4:

> "… I could explain things in my way but the time given was short and mostly taken by lead person".
>
> "… I am not happy with random selection in my group work assignment. Last semester, I could not find my group mates in one of group coursework, surprisingly two were withdrawn and one was transferred to other course. I raised my concerns and managed to submit as one person group ☺ and passed. What's point of such random groups with ghost peers?".
>
> "…. to be formative assessed and get zero marks is not helpful. Why would I waste my time in the classroom? Please set these as online quizzes and I could better use my contact hours in more productive way, I am a part time student and I want to use my time in most useful way".
>
> "… IVGs sound interesting idea but many were not ready for such quizzes as very short thinking time was given. The random questions were also challenging and one needs to be either Newton or Einstein to react that fast".
>
> "… it was nightmare to talk with X people as I could not understand a word. Complete waste of time…I still see that X getting more marks than me".

Comments from Level 5:

> "…. May I suggest to allocate random groups with different set of questions for each group, and come next week for assessment so that groups could workout best solutions".

[10] MEng Team Project is a 45 credit point's module covering both Semesters A and B.

"… plz make these quizzes summative assessed and let us feel bit rewarded, i.e. people should get paid for their work done".

"… my opinion was heard and valued in the IVG group. I don't know if the same will work in practice because most of our online chat groups are without face-to-face communication".

Comments from Level 6:

"… I felt like being named and shamed. May be it's my weakness or I was unlucky in random selection. Anyway, trust me, I am engineer and engineers love doing work. I see politicians talking and engineers working…so I keep calm and continue working!".

"…. I prefer working with my selected group mates as it saves my time-efforts-energy, because I know what/when and how to reach them".

Comments from Level 7:

"… I learnt a lot during my placement year. I think groupwork is a 'science' rather than 'art of talking'. We must be taught more about augmentation, negotiation, challenging etc also avoiding dominance of the lead person". MEng

"… I am new to university and hardly know anyone in the class. This was my first ever opportunity to act as a lead person. I never did this before in my life. I enjoyed it". MSc

Most of the students' comments were shared with programme committee team working for developing group work. These comments revealed that E&T students truly value their time and efforts and this awareness increases exponentially as they progress to their next level of their programme of study. At the same time, some vulnerable students were unhappy who might have learnt their lessons after getting reduced marks in their group work. Some comments suggested implementing IVGs as online group quizzes, which can be effective collaborative method, however the current IVG quizzes are not ready for VLE integration.

4. Summary and Conclusions

The template development and implementation of a random group quiz were presented. The quiz using Microsoft® Excel VBA, randomly picks a group from the attendance list and a desired number of questions from question bank, instantaneously. The bar charts showing performance of different IVGs awarding individual's efforts contributing to the group marks were auto-plotted displaying various statistics, in particular identifying vulnerable students. The IVG quiz template is designed for formative assessment incorporating peer assessment via EVS clickers engaging students and encouraging group co-ordination, cohesion and individual contributions to produce effective solution of a question. The rules of engagement to participate and peer assessment of the IVG quiz were kept simple and students were engaged in meaningful conversation exposing them to various paradigms of group dynamics. Based on the marks given by their peers the tutor input these in the MS Excel that generated automatically comparative charts. The marks awarded to individuals reflected individual's contributions to attain the achieved average group marks. Thus entire group's full contributions raised the group average marks whereas their poor performance damaged the group marks and consequently each individual received reduced marks. The main idea behind such marking scheme was to educate and engage students promoting positive group

dynamics.

At least three such IVG quizzes were given to various cohorts of MEng/BEng and MSc programme levels 4 to 7 at different times during a semester and at the end of the final IVG quiz, a survey was conducted to analyse the effectiveness of such quizzes. The results were analysed using Chi-square test that revealed that Level 4 and Level 7 (i.e., mostly MSc) are most vulnerable to group work activities and need more tutor support with clear instructions. The net positive responses of students from all programme levels surprisingly were high as 71% whereas the average acceptance level remained above 59% for all the questions appeared in the Questionnaire. These data show that the students liked such IVG quizzes as formatively assessed tests to help preparing for their summative coursework and final examinations, however, some suggested an appropriate portion of overall coursework marks should be associated with these IVG quizzes recognising the value of their efforts and time. Furthermore, some students mainly from Level 4 were critical to the idea since random grouping requires bit more time-efforts dedications to develop effective team and it is recommended that random group allocation should not be used for Level 4 students for their assessed group work, in particular online virtual groups. Nevertheless, variety of group-individual cooperative and collaborative work can be given to students in classroom environment using such IVGs quizzes. Some appropriate fraction of marks (i.e., 30% marks) should be set aside associated with the knowledge and application of E&T, management of group and resources, and remaining 70% marks for the subject specific learning outcomes.

It was also concluded that the poor group dynamics can cause potential issues even within smaller size randomised groups in classroom environment if the formed group is very scattered and members cannot make proper eye-contacts during their group discussion. Such situation may arise when cohort size is larger than 40 or the participants are seated in a wide-spaced classroom. In such of large cohort size, the entire class can be divided into multiple batches and IVGs could still be implemented on rota basis. The impact of cohort size, IVG groups and their obscured location due to random selection was studied using the concepts of homology and homotopy. Some fundamentals and early findings of these concepts were shared with readers, however; these still require further investigation to establish their correlation and variance within a noisy environment.

5. References

Alexander, M., & Kusleika, R. (2016). *Excel 2016 Power Programming with VBA*: John Wiley & Sons.

Anderson, D. L. (2017). Cases and Exercises in Organization Development & Change: Sage Publications.

Bodnar, C. A., Anastasio, D., Enszer, J. A., & Burkey, D. D. (2016). Engineers at play: Games as teaching tools for undergraduate engineering students. Journal of engineering education, 105(1), 147-200.

Brown, M., & Long, P. (2006). Trends in learning space design. In D. Oblinger (Ed.), Learning spaces (pp. 9.1-9.11): Educause.

Bussmann, U. (2014). Group Dynamics: The Nature of Groups as Well as Dynamics of Informal Groups and Dysfunctions. Anchor Academic Publishing.

Crawford-Lee, M. S., & Crawford-Lee, M. S. (2016). Towards a sustainable apprenticeship system. Higher Education, Skills and Work-Based Learning, 6(4), 324-328.

Colbeck, C. L., Campbell, S. E., & Bjorklund, S. A. (2000). Grouping in the dark: What college students learn from group projects. *The Journal of Higher Education, 71*(1), pp. 60-83.

Comrey, A. L., & Lee, H. B. (2006). Chapter 11: Analysing Frequency Data with Chi Square, *in Elementary Statistics: A Problem Solving Approach* (4th ed.): Lulu. com.

Council, N. R. (2001). Knowing what students know: The science and design of educational assessment: *National Academies Press*.

Dennick, R., & Exley, K. (2004). Small group teaching: Tutorials, seminars and beyond. London and New York: Routledge.

Edward, L., Damian, S., & Peter, C. (2006). The interaction of engineering 'types': A study of group dynamics and its relationship to self and peer assessment during computer-based exercises. *Engineering Education, 1*(1), pp. 39-49.

Emmer, E. T., & Stough, L. M. (2001). Classroom management: A critical part of educational psychology, with implications for teacher education. *Educational psychologist, 36*(2), pp. 103-112.

Fine, L. (2009). The SWOT Analysis: Using Your Strength to Overcome Weaknesses. *Using Opportunities to Overcome Threats., Createspace,* US-SC-North Charleston.

Goold, A., Craig, A., & Coldwell, J. (2008). The student experience of working in teams online. In Hello! Where are you in the landscape of educcation technology? in *Proceedings ascilite Melbourne 2008* pp.343-352,) Retrieved 19/05/2017 http://www.ascilite.org/conferences/melbourne08/procs/goold.pdf .

Hirsch, J., Zhang, X., Noah, J. A., & Ono, Y. (2017). Frontal temporal and parietal systems synchronize within and across brains during live eye-to-eye contact. NeuroImage, *8*(157), pp. 314-330.

Kashan, A. H. (2011). An efficient algorithm for constrained global optimization and application to mechanical engineering design: League championship algorithm (LCA). *Computer-Aided Design, 43*(12), pp. 1769-1792.

Lencioni, P. (2006). The five dysfunctions of a team. John Wiley & Sons.

Lipovetsky, S. (2009). Pareto 80/20 law: derivation via random partitioning, *International Journal of Mathematical Education in Science and Technology,* vol. 40, pp. 271-277.

Manktelow, J., Eyre, E., Jackson, K., Cook, L., Edwards, S., Bishop, L., Moss, I. (2015). Improving Group Dynamics: Helping Your Team Work More Effectively. Retrieved 02/05/2017, from https://www.mindtools.com/pages/article/improving-group-dynamics.htm

Mills, P. (2003). Group project work with undergraduate veterinary science students, *Assessment & Evaluation in Higher Education*, vol. 28, pp. 527-538.

MY Jamro. (2015). *Development and analysis of dynamic assessment landscape for effective management of programmes and modules*, in Programme Tutor Symposium, University of Hertfordshire, UK, 3rd July 2015.

MY Jamro. (2017). *Case Study: Engaging students of E&T in positive group dynamics using randomly generated instantaneous virtual groups (IVGs) in classroom environment*, in Programme Leaders Symposium, University of Hertfordshire, UK, 3rd July 2017.

Neo, M., & Neo, T.-K. (2009). Engaging students in multimedia-mediated Constructivist learning-Students' perceptions. Journal of Educational Technology & Society, *12*(2), 254-266.

Palmer, S., & Hall, W. (2016). An Evaluation of Group Work in First-Year Engineering Design Education. *Chapter 7 in Collaboration and Student Engagement in Design Education*, Hershey, PA: IGI Global., pp. 145-168.

Panadero, E., & Brown, G. T. (2017). Teachers' reasons for using peer assessment: positive experience predicts use. European Journal of Psychology of Education, 32(1), 133-156.

Rienties, B., Alcott, P., & Jindal-Snape, D. (2014). To let students self-select or not: that is the question for teachers of culturally diverse groups. *Journal of Studies in International Education, 18*(1), pp. 64-83.

Springer, L., Stanne, M. E., & Donovan, S. S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Review of educational research, 69*(1), pp. 21-51.

Takyar, D. K., (2015). Generate Test Paper from Question Bank Using Excel VBA; http://www.familycomputerclub.com/Generate-Test-Paper-from-Question-Bank-Using-Excel-VBA.html

Taylor, A. (2011). Top 10 reasons students dislike working in small groups… and why I do it anyway. *Biochemistry and Molecular Biology Education, 39*(3), pp. 219-220.

Wankel, C., & DeFillippi, B. (Eds.). (2005). *Educating managers through real world projects* (Vol. 4): IAP Information Age Publishing.

Appendices

Appendix-A1 Sample VBA code for generating Random Instant Virtual Group (IVG) and Questions from a spreadsheet. (Note: full VBA code can be shared with the enthusiastic academics on request subject to the University IPRs)

'Copyright © 2017 by M.Jamro@herts.ac.uk All rights reserved. No part of this VBA code may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the author/publisher, except in the case of brief quotations embodied in critical reviews and certain other non-commercial and academic uses permitted by copyright law. For permission requests, write to the publisher or contact author via email.

```
Private Sub CommandButton1_Click()
'You can also name this button as Group. First we define two variables
Dim i, RowNum
'We clear all the content in column B
Sheets("Sheet1").Range("B3:B7").ClearContents
'We use the 'for next' loop to get our questions for this Sample IVG Quiz. If you want 5 Members use i= 1 to 5
For i = 1 To 5
generate:
'We generate random integers. If you have 100 students in the class then use 100 in the random function. In our test quiz we consider 30
RowNum = Application.RoundUp(Rnd() * 30, 0)
'We want no duplicates within the same IVG group therefore we check with countif
If Application.CountIf(Sheets("Sheet1").[B3:B7], Sheets("Sheet2").Cells(RowNum, "A")) = 0 Then
'If not duplicate we get the question from sheet2 to sheet1
Sheets("Sheet1").Range("B" & Rows.Count).End(xlUp).Offset(1).Value = Sheets("Sheet2").Cells(RowNum, "A").Value
Else
'If number generated is duplicate we generate another random number
GoTo generate
End If
Next i
'We do some formatting of the data in sheet1
Sheets("Sheet1").Select
Range("B2").Value = "Instant Virtual Group members"
Range("B2").Font.Bold = True
End Sub
Private Sub CommandButton2_Click()
'You can name this as Generate ONE question. First we define two variables, these should be different than the above variables used in sub
'commandButton1, otherwise these will generate incorrect values. However to keep the VBA code simple, we resues the above code and simple
'change the names of variables and their locations in rows and columns
Dim j, RowNumQ
'We clear all the content in column C
Sheets("Sheet1").Range("C3:C7").ClearContents
'We use the 'for next' loop to get our questions for the Sample Quiz. If you want One Questions use 'j= 1 to 1
'as here we just display only ONE questions, hence we use:
For j = 1 To 1
generate:
'We generate random integers. If you 100 questions in your question bank use 100 in the random function
RowNumQ = Application.RoundUp(Rnd() * 100, 0)
'We want no duplicates so we check with countif
If Application.CountIf(Sheets("Sheet1").[C:C], Sheets("Sheet3").Cells(RowNumQ, "C")) = 0 Then
'If not duplicate we get the question from sheet3 to sheet1
Sheets("Sheet1").Range("C" & Rows.Count).End(xlUp).Offset(1).Value = Sheets("Sheet3").Cells(RowNumQ, "A").Value
Else
'If number generated is duplicate we generate another random number
GoTo generate
End If
Next j
'We do some formatting of the data in sheet1
Sheets("Sheet1").Select
Range("C2").Value = "ONE (random) Question is:"
Range("C2").Font.Bold = True
Range("C2").Columns.AutoFit
End Sub
Private Sub CommandButton3_Click()
'We can use earlier defines two variables
'We clear all the content in column C
Sheets("Sheet1").Range("C3:C7").ClearContents
'We use the 'for next' loop to get our questions for this Quiz. If you want 5 Questions use 'k= 1 to 5. But here we just display only 'two
questions, hence we use:
k = 0
For k = 1 To 2
generate:
'We generate random integers. If you 100 questions in your question bank use 100 in the random 'function.
RowNumQ = Application.RoundUp(Rnd() * 100, 0)
'This gets the number generated in column B. We want no duplicates so we check with countif
If Application.CountIf(Sheets("Sheet1").[C:C], Sheets("Sheet3").Cells(RowNumQ, "C")) = 0 Then
'If not duplicate we get the question from sheet3 to sheet1
Sheets("Sheet1").Range("C" & Rows.Count).End(xlUp).Offset(1).Value = Sheets("Sheet3").Cells(RowNumQ, "A").Value
Else
'If number generated is duplicate we generate another random number
GoTo generate
End If
Next k
'We do some formatting of the data in sheet1
Sheets("Sheet1").Select
Range("C2").Value = "TWO (random) Questions are:"
Range("C2").Font.Bold = True
Range("C2").Columns.AutoFit
End Sub
```

```
Private Sub CommandButton4_Click()
'This will save the data copy-paste in sheet5. Find the first blank cell in the sheet. Copy and 'paste data below it.
Dim rFirstBlank As Range
    ThisWorkbook.Activate
'1. Find last used row in destination sheet
    Set rFirstBlank = Worksheets("Sheet5").Cells(Worksheets("Sheet1").Rows.Count, 1).End(xlUp).Offset(1)
'2. Copy data
    Worksheets("Sheet1").Range("A3:J7").Copy
'3. Paste data
    rFirstBlank.PasteSpecial
End Sub
Private Sub CommandButton5_Click()
'We can use earlier defines Five variables. We clear all the content in column C
Sheets("Sheet1").Range("C3:C7").ClearContents
Dim m, RowNumR
'We use the 'for next' loop to get our questions for the Quiz. If you want 5 Questions use m= 1 to 5 questions, hence we use
m = 0
For m = 1 To 5
generate:
'We generate random integers. If you 100 questions in your question bank use 100 in the random function
RowNumR = Application.RoundUp(Rnd() * 100, 0)
'This gets the number generated in column B. We want no duplicates so we check with countif
If Application.CountIf(Sheets("Sheet1").[C:C], Sheets("Sheet3").Cells(RowNumR, "B")) = 0 Then
'If not duplicate we get the question from sheet3 to sheet1
Sheets("Sheet1").Range("C" & Rows.Count).End(xlUp).Offset(1).Value = Sheets("Sheet3").Cells(RowNumR, "A").Value
Else
'If number generated is duplicate we generate another random number
GoTo generate
End If
Next m
'We do some formatting of the data in sheet1
Sheets("Sheet1").Select
Range("C2").Value = "FIVE (random) Questions are:"
Range("C2").Font.Bold = True
Range("C2").Columns.AutoFit
End Sub
Private Sub CommandButton6_Click()
'Button Reset & Initialise Marks for New group
'We clear all the content in columns D3 to H7. All the marks given to each individuals
Sheets("Sheet1").Range("D3:H7").ClearContents
End Sub
Private Sub CommandButton7_Click()
'Start timer functionalities
starttimer
End Sub
Private Sub CommandButton8_Click()
'Stop (pause) timer
stoptimer
End Sub
Private Sub CommandButton9_Click()
'Reset timer
Sheets("sheet1").Range("i12").Value = ("00:06:00")
End Sub
'Timer beep function
Sub starttimer()
Application.OnTime Now + TimeValue("00:00:01"), "nexttick"
End Sub
Sub nexttick()
Dim myValue As Double
Dim myColor As Long
myValue = Range("i12").Value
If Sheet1.Range("i12") = 0 Then Exit Sub
Sheet1.Range("i12").Value = Sheet1.Range("i12").Value - TimeValue("00:00:01")
If Sheet1.Range("i12").Value <= TimeValue("00:01:00") Then
Sheet1.Shapes("TextBox 1").Fill.ForeColor.RGB = RGB(255, 0, 0)
'Red warning, your group conversation time ended and now got 1 minute to conclude
Else
Sheet1.Shapes("TextBox 1").Fill.ForeColor.RGB = RGB(0, 255, 0)
End If
starttimer
End Sub
Sub stoptimer()
On Error Resume Next
Application.OnTime Now + TimeValue("00:00:01"), "nexttick", , False
End Sub
Function Beepnow()
Beep
End Function
'Declaration
Option Explicit
Sub createmychart()
Dim Chart1 As Chart
Set Chart1 = Charts.Add
Chart1.SetSourceData Source:=Worksheets("sheet5").Range("I1").CurrentRegion, PlotBy:=xlColumns
Chart1.ChartType = xlColumnClustered
End Sub
'Error message in reserved cells
Sub ErrorMessage()
'ErrorMessage Macro
'Shows an error
MsgBox "You Must Entre value", vbCritical
Range("E23").Select
End Sub

'Other VBA codes for full operational IVG quizzes may be available on request subject to University IPRs.
```

Appendix-B1 Example of 'Sample IVG Quiz, illustrating developing and organising groups'

(a)

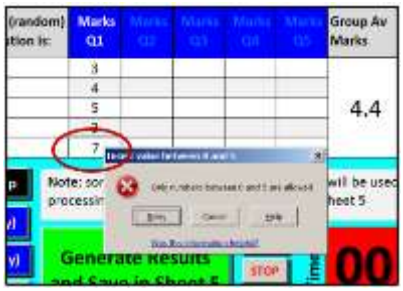
Ready for marking after assessment (start countdown timer when group is ready)

(b)

Finished with marking after peer assessment and ready to save data in Sheet 5

(c)

Error message entering accidently marks elsewhere on the datasheet (i.e. cells are protected)



(d)

Error message: entering incorrect marks '7'marks. Only valid numerical values between '0' and '5' are allowed.

(e)

Accidental entry in reserved cells is not allowed (i.e. Group Av Marks)

(f)

Accidental entry in reserved cells is not allowed (i.e. member 6 does not exit)

Figure B1. Various screenshots of sample IVG Quiz showing execution stages. Note that these screenshots show only 'One question' for each IVG group. The data produced after clicking green button will be for one component (i.e., one question) and one leader manages the entire group activity (see more operational details in Appendix B2).

Sheet #1: Assessment and Marking in classroom**.** Random groups are generated and peer assessed marks are input by tutor in Sheet1. All the data cells are protected, for example; in the 'Marks' column, the cells accept only numerical value between 0 and 5 (including decimal point values). To protect accidental or incorrect or forced entry in any in reserved cells will be rejected displaying approperiate warning messages (i.e. Question's column, Group Av and Indv-Group Av etc).

Group formation and random selection to maximize participation: *Conditional group formation.* Consider a cohort size, '$n = \mathbf{30}$' participants comprising '$m = \mathbf{5}$' in each group, constituting **6** random groups, '$N = 6$', without repeating, for example: groups, A; B; C; D; E and F, respectively, and let's call this as the 'Category-I'. For *surprise*d random reappearance of members from all 30 participants, **4** or more mixed groups can be formed. Ideally, selecting group members from combined two pseudo-random groups (i.e.

A and B, etc), hence '$k = 2$' expecting to form 15 possible mutual groups *combinations* of twos, e.g., AB, AC, AD..., EF or combinations of threes, or more, respectively, for $2 \geq k \leq 6$, can be achieved using formula: $\binom{N}{k} = \frac{N!}{k!(N-k)!}$, $k \leq N$. Let's call this the 'Category-II'. For an IVG quiz session, 10 random groups can be selected (i.e. 6 without repeat and 4 with members reappearing pseudo-randomly from mixed groups ensuring that selected random names have not appeared twice in previous IVGs confirmed from Sheet 5). These two Category -I and II are further arranged such that after every two IVG groups from Category-I, an IVG group from Category-II will appear. Therefore an expected order of the ten groups can be observed as under.

Order of IVGs	Category-I	Category-II	Comments
1	IVG#1	-	10 minutes per each group. The IVGs in Category-I are without repetition. Category-II contains IVGs with reappearing based on random selection of members from mixed groups using formula: $\binom{N}{k}$ for N=6, and $2 \geq k \leq 6$,
2	IVG#2	-	
3	-	IVG#7	
4	IVG#3	-	
5	IVG#4	-	
6	-	IVG#8	
7	IVG#5	-	
8	IVG#6	-	
9	-	IVG#9	
10	-	IVG#10	

Two hours (i.e. 120 minutes) per Quiz time distribution: 100 minutes for 10 groups (*i.e. 10 min time allowance per each group covering, 6 min for co-operatively group working answer; plus 2 min for peer assessment; plus 2 min catch-up/break time*) + **10 minutes** for final results and analyses/discussion/feedback at the end of quiz session + **10 minutes** welcome and switch off time (5 minutes each).

Appendix-B2 Sheet 5 Auto-populating and plotting the results with analysis

Sheet 5 is automatically populated with the data entry in the Sheet 1 by clicking on button 'Generate Results and Save in Sheet 5'. By default, the quiz is set to display up to 10 groups (6, + 4 expecting groups with repetition). More IVGs can be created with conditional repetition of names as explained earlier based on VBA code using combination or permutation. However, any number of groups can be added or set as default subject to availability of in-class contact time. It can be observed from the Figure B2 that few names are reappearing in different groups. If tutor would like to continue the quiz and generate new groups (i.e., IVG#11, IVG#12 and etc) then these will be added in the 'Group Comparison Chart' and also corresponding IVG# bar charts (i.e., these can be seen in the background, also given in more details in Appendix B3).

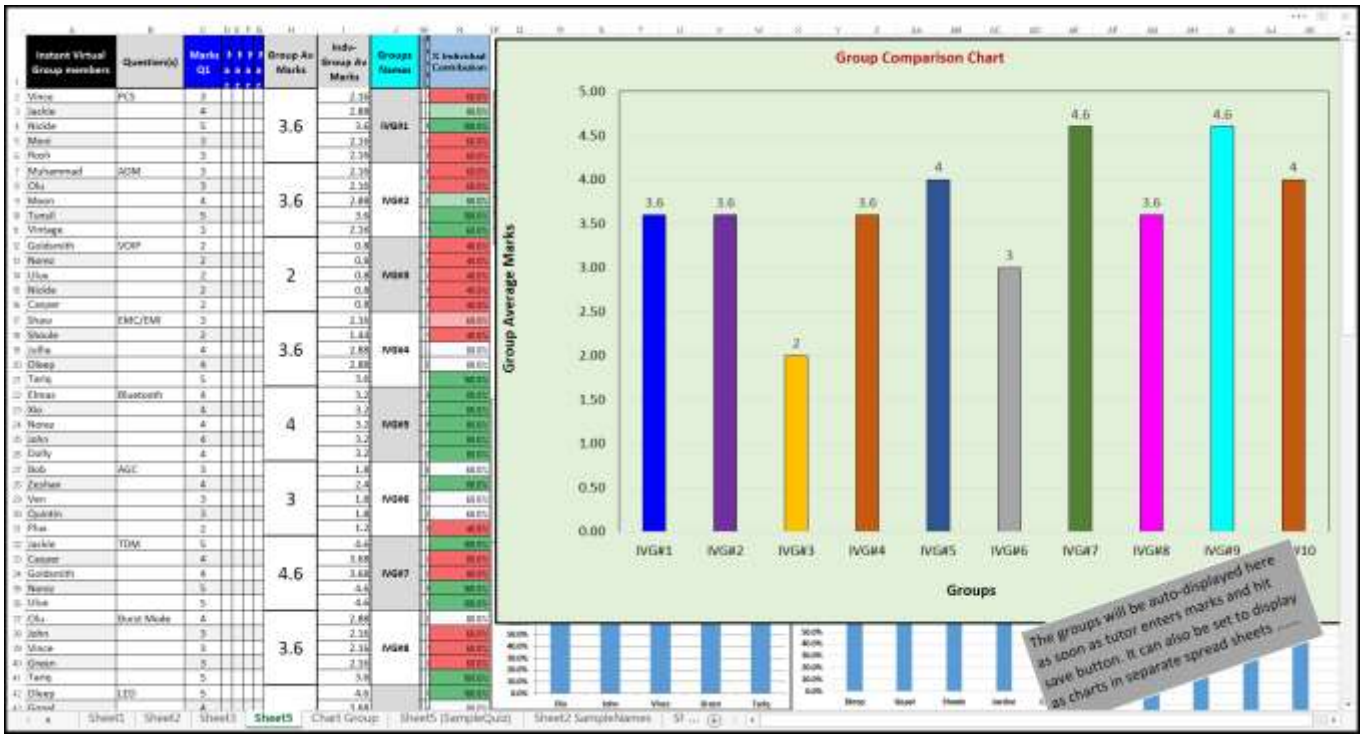


Figure B2. Structure of Sheet 5 to store data and auto-construct various statistics and plot the data to present to individuals and their IVGs.

Scenario #1: Generating only 'One question' for each IVG group on Sheet 1. On completion of allocated slot, tutor invites entire class for peer assessment and awarded marks are input for each individual in the marks column for Q1.

Scenario #2: Generating more than one question. This is suitable to test their leadership qualities. (i.e., challenging each member to lead a different single component of the quiz question). Here, maximum implementable question number can be set between 2 to 5 for each IVG group (i.e. in Excel, columns C, D, E, F and G, respectively, on spreadsheet Sheet1). The names appearing in the each question row-column-A, are the leaders responsible for managing group conversation and final answer to their given questions in column B. The entire IVG group cooperatively workout the answer for Q1 first and tutor invites entire class for peer assessment for Q1. Then moves onto Q2 and onwards. The rest of the process for remaining questions (i.e. Q2 to Q5) will be similar to Q1. This scenario is more time-constraint and challenging, and only suits the assessment with less number but well-articulated questions (i.e. between 5-to-10, instead of 100's short single term or phrase questions) randomly offered to IVG members who may already have attempted the whole assignment but will be assessed on just any one component.

Appendix-B3 Relating Homology and Homotopy with individual contribution and group performance

As given in Appendix-B2 (*Scenario #1*), similar statistical data and bar charts can be provided for each groups showing their individual contribution to build group marks. As shown in Figure B.3, each group is presented with a bar chart showing each member's effort as contribution in percentage making the group-average marks for that group. It also shows traffic light coloured analyses with green, white and red for best, average and poor contributions, respectively. For example, IVG#1 with 3.60 group-avg, Nickle and Jackie show investing 100% and 80% of their individual efforts, respectively, and were green flagged. Other group members, Vince, Moni and Rosh comparatively invested low efforts within the group and came under red flags with 60% each. The IVG#10 shows very promising group-avg marks of 4.00 identifying as all contributing much to group efforts with green flags. All the members in IVG#3 under performed and none showed enough efforts and all were flagged red.

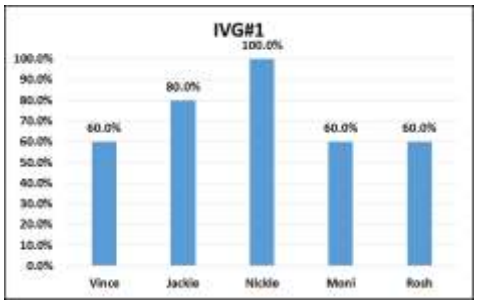
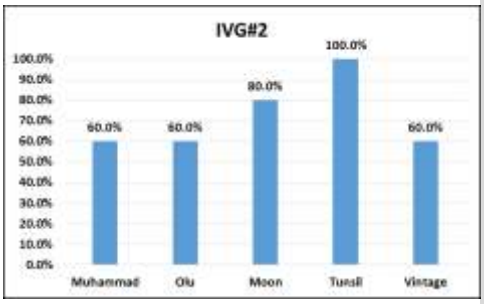
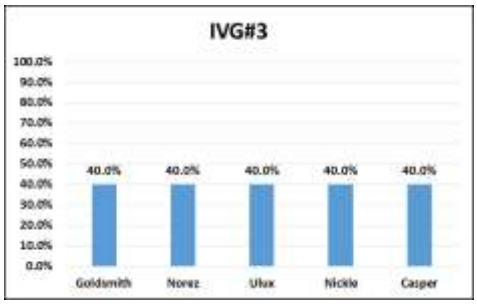
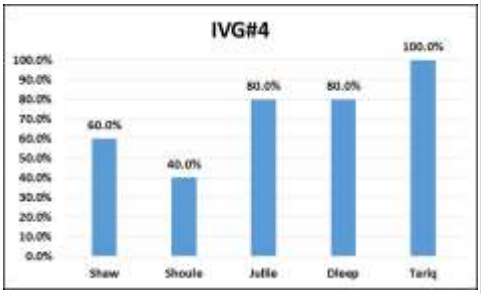
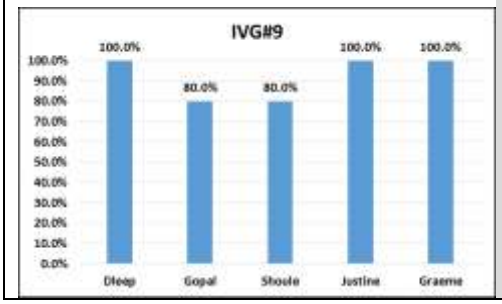
Individual efforts within the Group	Homotopic Impact	Individual efforts within the Group	Homotopic Impact
	3.60 Gr. Av Vince 60.0% Jackie 80.0% Nickle 100.0% Moni 60.0% Rosh 60.0%		3.60 Gr. Av Muhammad 60.0% Olu 60.0% Moon 80.0% Tunsil 100.0% Vintage 60.0%
	2.00 Gr. Av Goldsmith 40.0% Norez 40.0% Ulux 40.0% Nickle 40.0% Casper 40.0%		3.60 Gr. Av Shaw 60.0% Shoule 40.0% Jullie 80.0% Dleep 80.0% Tariq 100.0%
	4.60 Gr. Av Dleep 100.0% Gopal 80.0% Shoule 80.0% Justine 100.0% Graeme 100.0%		4.00 Gr. Av Green 80.0% Tariq 80.0% Soppy 80.0% Alexander 80.0% Joseph 80.0%

Figure B3. Selected IVGs screenshots from 'Sample IVG Quiz' sessions showing comparison of their individual contributions and resultant group homotopic impact.

The coloured scale patterns are auto produced from chart analysis when a group of cells are selected in Excel for 'quick analyses. This shows individual performances associated with their group homotopy. A group is said to be 'homotopic' such that individual efforts are completely transformed into group contributions. For example, all green (or combination of green and white) flags demonstrate full-homotopy that can be ranked as excellent, better and good, respectively, based on their percentages. However, the red flags in IVGs can be seen as significant threat making a group partial- or non-homotopic affecting the overall performance leading to dysfunctionality. This rank classification is given in the Table B3.1. The card colour on top of the deck represents the 'group homotopy' where the layers underneath show transformation based on individual efforts, green, white and red for full, partial and non- homotopy, respectively.

Table B3.1 Homotopy classification and ranks

Homotopy class	**Traffic patterns**	**Ranks and their conditions**				
		Excellent	Better	Good	Average	Poor
Full homotopy		all green	more green and some white	some green and more white	-	-
Partial homotopy		-	-	-	combination of all colours	-
Non-homotopy		-	-	-	-	all red

The effective communication among randomised IVG members within a classroom environment can be dependent on physical room area. As a rule of thumb, a regular teaching classroom of 30 students may require a floor space of 45 m^2 (i.e. length 7.5m × width 6.0m) giving an average of 1.5 m^2 desk space per single student (this excludes floor space for teaching desk, equipment, partitioning, etc). Therefore, it is expected that an average random group of five could spread onto a floor plan within 7.5 m^2 to 30 m^2. The random shape of 'finite' *physical space* occupied by a group can be visualised considering various possible combinations of vertices forming triangular shapes based on *simplicial complexes*[11].

[11] More analytical discussion can be found in the reference Jonsson, J. (2008). *Simplicial complexes of graphs,* (Vol. 3): Springer. *https://link.springer.com/content/pdf/10.1007/978-3-540-75859-4.pdf, date accessed: 12/07/2017.*

Table B3.2 Simplicial complexes and effective peer communication

***x*-Simplex**	**0-Simplex**	**1-Simplex**	**2-Simplex**	**3-Simplex**	**4-Simplex**
Diagram (space shape)					
Effective transmission area					
Shape description	single point, vertex	line segment, edge or vertices	triangle	tetrahedron	cell with 5 vertices or pentachoron
Communication	An individual	The mutual understanding between/among peers shown by algebraic Venn diagrams showing intersectional area (i.e. two-way communication), several members require comparatively more synchronisation time for developing mutual consensus or agreement.			

The distance between two members (i.e. two points in space) determines the effective transmission area to establish suitable communication as environmental noise increases *exponentially* with increasing distance. There are various parameters associated with poor group dynamics within and across the groups building '*peer pressure'* causing *inertia*. These phenomena are under investigation. Although it is commonly considered that '*two heads are better than one*', but things may get complicated when multiple heads are put together. In such cases, various group dynamics must be carefully controlled (i.e. time keeping, conflict management, and convergent conversation, etc). All this requires increasing mental work and more synchronisation time and efforts among peers with increasing number of peers as function of covered space area as shown in Table B3.2. The space takes a regular shape for effective transmission with the shorter radius and if the LOS homology among all members is maintained then the effective communication will take place. The cooperativeness may decrease with increasing number of vertices and triangles, and hence can reduce overall group cohesiveness. For shorter distances, the orientation of triangulation does not affect the homology and therefore the 2-simplex is ideal for consistent homology requiring less sync time as compared to large *x*-simplex. With increasing number of '*x*', the optimal space spread due to diverse simplicial complexes can be difficult to maintain the *Barycentric* coordinate system, For example; with $x > 4$ most of the peers may be located away from the centre point and these members can easily find themselves blocked and disengaged. However, 4-simplex closely spaced triangles with clear LOS homology and with minimal obstructions still can produce positive results leading to effective group communication among the members. Keeping smaller value of '*x*', all individual efforts can easily be transformed into mutual group contribution resulting more homotopy. Hence, it is expected that an IVG with 4 or 5 members can yield better performance as compared lesser or larger group size.

Appendix-C Anonymous Quiz Survey Questionnaire handed in as paper copy (the similar Questionnaire was set as a PowerPoint presentation using TurningPoint Technologies® EVS quiz)

Please identify your Programme Level (i.e. 4, 5, 6 or, 7 MEng or MSc)		Level 4	Level 5	Level 6	Level 7 MEng	Level 7 MSc
		○	○	○	○	○
Read following questions and choose ONE option as your best answer						
Q. No.	**Question (Topic)**	**Strongly Agree 1**	**Agree 2**	**Neither 3**	**Disagree 4**	**Strongly Disagree 5**
Q1	I know the difference among Group-work, Group-Individual-work and Individual-work	○	○	○	○	○
Q2	Now I know my weaknesses/strengths and can decide my role within a group	○	○	○	○	○
Q3	I can easily introduce myself to the new members (i.e. random grouping)	○	○	○	○	○
Q4	The IVG quiz helped me to gauge my communication skills	○	○	○	○	○
Q5	I prefer making a group 'ourselves' rather than random selection	○	○	○	○	○
Q6	The randomness of IVG quiz kept me active throughout the test session	○	○	○	○	○
Q7	More IVG quizzes with small summative assessment including feedback will help me	○	○	○	○	○
Q8	I understand 'group dynamics' more than last semester/year	○	○	○	○	○
Comments (*Optional*)	*Please write your comments and suggestions to improve our system. Do not write your ID as this is anonymous survey.*					

Figure C.1 Anonymous Quiz Survey Questionnaire.

Appendix-D Chi-Square Test (Degrees of Freedom)

Standard χ^2 distribution											
Degrees of Freedom (*df*)	**Probability (*p*)**										
	0.95	**0.9**	**0.8**	**0.7**	**0.5**	**0.3**	**0.2**	**0.1**	**0.05**	**0.01**	**0.001**
1	0	0.02	0.06	0.15	0.46	1.07	1.64	2.71	3.84	6.64	10.83
2	0.1	0.21	0.45	0.71	1.39	2.41	3.22	4.6	5.99	9.21	13.82
3	0.35	0.58	1.01	1.42	2.37	3.66	4.64	6.25	7.82	11.34	16.27
4	0.71	1.06	1.65	2.2	3.36	4.88	5.99	7.78	9.49	13.28	18.47
5	1.14	1.61	2.34	3	4.35	6.06	7.29	9.24	11.07	15.09	20.52
	Non-significant								Significant		

Figure D.1 Chi-Square Test (Degrees of Freedom).

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