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Active Learning Strategies for Higher Education: the Practical Handbook

Centre for Higher Education Research, Policy and Practice

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ACTIVE LEARNING STRATEGIES

For
HIGHER EDUCATION
THE PRACTICAL HANDBOOK

Centre for Higher Education
Research, Policy & Practice





Active Learning Strategies For Higher Education

THE PRACTICAL HANDBOOK

FURTHER INFORMATION

More details on CHERPP

The Centre for Higher Education Research, Policy & Practice (CHERPP) is an international collaborative project hosted by the University of Ontario Institute of Technology (UOIT), Durham College, and TU Dublin. A Memorandum of Understanding to establish CHERPP was signed by all three institutions on November 2, 2016. Association with CHERPP is open to all researchers and practitioners in higher education. <https://cherpp.ca/>

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FOREWARD

FOREWARD

As joint Directors of Centre for Higher Education Research, Policy and Practice (CHERPP), it gives us great pleasure to introduce you to a handbook that represents all that is good about the collaborations that take place through our centre. The volume that you are holding is the result of many hours' commitment by Staff from across our member Institutions in both Canada and Ireland. These contributors have given their time tirelessly to make this manual a reality, for the benefit of students across Durham College, UOIT and TU Dublin. They have also recognised the importance of Educators having excellent resources, created by practitioners that have tried and tested the strategies that are outlined over these pages.

CHERPP has emanated from previous Higher Education in Transformation Conferences where the Presidents of five Institutions recognised the importance of creating a vehicle within which staff could come together to share their understanding of how they make a difference and contribute to the constantly changing field of higher education. With the support of each institution as well as the Government of Ireland Academic Mobility Fund and the Higher Education Authority, professional and academic staff are now working on over 30 long term projects, with that number set to double in the coming years. However, the beauty of what a centre such as CHERPP can contribute to Higher Education lies in the recognition of difference. These differences exist within our cultures, student profiles, teaching approaches and institutional missions, to name but a few. Our members,

such as the Contributors of this manual, have embraced these differences and recognised the strengths that lie within them to work together to show what can be achieved when diverse views and styles are channelled to improve the student experience.

The manual itself is based on a sound method that the Educator can easily deploy. This is made up of easy stages for each activity which they and their students can embrace. This student-centred pedagogical approach allows learners to build their understanding while also taking responsibility for their own learning where the educator acts in a facilitator or enabler role. This active, enquiry-based approach is at the heart of what Durham College, UOIT and TU Dublin endeavour to provide to students as it can be applied to diverse problems and contexts within their educational journey and across disciplines. It also provides learners with a framework to use when working on problems that they will encounter within the workplace and encourages lifelong learning.

We hope that you will receive the many benefits of this manual and that it will spark a curiosity within your students that active, experiential learning so often does. Congratulations to all of the Contributors on what is a wonderful contribution to the rapidly changing ecosystem of Higher Education.

**Dr Cormac Doran and
Professor Brian Campbell**

ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

In ordinary life we hardly realise that we receive a great deal more than we give, and that it is only with gratitude that life becomes rich.

Dietrich Bonhoeffer

The flipped classroom phenomenon in Higher Education has forced many educators to reconsider on how to best to utilise lecture time. Many students are also voting with their feet with low attendance figures being recorded in many institutions. During the Higher Education in Transformation Conference 2016 (HEIT 2016) there were several highly energised debates and instructions/examples on how to implement active learning. A key point that emanated from these discussions was that lecturers needed practical direction on how to embed active learning strategies into the lecture room. With the ambition of meeting this challenge the authors have created a practically based resource, Active Learning Strategies for Higher Education, The Practical Handbook, which will include full instructions and examples for the delivery of active learning strategies for higher education. It is hoped that this book, and engagement with several strategies within it, will allow lecturers to redesign the time available with students to enhance their learning experience.

Of course, organising something of this magnitude and bringing it to fruition relies on the good will and support of many people. We would firstly like to thank our individual institutions, Durham College, TU Dublin, and UOIT, for supporting our endeavours from the outset. We would also like to acknowledge the support of the Government of Ireland Academic Mobility Fund and the Higher Education Authority. A special thanks to Dr Cormac Doran and Professor Brian Campbell for creating the space for this collaboration to take root; your efforts allowed us to do our thing! A distinct acknowledgement to Dr Philip Owende; your example and support has guided this work from initiation to completion, much appreciated!

And finally, I would like to express my gratitude to the many contributors; your passion for your craft, your critical view of pedagogy and the love for your students is evident in your contributions. I look forward to our future international collaborations.

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Nicola Duffy has been a lecturer at the Institute of Technology Blanchardstown since 2011 and previously with Letterkenny Institute of Technology. Nicola has thirteen years' experience lecturing and currently teaches on the BA (Hons) in Creative Digital Media specialising in the areas of UX, Design Thinking, Visual Communication and Interaction Design. Her research interests include Inclusive Design, UX and Interactive Design. She holds a Masters in Design by research from Letterkenny Institute of Technology and was awarded a scholarship from the Minister for Children to undertake this masters. Nicola is a member of the Institute of Designers Ireland (IDI).



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Bill Hunter was born in Larne, County Antrim. He has worked for universities in Ohio, Rhode Island, Nova Scotia, Alberta, and Ontario. He has had research leaves to New York, Ireland, Northern Ireland, and New Zealand. In 2002, he was the founding dean of the Faculty of Education at the University of Ontario Institute of Technology. Before that, he spent 16 years as an education professor and department head at the University of Calgary. He was previously on the faculty of Mt. St. Vincent University in Halifax, Nova Scotia. With Roger Austin of Ulster University, Hunter published *Online Learning and Community Cohesion*, an examination of international projects using ICT to bring together children and teachers from communities in conflict. In addition to publications in research journals, he has had extensive experience as a reviewer and editor for research journals, most notably as editor of the *Canadian Journal of Education*. Since 2010, Hunter has had his graduate students collaborating on the construction of a wiki focused on principles of learning. That work was recently highlighted in a special issue of the *Canadian Journal of Action Research* featuring student reflections on wiki-building as a learning process.



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Mark Keyes has been employed at ITB since 2009, initially as a lecturer and currently as Work Placement Coordinator. With a background of over 20 years' experience in the construction industry, he has been active in the development and delivery of up-skilling programmes in the fields of energy efficiency, renewable energy and building retrofit. Since 2011, he has managed a number of EU-funded projects at ITB, including Build UP Skills Ireland (BUSI) and QualiBuild, where he led work packages developing upskilling programmes for construction workers in the field of low energy buildings. Mark is currently responsible for coordinating Learn + Work programmes at ITB, an innovative model of training designed in collaboration with industry. He holds a Diploma in Arts (Training & Education) from NUI Galway and an MSc in Applied eLearning from DIT.



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Barry Ryan is a research active applied biochemist who enjoys blurring the academic lines between teaching, learning and research. He is engaged in the development and execution of high quality, often technology enhanced, learning experiences and he is enthusiastic about sharing his research-informed pedagogy. His primary degree is in Biotechnology, with his PhD in Applied Biochemistry. Subsequent postgraduate teaching and learning qualifications include a Postgraduate Diploma in Higher Education, an MSc in Applied eLearning and an MA in Higher Education. His pedagogical expertise and impact have been recognised by institution level (DIT Presidential Teaching Award, 2012 and 2013) and national level awards (Jennifer Burke Innovation in Teaching Award, 2014). He has also been accredited as a Senior Fellow of the HEA (2016) and a Chartered Science Teacher (CSciTeach, 2017).



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Robert Savelle is an instructor in the School of Interdisciplinary Studies at Durham College. With nearly 20 years' teaching experience, Rob began his education career as an ESL instructor to adult learners in Paris, France, prior to completing his Bachelor of Education at Lakehead University in Ontario. Rob then worked in Mexico City, teaching IGCSEs and A-Levels in History, Geography and Environmental Science at an international secondary school before moving to Shanghai, China, and teaching similar subjects in the International Baccalaureate's Diploma Programme, for which he remains an exam author and senior examiner. Upon returning to Canada, he completed his MA at Trent University, focusing on community-based research and education.



Joseph Smith

Joseph Smith has been a lecturer in ITB since 2004. Previous to this, he spent 12 years as an instructor in Wheatfield Prison Dublin where he ran a construction workshop for prisoners. He has presented at a number of conferences including the International Network of Innovative Apprenticeship Conferences (INAP 2017) and the International Conference on Engaging Pedagogy (ICEP 2018). He has a keen interest in how students learn and implementing new teaching methods. He currently teaches maths on a number of undergraduate courses in the engineering, computing and horticulture departments. He has a number of certificates in advanced Brickwork Technology, Construction studies and a BA in Education from NUI Galway.



Barry Thompson

Barry Thompson enjoyed a rewarding 26 year first career as an Industrial Millwright. His second career as an instructor at one of Ontario's Colleges of Applied Arts and Technology has been equally rewarding. He treasures each new day educating the next generation of tradespeople. His research interests include instructional design, liberal education and the place where the head, hands and heart meet in trades' education. As part of this new career, he has completed an undergraduate degree in English Literature and a Master's degree in Adult Education.

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INTRODUCTION

INTRODUCTION

Since you are reading this page, it seems likely that you have some interest in, or at least curiosity about, active learning. Perhaps you have searched for the term on the Internet. Such a search would yield a massive number of links (I got over 750,000 hits with Bing and more than twice that with Google)

Clearly, there is a lot of information about this topic and a lot of interest in it. If you began to look through that information, you would have quickly found that there is a tremendous amount of redundancy—there are myriad sites that define active learning, that advocate for it, that provide a sample of methods, and that provide links to further information. Refining the search, for example, to find resources in post-secondary science education, cuts down the volume of hits (in my case, to about 75,000 Google hits), but many of those links still deal with general issues. Further refinements are, of course, possible and an academic search engine like Google Scholar might be expected to find fewer, more relevant, hits, but in my case, the number of hits actually increased to over 94,000. While it was easier to find relevant links in this collection, even the titles introduced new terminology like 'student engagement', 'flipped classroom', and 'critical thinking'.

If you spend the time, you can find information that will address your specific questions and point you towards teaching strategies that might work for you. In this volume, you will find articles by people who have not only taken the time to do that research, but have taken the further steps of developing applications of active learning strategies in their own classrooms. They have reflected on the results they got and they have done the analysis and synthesis necessary to enable them to write concise and focused papers that are meant to inspire others and to guide them in developing similar strategies for their own classrooms.

The broader framework to which active learning belongs is constructivist learning—the idea that people learn through a process of building mental representations of the concepts and ideas they are exposed to. Some of the active learning strategies described in this work specifically structure

activities that involve learners in sharing their ideas with others—usually called 'social constructivism'. While the descriptions in this book are meant to be complete standalone guides to the pragmatic use of specific strategies, readers who would like to learn more about the underlying theories might refer to a series I prepared specifically for post-secondary instructors (Hunter, 2015a, 2015b, 2015c).

Readers of this work might well wonder 'Many of these strategies appeal to me, how do I choose among them?' It is a reasonable question. All of the strategies require some advanced preparation, possibly including instructor-authored cases or problems, worksheets, recording forms, or other instructional resources. Choosing one requires a commitment of time and energy. Moreover, all of the authors identify possible problems and a frequent one is students being reluctant to participate in something unusual. That experience has also appeared in the research literature along with strategies for addressing the issue (Tharayil, 2018). So, though there is a risk in choosing to adapt one of these strategies with a class full of students who have been schooled to believe their job is to acquire information for regurgitation, that problem need not deter committed instructors. With this in mind, it is important to remember that the success of any educational innovation is dependent on the extent to which the instructor believes in the efficacy of the innovation. The first step in choosing, therefore is simple and obvious: pick a strategy that you really like and that you think you can believe in.

Scanning all of the strategies will help with that, but many of the strategies involve some sort of group work and I think the 'Group Work' strategy by Mark Keyes and Richie Ryan does a great job of laying out the whys

and wherefores of working with groups. You would do well to read that chapter and to use the information in it to help you think about what kind of group work you can most comfortably manage—that may help you choose a strategy that fits your style.

Most of the authors indicate that the strategies they describe work well across different kinds of classes (large, small, lab, etc.) and subject areas, but you might well see that some method makes more sense for your situation. For example, if you have been using 'word problems' in a mathematics module, you might readily see how, by adding some context to the word problem and creating characters who have to solve the problem, you might be able to structure a 'case' that would get students to focus on the critical decision factors in solving the word problem. Or if you want to get your feet wet slowly and you have some rather focused question to which students might legitimately have diverse answers, then Think, Pair, Share might be just the thing to get you and your students engaged in active learning.

In any event, the objective is to get students involved in their own learning, to think more about meaning and about application and about analysis. We want them to begin producing ideas and testing them and sharing them and learning to give and to accept constructive criticism. We want them to take responsibility for what and how they learn so that they lay the foundation for a lifetime of learning—and we want them to see that THAT is exciting. So, as a closing note, let's all remember to model for them what excited and engaged learning is all about by participating in the process with them.

Bill Hunter



Image 1: Students working in a group setting



Image 2: Students discussing group tasks in a group setting.

01 Active learning strategy

ACTIVE LEARNING STRATEGY 01

Minute Paper

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THE STRATEGY

MINUTE PAPER

Minute paper is a brief classroom exercise that can be used to encourage students to reflect on their learning. The instructor poses one or more questions related to the current lesson, and students are asked to quickly write their responses and submit them to their instructor. Thus, minute paper also serves as a formative assessment technique.

The brief nature of this activity makes it easy to review student responses and requires minimal time to facilitate in class. Despite its simplicity and ease of use, this strategy can be of great benefit to both instructors and students alike. The activity promotes active learning, which can be especially valuable in larger classes, where instructor/student relationship building can be challenging. As they are being asked to reflect on the current lecture, students are encouraged to actively listen and remain focused during class. The minute paper also provides instant feedback to both teachers and students in relation to the levels of student understanding achieved during the lecture. The instructor can quickly see what topics students perceive as having the greatest importance, and what

misconceptions or questions remain. This can then be addressed in the next lecture and can thereby improve the students' learning experience in a timely manner. Thus, students may be more inclined to give valuable feedback through a minute paper activity rather than through student evaluations that take place at the end of the semester, where their responses can only improve the learning experience of the next cohort.

Many variations of the minute paper are possible. Students may be asked to explain the most important thing they learned in class, or to reflect upon any questions they have which remain unanswered (Angelo & Cross, 1993). The minute paper could be completed individually or collaboratively with small, or even large, groups. Students' responses could remain anonymous or not and could even be graded. Additionally, the minute paper could be conducted at the beginning, middle, or end of a class, or could be implemented multiple times throughout the lecture.

RESOURCES

Although no resources are required, you may wish to provide students with a handout with the questions you wish students

to answer. (See minute paper handout). Alternatively, blank index cards can be distributed to students for this exercise.

WHAT YOU CAN DO TOMORROW

Near the end of your class ask students to write their answers to the following questions:

- List 3 of the most important points you learned in today's class.
- List 2 specific areas that are unclear or that you're unsure of from today's class.

Let students know that they will have one minute to complete this task. Have students leave their written responses on their desks or ask them to hand them to you on their way out of the classroom. Read through student responses to gain an understanding about what students have learned, and what questions remain. Address any questions or misconceptions with your students during your next lecture.



Image 1: Students listing important points learned during class

STEPS FOR IMPLEMENTATION

STEP 01

PREPARATION

Write down some questions to which you would like your students to respond to. The questions may be related to the desired learning outcomes or tailored to specific aspects of the session.

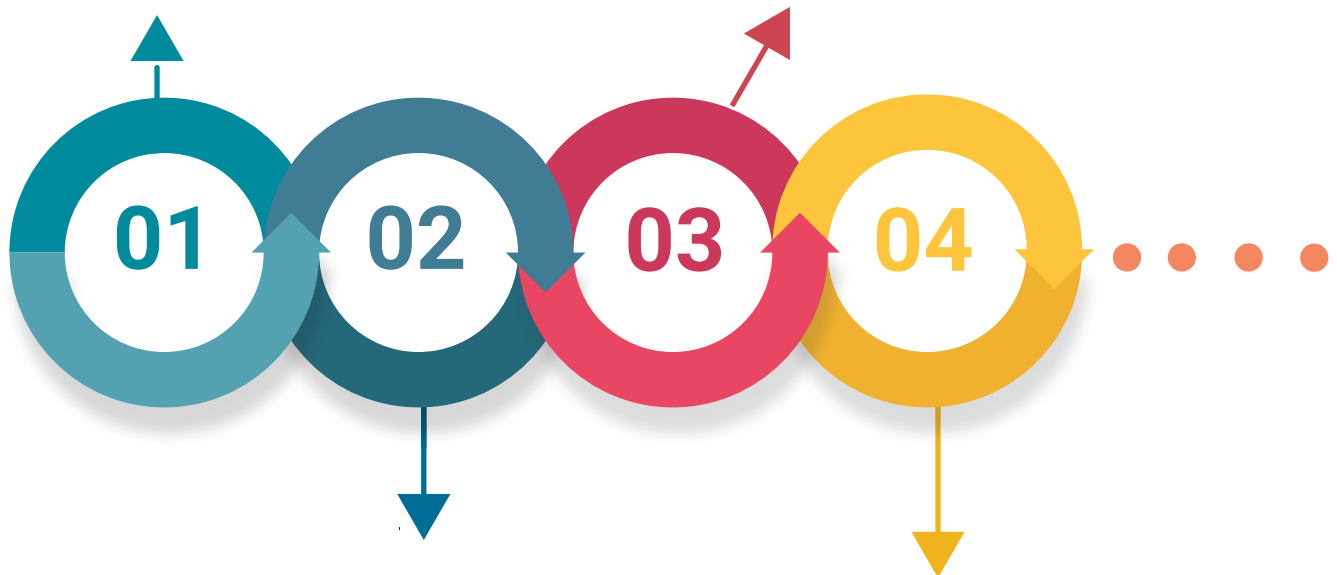
1. List 3 of the most important points you learned in today's class.
2. List 2 specific areas that are unclear or that you're unsure of from today's class.
3. Complete the following math problem [enter a problem].
4. How can the information you learned in today's class be used in your day-to-day life?
5. What concepts from today's class remain unclear?
6. How could the online learning activities provided in this course be improved?

Be sure to select question(s) that will provide you with useful feedback and consider how you might act on the students' responses (e.g. there is little merit in asking whether students would prefer a midterm evaluation if you have already decided that you will have one).

STEP 03

GET YOUR STUDENTS READY

At the appropriate time during the lecture, present students with the prepared questions and ask students to get a piece of paper (you could also provide them with a sheet of paper or an index card). Ask them to write their name on the top of the paper, or inform them to leave their names off if you prefer that they remain anonymous.



STEP 02

ANONYMOUS OR NOT?

Decide whether or not you would like this exercise to be anonymous. Anonymity typically results in more honest responses; however, it prevents you from discussing and addressing responses with individual students.

STEP 04

PRESENT YOUR QUESTION(S)

Write one to three questions on the board or incorporate the question(s) in your presentation slides. Alternatively, you can print the question(s) on the sheets of paper you have provided.

STEP 05

START TIMING

Let students know that you will be giving them one minute (or more time if you prefer) to respond to your question(s) honestly and concisely. Encourage point form responses if appropriate.

STEP 07

REVIEW THE RESULTS

Read through all the student responses and list the main ideas in each response. If you notice repetition in the responses, start to tally them up, rather than repeating them. In the end you should have a tallied list.

STEP 09

SHARE

During your next lecture, preferably at the beginning, share a summary of the responses with your class. Show the students that you did take the time to read through the responses. If appropriate, let the students know what action you have decided to take. If, for example, students reported that your online learning activities were useful, you may choose to post more of these activities. Alternatively, if the responses suggest that students are not grasping the content well, you may decide to incorporate more examples or checks for understanding throughout your lectures.



STEP 06

COLLECT THE PAPERS

Allow students time to discuss their answers and questions with their peers (Angelo & Cross, 1993). If the activity was completed at the end of class, you could ask your students to hand you their responses on their way out the door.

STEP 08

REFLECT

Reflect upon the responses you received. Did students achieve the learning outcomes you set out in your lesson? Are there any common mistakes or misconceptions you may want to address? What concept(s) should you revisit or clarify in the next lecture? Can you make any changes to your teaching style or course structure which might better support student learning?

OVERCOMING PUSHBACK

Even though this activity is quite simple and requires minimal time to complete, students may express frustration with a) not knowing where to start and b) understanding the purpose of the exercise.

I DON'T KNOW WHERE TO START...

Providing structure in terms of the number of points students may include in their responses can help to overcome potential discomfort with the open-ended nature of this activity. You may also wish to model an appropriate response the first time you use this strategy in your class. Be careful not to lead students to respond in a particular

way, however; you want them to express themselves authentically and honestly.

WHY ARE WE DOING THIS?

You may wish to emphasise the importance of active participation and reflection in the classroom, and the positive effect this can have on student learning. Additionally, explaining to students that you will read their responses and plan to use them to identify areas that may require further clarification can also help to reinforce the purpose of the exercise.

CASE STUDY

In a session facilitated for new clinical instructors and faculty advisors, a minute paper activity was posted on a PowerPoint slide at the end of the session. This allowed the learners to reflect on what they had taken away from a very busy afternoon of training

and to provide facilitators with feedback on the overall session.

Participants were given one minute to jot down their key takeaways from the session, ask any remaining questions, and provide feedback regarding the session.



Image 2: Presenting minute paper task to participants.

Handouts with instructions were also provided to the learners, and participants were asked to write their responses directly on the handout. This simple task encouraged participants to recall the big ideas from the session, reflect on the experience, and think about what further questions they had. After the session was complete, the facilitators tabulated the ideas generated.

In doing so, they were able to identify components of the session that were more memorable for the learners, as well as aspects that could be improved in future sessions. As this particular session was only a one-day event, remaining questions that were provided in the responses were addressed in an email to all participants.



Image 3: Learners participating in minute paper activity.

SUMMARY

The minute paper is a very simple active learning and feedback strategy, which can also serve a formative assessment function. Although the activity is quite short, it gives students an opportunity to reflect on learning from the lecture and compose any outstanding questions. As a formative assessment strategy, the minute paper also provides the instructor with timely feedback, which may be used to further improve

student learning. After collecting and analysing student responses, the instructor can then address student misconceptions and remaining questions. In doing so, the instructor conveys the message to students that they are respected and that their success is valued. Thus, all students, even those that may not be comfortable speaking in class, are given a voice.

FURTHER READING

Cross, K. P., & Angelo, T. A. (1988). *Classroom assessment techniques: A handbook for faculty*. Ann Arbor, Mich.: National Center for Research to Improve Postsecondary Teaching and Learning, University of Michigan.

Stead, D. R. (2005). A review of the one-minute paper. *Active learning in higher education*, 6(2), 118-131.

TEMPLATE

Minute Paper Handout

Please take a minute to jot down your key takeaways and remaining questions from today's lesson. Point form is fine. You do not need to add your name.

List 3 of the most important points you learned in today's class.

List 2 specific areas that are unclear or that you're unsure of from today's class.

* Questions adapted from Angelo & Cross (1993).

02 Active learning strategy

ACTIVE LEARNING STRATEGY 02

Connect-Extend-Challenge

Jordanne Christie

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THE STRATEGY:

CONNECT-EXTEND-CHALLENGE

The Connect-Extend-Challenge activity is a visible thinking tool that proposes the following set of three questions that encourage students to reflect on their thinking and to assimilate new information with prior knowledge:

- **CONNECT:** How are the ideas and information presented CONNECTED to what you already knew?
- **EXTEND:** What new ideas did you get that EXTENDED or pushed your thinking in new directions?
- **CHALLENGE:** What is still CHALLENGING or confusing for you to get your mind around? What questions, wonderings or puzzles do you now have?

This activity guides students to reflect on their prior background knowledge, identify new learning, and think about how new knowledge challenges or puzzles them. This activity was developed as part of Harvard's Project Zero Visible Thinking (2016) initiative which is focused on teaching practices that help make thinking visible. Its purpose is to help demonstrate to students that ideas and information can connect to other subjects and topics that they already know, and to get students to think in new ways and question assumptions. In addition, the Connect-Extend-Challenge activity provides an opportunity for students to make their thinking visible and helps to support the development of metacognition skills.

Defined broadly as 'thinking about one's thinking', metacognition is about being able to successfully plan, monitor, and evaluate your own learning. Many students who enter college lack metacognitive skills or fail to recognise when to use them (Flavell, 1979). As educators, it is important for us to help



Image1: Students Connecting

foster the development of metacognitive skills in students as these skills can help them to become successful lifelong learners. Research shows that metacognitive capabilities develop over time and that metacognition improves with appropriate instruction, suggesting that students can be taught to reflect on their own thinking (Brown & DeLoache, 1978). When students engage in metacognition, they become aware of their strengths and weaknesses as learners and are more likely to 'actively monitor their learning strategies and resources and assess their readiness for particular tasks and performances' (Bransford, Brown, & Cocking, 2000, p. 67). In addition, there is evidence that improved metacognition is associated with promoting students' overall academic success (Kuhn and Pearsall, 1998).

The Connect-Extend-Challenge activity supports metacognitive reflection by asking students three questions that encourage them to identify new information and ideas that are consistent with their prior understanding of a topic, that encourage them to revise or modify their thinking, and that are confusing or puzzling to them. This process helps students to deepen their understanding of a topic and become more thoughtful and reflective learners. This activity works best after students have been introduced to a new idea, concept or topic that might challenge their initial understanding or perspective (Facing History and Ourselves, 2018). The Connect-Extend-Challenge activity is broadly applicable to any discipline and works well with the individual, in small groups, or as a whole class activity.

RESOURCES

- This activity requires a handout, slide or flipchart paper with the Connect-Extend-Challenge questions, and optionally you can also provide Post-It Notes for students to record their responses to the questions. If you are teaching in an online or hybrid environment you can create a collaborative Google Doc (<https://www.google.com/docs>) with the Connect-Extend-Challenge questions listed where students can collaboratively post their responses to the questions, and review their peers' responses.
- Alternatively, you could also use a bulletin board tool such as Padlet (<https://padlet.com>) where you could provide the Connect-Extend-Challenge questions and students could post their responses for the rest of the class to see, either anonymously or with their names associated.
- In addition, you could also use an audience response tool such as Socrative (<https://www.socrative.com>) to pose the Connect-Extend-Challenge questions to students and to collect the responses and share them with the class for discussion.

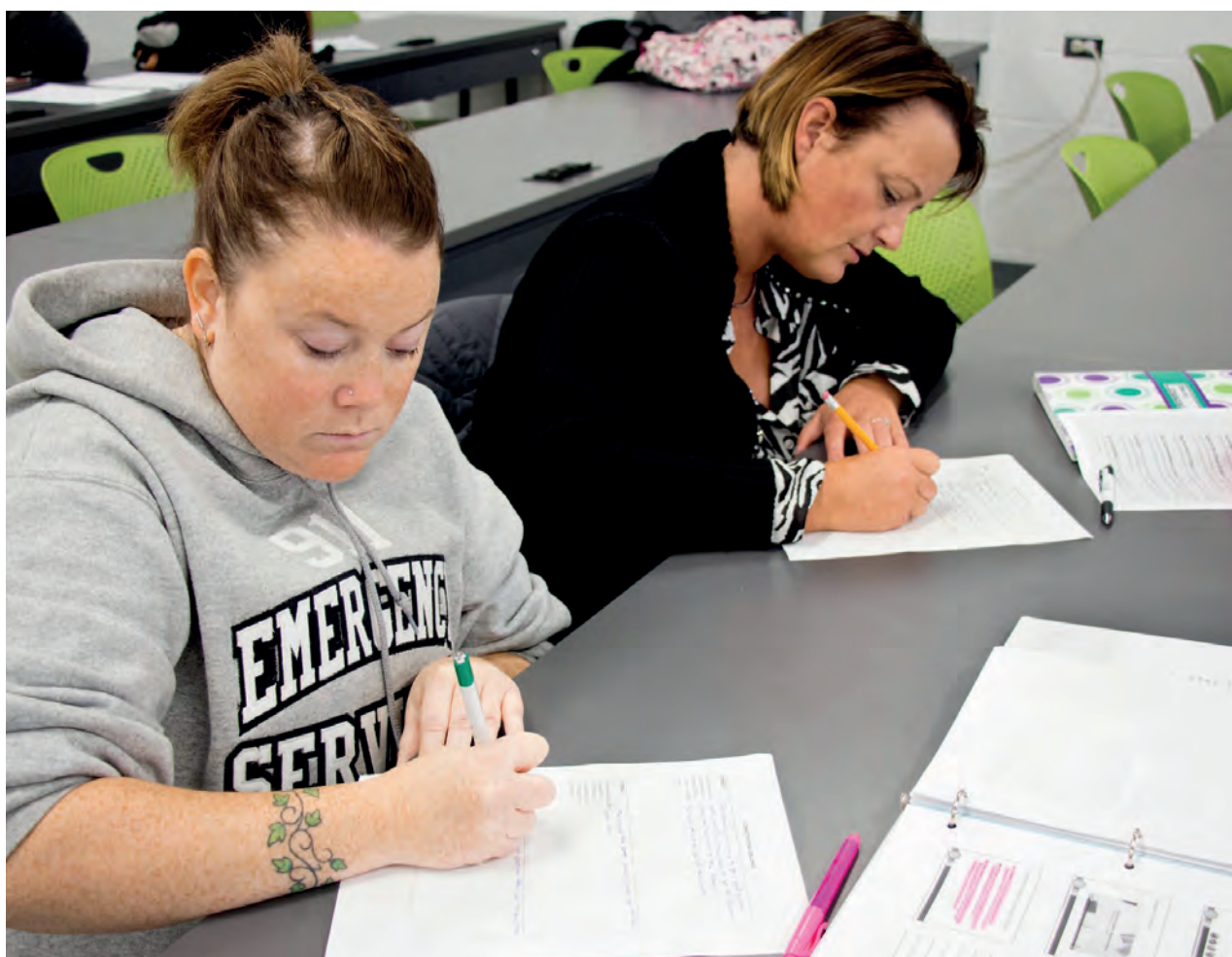


Image2: Students preparing their responses

WHAT YOU CAN DO TOMORROW

If you would like to use this activity right away, you can easily add it to an upcoming lesson where students have been introduced to an idea, concept or topic and are receiving new information or perspectives that might challenge their initial understanding. Upon exposure to a new idea, concept or topic, you can provide students with a handout that has the following questions:

- **CONNECT:** How are the ideas and information presented **CONNECTED** to what you already knew?
 - **EXTEND:** What new ideas did you get that **EXTENDED** or pushed your thinking in new directions?
 - **CHALLENGE:** What is still **CHALLENGING** or confusing for you to get your mind around? What questions, wonderings or puzzles do you now have?
-

You may also pose the questions verbally, or add them to a slide or flipchart paper. As a low risk activity, students may possibly be asked to complete the questions individually. Student responses can then be shared anonymously or publicly with the use of Post-It Notes to encourage discussion and debate. For a more medium risk option, you could ask students to work in small groups to answer the questions and have each group share their responses with the entire class, noting common themes and questions.

STEPS FOR IMPLEMENTATION

STEP 01

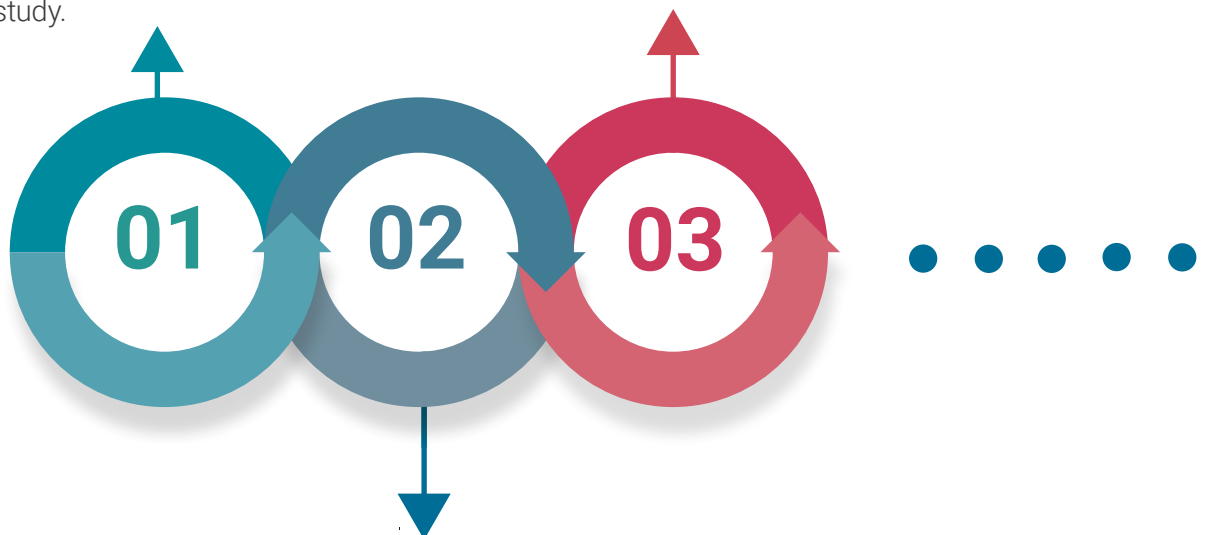
.....

Identify a course concept or idea that may be new to the students and which has potential to challenge initial levels of understanding. The activity can be used at various stages during a lesson, for example, when introducing a new resource, throughout a lesson, or at the end of a unit of study.

STEP 03

.....

If the activity is to be completed individually, you can prepare a handout with the Connect-Extend-Challenge questions, or you can provide Post-It Notes to students and ask them to jot down their responses. If the activity is to be completed in small groups, or as a whole class, you may want to provide flipchart paper to record the responses.



STEP 02

.....

Once the most appropriate time has been decided for use of the Connect-Extend-Challenge activity, you can decide whether you want the activity to be completed individually, in small groups, or as a whole class.

STEP 04

Have students engage in a lesson or discussion, view a video, read an article, listen to a guest presentation, or participate in any other teaching and learning situation where they may encounter new knowledge, and then pose the Connect-Extend-Challenge questions. When posing the Connect-Extend-Challenge questions to students you can customise them to the situation.

For example:

CONNECT: How do the ideas and information from this lesson/discussion/reading/video/guest presentation connect to what you already know about _____?

EXTEND: How does this lesson/discussion/reading/video/guest presentation extend or broaden your thinking about _____?

CHALLENGE: Does this lesson/discussion/reading/video/guest presentation challenge or complicate your understanding of _____? What new questions does it raise for you?



After students have completed their responses, you can debrief the activity with paired or whole-group discussion. You can address the identified questions and challenges, or have students work individually or collaboratively to provide suggestions of how to overcome the challenges or answer the questions. Alternatively, you can have students submit their responses and you can review them to identify any misconceptions, new learning, and outstanding questions which you can address in the next class or by sharing additional resources.

If you are using this activity in-class, be sure to schedule enough time to ask the questions (approx. 2 minutes), to allow students to respond (approx. 5–7 minutes), and to collect and discuss their responses (approx. 10 minutes).

OVERCOMING PUSHBACKS

Students may struggle making connections between the new material and their prior knowledge, as well as identifying new learning and challenges, so you may want to provide some prompts to help them overcome this such as:

- **CONNECT - CONNECT:** 'I already know the following about this topic...' or 'This reminds me of...' or 'I have encountered similar information in the past when...'
- **EXTEND - :** 'This added to my thinking because...' or 'I used to think... Now I think...'
- **CHALLENGE - :** 'This makes me wonder...' or 'This surprises me because...' or 'I would like to know more about...'

Also, students may be reluctant to share their responses, so you may want to start the activity by having the students answer the questions individually and then have them pair up to share their responses. You can then have the pairs join to form small groups and each group can report one or two responses from each question. You can also have the students submit their responses anonymously and use the information to get a general overview of how the class has understood the new knowledge.

CASE STUDY

One example of how I have used the Connect-Extend-Challenge activity is in my General Education course at Durham College entitled 'Social Innovation: Becoming a Changemaker'. This course has been designed using a 'hybrid' format which means that it integrates both face-to-face learning and online learning in the delivery of the course. In this course, students have one hour of online learning and two hours of face-to-face learning each week. The one hour of online learning consists of online readings, videos, discussion forums, self-directed learning activities, small group activities, etc., which students can complete anytime,

anywhere prior to the face-to-face class each week. In the two-hour face-to-face class, we will build on the activities that students have completed online and extend the conversation.

For the purposes of this course, I included the Connect-Extend-Challenge activity in my face-to-face lesson in Week 9 which was focused on the Ideate phase of the Human-Centered Design framework. Prior to attending the face-to-face class where we completed the Connect-Extend-Challenge activity, students were required to read a short article about the Ideate phase and complete an online brainstorming activity where they had the opportunity

to apply some of the principles from the reading and to practice a brainstorming approach. When they arrived to the face-to-face class, I asked students to share in small groups some of the key elements of the Ideate phase that they learned about online through the reading and brainstorming activity. I then played a short, two-minute video that depicted a group of experts completing the Ideate phase of the Human-Centered Design process which showed a real-life application of this phase. After watching the video, I provided the following prompt to the students via a PowerPoint slide and provided them with a handout to record their responses:

- **CONNECT:** How are the ideas and information presented in the video CONNECTED to what you already knew about brainstorming and the Ideate Phase?
- **EXTEND:** What new ideas did you get that EXTENDED or pushed your thinking in new directions?
- **CHALLENGE:** What is still CHALLENGING or confusing for you to get your mind around? What questions, wonderings or puzzles do you now have?

The students were given five minutes to record their individual responses and then I asked them to form a small group and discuss their responses with their peers, with the students noting any similarities and differences. I then asked each group to share some of the connections and extensions that they discovered as well as any questions that emerged from their individual responses and group discussion. As a whole class we debriefed the activity and discussed how the Ideate phase is similar to traditional brainstorming processes that many have experienced in other courses. We also discussed some of the common questions that emerged from their small groups such as how do you come up with original ideas, and how do you properly articulate your ideas and make sure that you don't lose them during the Ideate process.

This activity helped to connect students' new knowledge about the Ideate phase of the Human-Centered Design process with their prior knowledge and experience with brainstorming, and also helped to highlight some of the key features of the Ideate phase which makes it unique from other frameworks and applicable to social innovation. It also allowed the entire class to benefit from the discussion of some common questions about the Ideate phase and helped to address misconceptions before moving on in the lesson where we explored specific techniques that are used in the Ideate phase.



Image3: Students in a small group discussing their responses

SUMMARY

This activity encourages students to reflect on their prior background knowledge, identify new learning, and to think about how new knowledge challenges or puzzles them. It also helps to support metacognition as it guides students to reflect on their own thinking about new ideas, concepts or topics that

might challenge their initial understanding or perspective. The Connect-Extend-Challenge activity is effective for any discipline and can be used individually, in small groups, or as a whole class activity both in the classroom and online.

FURTHER READING

Harvard Project Zero. (2016). Connect Extend Challenge. Retrieved from http://www.visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03d_UnderstandingRoutines/ConnectExtendChallenge/ConnectExtend_Routine.html

Ritchhart, R., Church, M., & Morrison, K. (2011). Making thinking visible: How to promote engagement, understanding, and independence for all learners. San Francisco, CA: Jossey-Bass

TEMPLATE

CONNECT-EXTEND-CHALLENGE

<p>CONNECT:</p> <p>How are the ideas and information CONNECTED to what you already knew?</p>	
<p>EXTEND:</p> <p>What new ideas did you get that EXTENDED or broadened your thinking in new directions?</p>	
<p>CHALLENGE:</p> <p>What CHALLENGES or puzzles come to mind as you think about the ideas or information that was presented?</p>	

03 Active learning strategy

ACTIVE LEARNING STRATEGY 03

Team Paper

Barry Thompson

Durham College

THE STRATEGY

TEAM PAPER (WITH A GOOGLE DOC)

The Team Paper activity is an active learning strategy that utilises small groups to discuss an issue or subject and then large groups to debrief and disseminate the learning evenly throughout the class. This activity is ordinarily performed in a classroom using large A2-sized sheets of paper (Durham College, 2018). However, a digital twist has been applied here with the paper being replaced by an online collaborative document using Google Docs (Google Sites, 2018).

The 'Team Paper' activity combines small group work, large group discussion and writing, which fosters learning in the middle and higher levels of the cognitive learning domain (Cranton, 2000). The Team Paper activity is an effective strategy to help students understand complex concepts and contributes to higher levels of cognitive learning as defined by Blooms taxonomy (Bloom, 1956).

The activity requires students to discover information about a concept. This is achieved

through a combination of learning and experience from both small group discussion with their peers and large group discussion guided by a facilitator. One of the best learning environments for fostering critical thinking is within a social setting, where learning can be demonstrated and reinforced while arguments are expressed through speech and writing (Brookfield, 2012). The Team Paper activity encourages learners to practise and utilise critical thinking skills in such a setting.

The classroom design may not always be suitable and fixed furniture/equipment may present additional challenges when attempting to foster small group work in our classrooms. This chapter, therefore, includes a description of how the Team Paper activity can be implemented using both a paper-based approach in a small, group-work-friendly classroom and also a digital alternative, for when classroom settings are unsuitable.

RESOURCES

PAPER-BASED VERSION:

- Colour markers
- A2- sized paper
- Tape
- Wallspace

DIGITAL VERSION:

- Web-enabled classroom with a PC or mobile device for each student
- PC and projector to display the completed Google document

WHAT YOU CAN DO TOMORROW

The paper-based version of the Team Paper activity can be implemented almost immediately. All that is needed is the material listed earlier and some wall space for students to display the outcomes employing the following steps:

- Divide the class into small groups of 3–4 students each, giving each group an A2 sheet of paper and a variety of colour markers.
- The facilitator introduces the topic to be discussed, followed by a series of questions. Students work silently, writing their responses to the topic on their group's A2 sheet using bullet points.
- Having completed the silent exercise,

the group discuss what they wrote as individuals and add any other ideas that arise from the group conversation.

- After the small group discussion is over, the chart papers are posted throughout the classroom and the students will perform a 'poster walk' to view other groups' results.
- The class reconvenes as a large group to debrief (identify key points and clarify misconceptions) and explore underlying principles pertaining to the topic.

FULL IMPLEMENTATION

As mentioned in the introduction, sometimes the available classroom may be unsuitable for small group work activities. The paper-based version of the Team Paper activity needs a surface area large enough to place an A2-sized sheet of paper and enough room for 3–4 students to gather around the paper. The image below (Image 1) is an example of a typical computer lab and, as can be seen, it has no usable desktop surface area. In this situation, the access to computers enables a digital approach. This strategy could also be applied with students who have access

to smart phones as the Google Docs app will work on any such device.

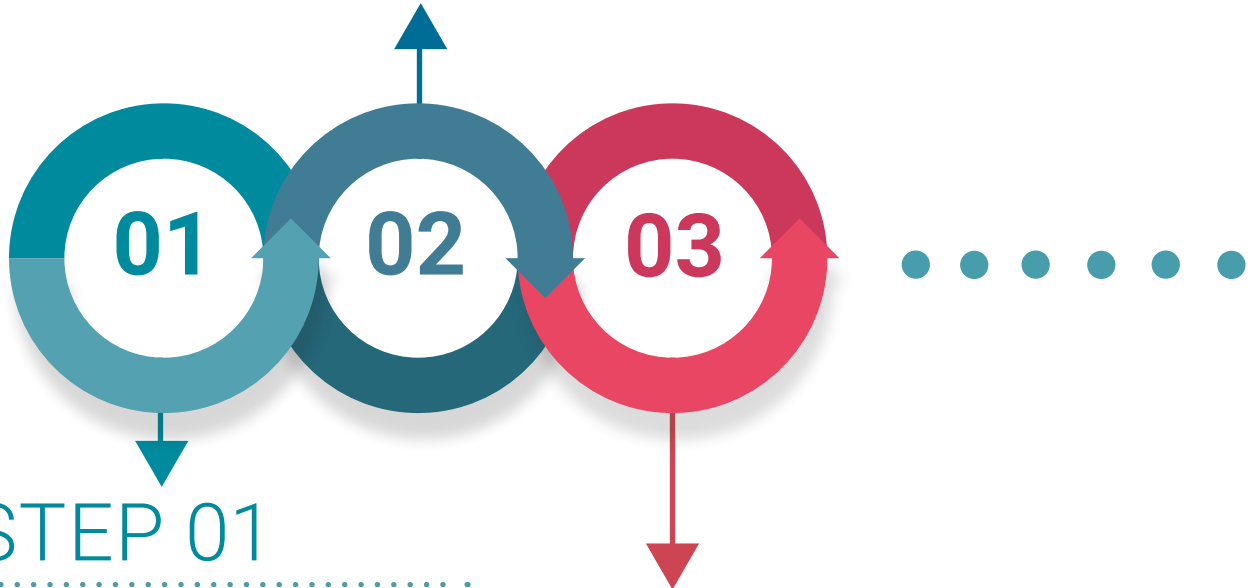
With Google Docs, everyone that accesses the online document can enter information at the same time and can view what others have entered instantaneously. The document created is effectively a digital version of the A2 poster that students would create in the classroom-based activity. The document exists in the Google Cloud and is accessible from any web browser on any device.

STEPS FOR IMPLEMENTATION

STEP 02

PRESENT THE ACTIVITY AND FORM GROUPS

Refer the students to the posted link to Google Docs and ask the students to open the document on their computers or devices. Introduce the topic and explain the activity (see the Team Paper Template for sample instructions). Break the class into small groups to begin the activity.



STEP 01

PREPARATION

Decide on a Topic: Decide on the topic that needs to be discussed. The Team Paper activity is useful for complex concepts that are difficult to differentiate. Globalism versus globalisation is a good example of two different areas that students typically presume are the same.

Create document in Google Docs: For guidance, see the Team Paper Template at the end of this chapter and a link to the Google Docs help page in the Resources section.

Post the Google Docs Link: This can be done on the overhead projector during class or as a link in the Learning Management System (LMS).

STEP 03

SILENT INDIVIDUAL RESPONSES – 5 MINUTES

Students individually and silently enter responses to the exercise topic into the area assigned to their group (see Team Paper Template instructions section for more detail).

STEP 04

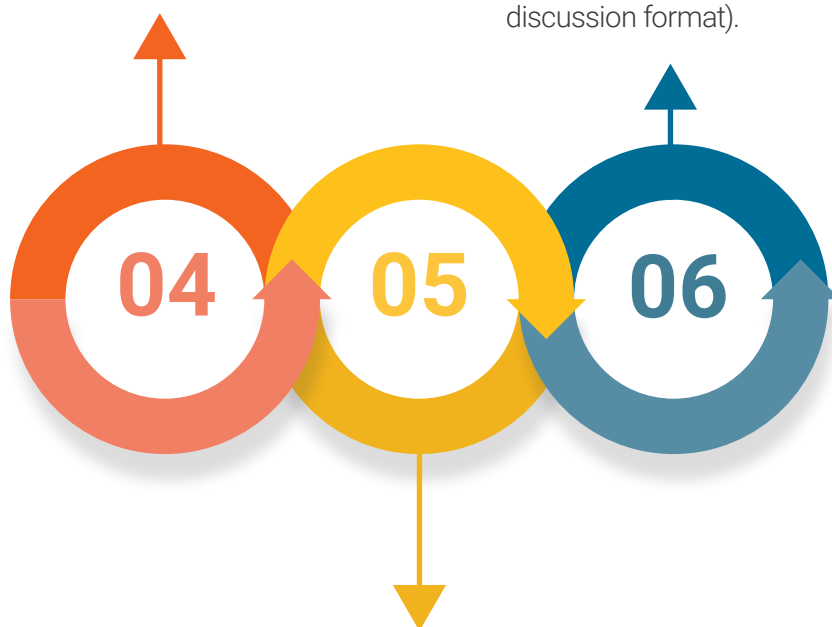
SMALL GROUP DISCUSSION 10 MINUTES

Students gather together in their groups around one computer screen displaying the document and discuss entries made in their response area on the document. The group then have an opportunity to enter any additional points that may arise from the discussion.

STEP 06

SOLUTIONS

Display the completed Google Doc on the projector screen and discuss the results as a large group. This provides an opportunity to identify common themes, summarise overall results, and ensure that the activity has managed to address the learning required for the topic (see Image 2: Sample document on Google Docs of a large group discussion format).



STEP 05

DIGITAL POSTER WALK - 5 MINUTES

The small group session is followed by a digital 'poster walk' whereby students get an opportunity to view what the other groups entered into their group response areas.

OVERCOMING PUSHBACKS

STUDENTS RESIST SMALL GROUP WORK

Students often shy away from working in groups and may express a preference for less active learning strategies. A simple reminder of the relevance of team-based scenarios in industry is often all that is needed to encourage students to engage in group

work. For example, industrial mechanics rarely work alone, as the complexity and size of industrial equipment is such that a team of tradespeople is often necessary to diagnose machine problems.

CASE STUDY

INTRODUCTION

A digital 'Team Paper' activity was conducted with a class of 40 second year mechanical technician students in preparation for apprenticeships. Their duties as apprentices involve repairing industrial equipment and, as a result, they need to understand the difference between many industrial maintenance terms. These students do not have any industrial experience with machinery, but they have worked on various pieces of equipment in the lab or workshop as part of their school work. The digital version of the Team Paper activity will use the experience the students have gained with the lab equipment to aid understanding of industrial maintenance terms.

1. PREPARATION

The maintenance terms 'reliability' and 'maintainability' are two complex topics that are difficult to differentiate. In this case, the students were asked to explore these topics in the context of machines that they have

worked on in their shop classes. A document was created on Google Docs (based on the Template provided at the end of this chapter) requiring each small group to enter reliability and maintainability suggestions suitable for a specific piece of machinery. The students accessed the link to the document through the LMS.

2. PRESENT THE ACTIVITY

The instructions (see Image 2: Sample Google Doc) for the activity outlined on the first page of the Google Doc were discussed as a large group. The class was then divided into ten small groups of four students each. Each of the ten small groups were assigned one of the ten machines listed in the document. Each of the ten different machines had a text box where students entered reliability suggestions and a text box where they entered maintainability suggestions (see Image 3: Examples of Student Entries).

3. SILENT INDIVIDUAL RESPONSES

As per the instructions, the students took 5 minutes to silently and individually enter maintainability and reliability suggestions for their group's specific machine. The students could see what the other students were adding instantaneously.

4. SMALL GROUP DISCUSSION

Upon completion of the individual activity, each small group was asked to gather around one computer screen. The small groups were given 10 minutes to discuss their collective suggestions and make any amendments or additions to their machine's text boxes on reliability and maintainability as needed.

5. DIGITAL POSTER WALK

When the ten-minute small group discussion was complete, the students were asked to take 5 minutes to 'walk' around and view the other groups' reliability and maintainability suggestions for their machines within the online document.

6. LARGE GROUP DISCUSSION

The entire class reconvened to discuss the findings as a group. The discussion was framed around the questions outlined in Item 4 of the Instructions section of the document (see Image 2). This ensured that the students' suggestions aligned with the experts' suggestions for reliability and maintainability.



Image 1: A computer lab that is unsuitable for the traditional paper-based Team Paper

Reliability and Maintainability

A Team Paper

Instructions

After these instructions, this exercise lists five pieces of equipment (Assets in the CMMS) that you have worked on in some form or another during shop time. I will ask you to form into groups of three and then assign your group to one of the five pieces of shop equipment. Using your past experience in the shop and the definitions of reliability and maintainability, you will:

1. Take five minutes to individually and silently enter at least one improvement that increases the reliability of your assigned piece of equipment and at least one improvement that increases the maintainability of your piece of equipment.
2. After five minutes have elapsed, I will ask your group to gather and discuss what each student entered into the form. One member of your group will enter any additional points that may have arisen from your discussion. The group session will last ten minutes.
3. The group session will be followed by a 'poster walk'. This is a term that applied to the days when we would have completed this activity on flip chart paper. In our case, we will simply look at what the other groups entered as improvement items for their assigned equipment.
4. After five minutes of the 'poster walk', I will post the results on the overhead and we will discuss our results as a large group. We will frame our discussion around the following questions:
 - a. Do we, as maintenance people, have more influence over reliability or maintainability?
 - b. Which of the two terms is more dependent on equipment history?
 - c. Some changes are easier than others:
 - i. Does the change involve other trades?
 - ii. Does the change involve other departments?

Gorman - Rupp Self Priming Pump

1. How can we make this pump more reliable?

2. How can we make this pump more maintainable?

More machines as needed for each small group ...

Image 2: Sample document on Google Docs from the Team Paper case study.

Gorman-Rupp Self Priming Pump

1. How can we make this pump more reliable?

Remove the v-belts and drive the pump directly
Oil the pump every day
Paint the motor blue
Clean the sight glass

2. How can we make this pump more maintainable?

Reduce the number of bolts in the belt guard
Oil the pump every day
Put a tag on the oil plug that says what kind of oil to use
Replace the socket head cap crews with the hex head so that they are all the same

Image 3: : Examples of Student Entries

CASE STUDY CONCLUSION

The students enjoyed discussing their shared experiences with the shop class machinery. The various pieces of machinery in the shop have unique characteristics that may make them difficult to work with or design flaws that make them difficult to maintain. These characteristics and flaws applied to the

reliability and maintainability discussion. With their workshop experience, the two definitions and the collective wisdom of their small groups, the students produced solutions that met the learning outcomes of the subject matter.

SUMMARY

One of the best learning environments for fostering critical thinking is within a social setting where learning can be demonstrated and reinforced while arguments are expressed through speech and writing (Brookfield, 2012). Whether the Team Paper activity is performed as a traditional paper-based activity or given a digital 'twist', students are

encouraged to think critically and discover information about complex topics through a combination of: 1) individual experience and learning, 2) their peers' experience and learning, 3) large group discussion, and 4) the facilitator's guided debrief and summarisation.

FURTHER READING

Development: Durham College CAFE Learning Techniques:

<http://cafe.durhamcollege.ca/index.php/teaching-learning/learning-techniques>

Bonwell, C. C., & Eison, J. A. (1991). Active learning: Creating excitement in the classroom (ASHE-ERIC Higher Education Rep. No. 1). Washington, DC: The George Washington University, School of Education and Human Development

TEMPLATE

EXERCISE TOPIC

A Team Paper

Introduction:

The instructor will ask you to form into groups of three or four. Following these instructions, you will find an area where your small group can enter responses to the topic introduced by the instructor. The instructor will then lead you through a series of timed steps to complete this exercise:

1. Step 1 - Five Minutes – Silent Individual Responses
 - a. Individually and silently enter your responses to the exercise topic into the area assigned to your group below. You will see your fellow small group members' responses as they are entered. This is a live document.
2. Step 2 - Ten Minutes – Small Group Discussion
 - a. Your instructor will ask your group to gather together and discuss what each student entered into your small group's response area. Your group will enter any additional points that may arise from your discussion.
3. Step 3 – Five Minutes – Poster Walk
 - a. The small group session will be followed by a 'poster walk'. This is a term that applied to the days when this exercise would have been completed using markers and flip chart paper. In this case, the instructor will ask that the students look at what the other groups entered into their group response areas.
4. Step 4 – Ten Minutes – Large Group Discussion
 - a. After five minutes of the 'poster walk', the instructor will post the Google Doc on the overhead projector and will discuss the results as a large group. This is a time to identify common themes, summarise the results, and ensure that the exercise topic has been addressed fully and correctly.

Small Group 1: Enter responses from your group below:

Student responses will be seen here.

Small Group 2: Enter responses from your group below:

Student responses will be seen here.

Enter additional small groups depending on class size.

04 Active learning strategy

ACTIVE LEARNING STRATEGY 04

Pluses, Minuses & Interesting Points (PMI)

Robert Hickey

TU Dublin

THE STRATEGY:

PLUSES, MINUSES & INTERESTING POINTS

Pluses, Minuses and Interesting/Important Points (PMI) is an activity which allows students to share their knowledge and subsequently help qualify their individual understanding of a topic via peer and teacher discussion and feedback. One of the best ways to get students to engage in a class activity is to put them into a situation where they cannot escape without doing and learning something. PMI is a simple, straightforward and collaborative/social activity that requires a little bit of planning to ensure its success: 'fail to prepare, prepare to fail'.

A PMI strategy can be adopted with any of your lecture topics whereby students are afforded an opportunity to ponder a topic individually while recording thoughts and ideas on a PMI sheet.

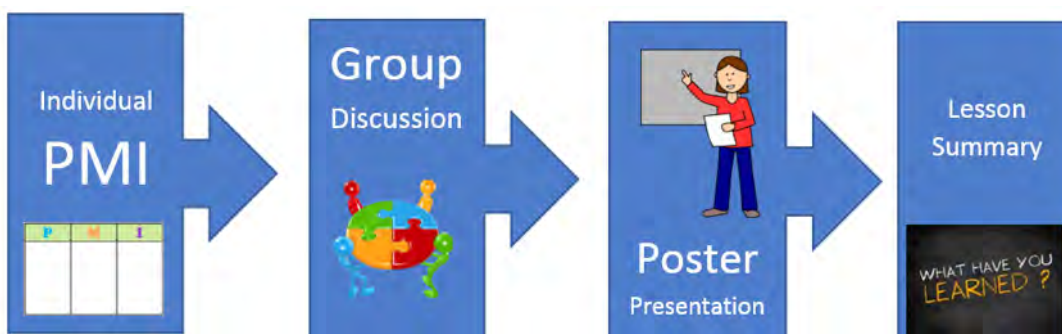
For the 'I' in PMI you can either use 'Important' Points or 'Interesting' Points. Important Points are more suited to practical applications while Interesting Points are suited to abstract or theoretical topics.

ACTIVITY

INDIVIDUAL PMI

6 minutes are allocated to complete the individual PMI sheet at the beginning of the activity based on 2 minutes for each acronym. During the activity, it is important to encourage students to focus on each specific acronym (P,M,I) for the allocated 2-minute duration. It is important also to

a small number of points for each acronym, the output collectively will be much greater once they come together in groups. If more than 2 minutes are allocated to each acronym, some students may become bored which can lead to a lack of focus and cause students to rush through the individual activity.



GROUP COLLABORATION/ DISCUSSION AND PRESENTATION

Having completed the individual PMI activity, students are afforded an opportunity to discuss and contribute to a collective PMI in a small-group setting. To improve time spent on-task and maintain learner focus, it is important that students are made aware of the purpose of the collaboration and that collective group participation is required for successful output.

Groups are invited to present the outcome of their discussion with the whole class group while also affording opportunities for questions and answers. Each group presentation should take no longer than 5 minutes, but this may be reduced if working with larger class sizes.

GROUP SIZES

Ideally group sizes should be limited to 3–4 students as it can be easy for students to become anonymous or some views to be excluded in a larger group setting.

POSTER CREATION/LESSON SUMMARY

Poster creation allows students to summarise key points from a lesson and can result in significant learning particularly when it reinforces newly obtained knowledge.

Affording students an opportunity to display learning in a graphical format encourages creativity while also making the information more relevant and appealing to those with a preference for visual media.

IS THERE A NEED FOR PRE-SESSION ACTIVITY?

This activity would generally require students to complete a task prior to the class activity. This task may be reading a chapter in a book, reviewing a blog post, or looking at a video on the topic. Incorporating a worksheet

(Figure 1) as part of the pre-activity task will improve student pre-session engagement and encourage learners to process the information at some level.

Worksheet



Module	Sustainable Technology 2
Subject	Construction
Topic	Airtightness in Buildings
Lesson	No.9
Worksheet	No.9
Directions	The answers to these questions are contained in your notes on Airtightness in Buildings. I recommend that you read the question, find the answer and then write the answer out for each of the following. This will facilitate you to achieve the learning outcomes for the lesson.

1. State 3 reasons why airtightness is important.

1. _____

2. _____

3. _____

Figure 1: Sample worksheet

Although a pre-lesson task can provide more time for student activity during the session, it is not essential. Every student will have some level of knowledge on most topics being

studied while the gaps in knowledge can be filled during in-class learning activities and through peer learning.

RESOURCES

- **PMI:** A printed (blank) PMI sheet (see template) for every student.
- **Discussion:** Large sheets (A2) to record group output from PMI discussion (one per group).
- **Poster:** Large sheets of paper for each group of students to create their posters (Size A2 or A3).
- One packet of large coloured markers for each student group.
- Roll of masking tape/blue tack for hanging up completed posters.

WHAT YOU CAN DO TOMORROW

The PMI strategy can be amended to suit a variety of situations.

The important points to consider are:

1. Frame your question carefully and with intent relevant to the desired learning outcome (think about what it is you want your students to know or learn).
2. Ensure all students formulate an answer to your question. (in writing).
3. Make sure all students share their answers with the rest of the class. (ideally using a method that can be accessed later for reference purposes).
4. Give the students instant feedback and summarise the main points that they have presented (this is so they can all see the value of their contributions and of the overall activity).

Below is an example of how someone could implement this strategy in their lecture tomorrow as an activity facilitated by the lecturer.

CLASS PMI

Present a blank PMI digitally on the screen and pose the question to students in an effort to complete the PMI sheet together. The lecturer leads the discussion and debate, filling the plus, minus and important columns in turn based on student responses. This approach ensures that every student is involved in the creation of the PMI and in discussion when justifying their input.

**Topic Sheet
For Lateral or
Creative Thinking**



Course	Energy Efficient Domestic Retrofit Technology
Module	Sustainable Technology 2
Topic	PMI for Building Materials
Lesson	No: 2
Directions	Using numbered bullet points list what you think are Pluses , Minuses and Important points about Building Materials, when it comes to the thermal performance of a building.

Pluses	Minuses	Important Points

Figure 2: Sample worksheet

STEPS FOR IMPLEMENTATION

STEP 01

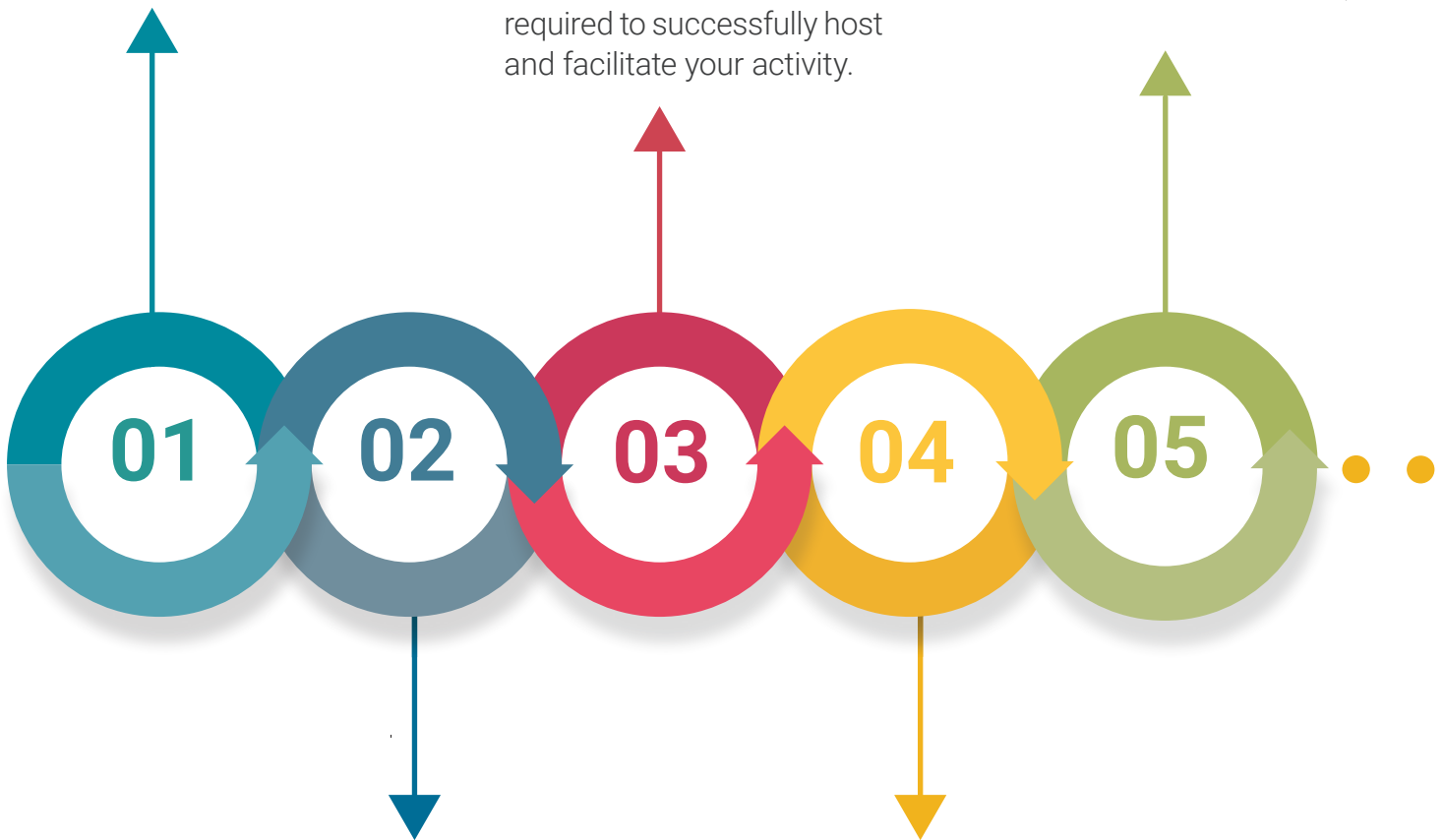
Formulate the question for your specific topic using the PMI template provided.

STEP 03

Gather all the resources required to successfully host and facilitate your activity.

STEP 05

PMI individual thinking activity for 6 minutes (2 minutes each for Plus, Minus and Interesting Point).



STEP 02

(If Required) Provide the student with the pre-workshop task, information and materials including associated workshop sheets

STEP 04

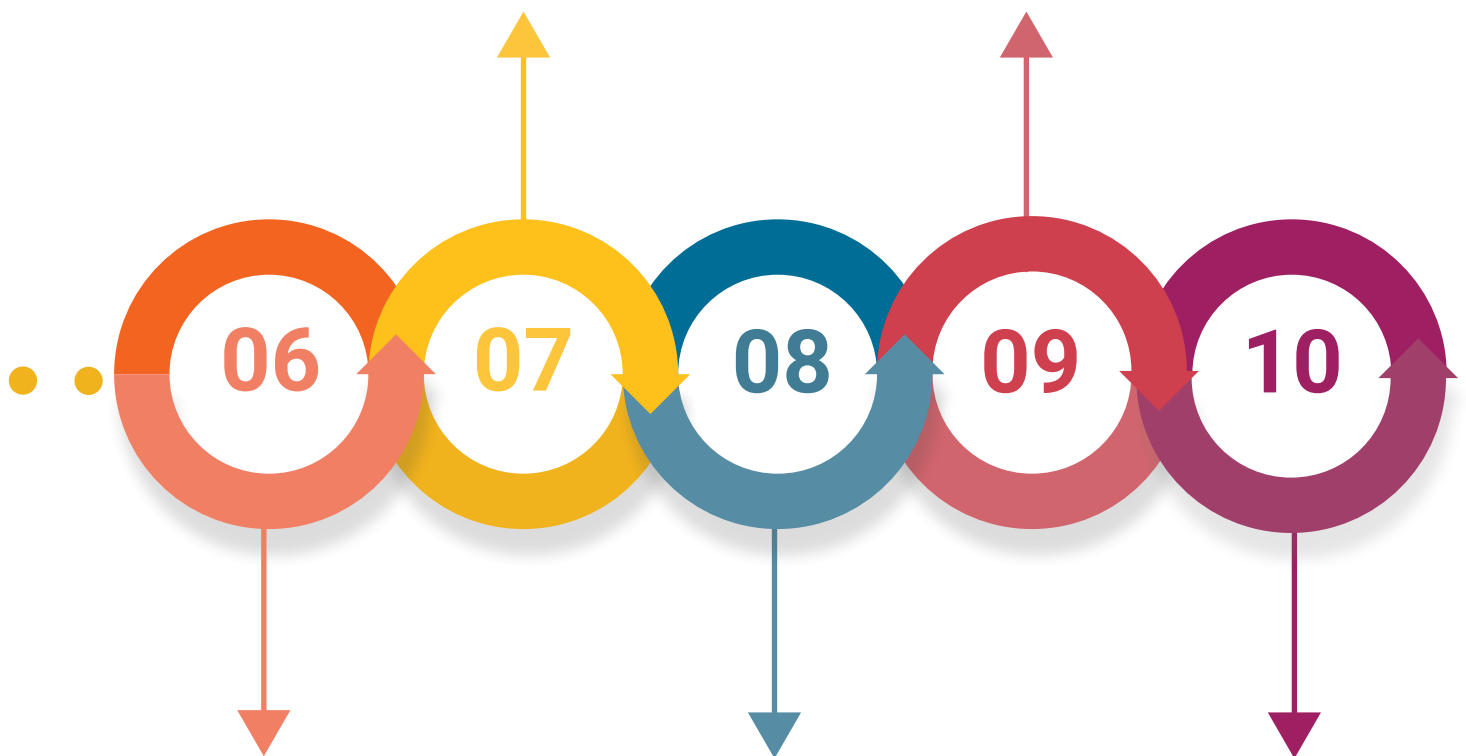
Hand out PMI sheet and explain with particular focus on rationale of PMIs and the workshop schedule.

STEP 09

Questions and comments after each group presentation from the lecturer and/or from other students. This stage allows for the lecturer to highlight any misconception and fill any remaining gaps in knowledge.

STEP 07

All posters should be hung up and numbered before any of the presentations begin. Masking tape or blue tack is supplied for hanging up posters.



STEP 06

Group work (split into small groups) to create a collective PMI poster (based on their individual PMI sheets).

STEP 08

Sharing – groups create and deliver poster presentation based on their collective PMI to the rest of the class (5 minutes). NB: students should include their names on their group poster, particularly if being used for assessment..

STEP 10

Summary – synopsis of their posters by the lecturer, highlighting commonality and filling in the gaps. It is also beneficial to highlight the usefulness of this activity at this stage.

OVERCOMING PUSHBACKS

Some of the more common attempts to push back on the use of PMI & Present strategies include:

Why do we have to do this?

(Creating the posters) (Students)

Explain to your students that posters are used extensively at conferences as well as at PhD level as a means of presenting complex material and group presentations are widely used by professionals in industry for planning and solving problems.

Why is your class so disruptive?

(Students, Peers, Management)

Noisy students talk and laugh loudly. This is great once the students maintain their energetic focus on the topic at hand.

Why are some students deciding not to participate?

(Students, Peers)

This happens already in traditional class/lecture settings. The implementation of this strategy encourages each student to participate in an active way. It is very difficult not to engage in this.

What happens if students do not read/view material (if required) before attending?

(Students, Peers, Management)

Although this happens already in traditional classroom settings, this activity builds on existing knowledge through meaningful discussion with peers who have engaged with pre-workshop material.

CASE STUDY

INTRODUCTION

A PMI is a direct thinking tool designed by Dr Edward De Bono to help focus the mind (De Bono, 1993). It can be used in any situation to elicit thoughts and ideas from a person or group of people on any subject or topic. This activity has been used successfully by the author for a wide variety of disciplines for more than ten years. Below is a descriptive discussion of this activity in action

OVERVIEW

The topic for this lesson and PMI was Roofs, from the module Sustainable Technology 2, a third year module in a BSc in Sustainable Electrical Control Technology at ITB. The lecture time slot was 2 hours with 40 students. The classroom being used had movable tables and chairs, which was very useful for organising group work. Prior to the lecture (usually 1 week in advance) the students were given a link (on Moodle) to a pre-created 25-minute video on Roofs to view in their own time along with an accompanying worksheet. Students were asked to complete the worksheet and bring it into the lecture.

Worksheet



Module	Sustainable Technology 2
Subject	Construction
Topic	Airtightness in Buildings
Lesson	No.9
Worksheet	No.9
Directions	The answers to these questions are contained in your notes on Airtightness in Buildings. I recommend that you read the question, find the answer and then write the answer out for each of the following. This will facilitate you to achieve the learning outcomes for the lesson.

1. State 3 reasons why airtightness is important.

1. _____

 2. _____

 3. _____

Topic Sheet
 For Lateral or
 Creative Thinking



Course	Energy Efficient Domestic Retrofit Technology
Module	Sustainable Technology 2
Topic	PMI for Building Materials
Lesson	No: 2
Directions	Using numbered bullet points list what you think are Pluses , Minuses and Important points about Building Materials, when it comes to the thermal performance of a building.

Pluses	Minuses	Important Points

At the start of the class the students were given a 5-minute overview of the planned timetable for the lecture slot including a rationale for the method being used. Although some students thought the idea of making posters was 'childish', it was explained to them that academics and professionals alike use posters extensively to

convey large amounts of complex information and ideas. Students were also made aware that group work is a strategy used extensively in industry for generating ideas and problem solving with outcomes displayed and recorded on white boards and flip charts.

ACTIVITY

Students were given 6 minutes to complete the individual PMI task sheet: 2 minutes for the Pluses, 2 for the Minuses, and 2 for the Important Points. Although some students engaged with the activity immediately, some began talking while others didn't do anything to begin with. However, moving around the classroom, the lecturer encouraged students

to work on their own and to write down anything that came to mind as, at this stage, there were no wrong answers. The students were asked to focus only on Pluses, then Minuses, and then Important Points during each of the 2-minute tasks, and they were asked not to move on until the time had elapsed.



Image 1: Group activity students creating their posters

The class was randomly split into groups of 4 (minimum 3, maximum 5) and asked to produce a poster using the sheets and large coloured markers provided. The poster should represent the collective results of the group's individual PMI sheets. 40 minutes

were given for the groups to produce their posters. They were encouraged to use references on their posters to give their work credibility. When references were not used during their presentations the students' work was heavily critiqued.

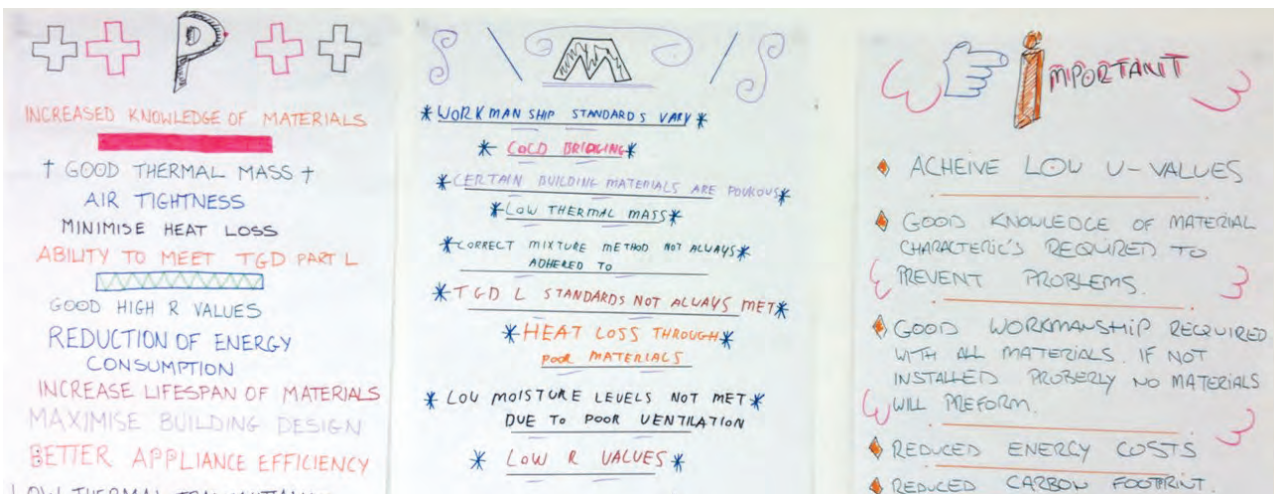


Image 2: Group Posters

After the 40 minutes, all groups were directed to hang up their posters on the walls or white board using masking tape (blue tack can leave marks). Each group was given 5 minutes for presenting inclusive of Q&A from Peers. Strict time management was essential for all of this to run smoothly and for all groups to get an equal amount of time

for presenting (no overruns were allowed). After all the presentations were given, the lecturer briefly summarised the topic using quality examples from the different students' posters to emphasise the main learning outcomes from the lesson. A photo of each poster was then taken to be shared with the students on Moodle.

Example lecture slot 2 hours

- 40 students, split into 10 groups of 4
- 10 groups @ 5 min/presentation = 50 min
- 15 min intro including PMI sheet
- Approximately 45 min to work on posters
- 10 min to summarise and take photos

TOP TIPS FOR SUCCESS

With any new activity, the most important thing is to give it a go. Choosing your first topic can be difficult and although you might be tempted to choose an easy topic to begin with, choosing a more difficult one or a topic that either you or your students struggle with can have a surprising or even illuminating result.

Although this activity can be adapted to other learning scenarios, it is recommended to stick to what has been outlined initially. Give the students the freedom to get things wrong and discuss the issues amongst themselves

but within the framework provided. The 6-minute individual activity at the start must be done in silence so that the student is given an opportunity to focus the mind. The rest of the activity may be very noisy, so do not feel too bad about demanding silence for the 6 minutes. Let the students know that their presentations will be no longer than 5 minutes and stick to this time limit. Encourage students to convey their message clearly, use sketches if desired, and also to reference posters to add veracity to their work.

FURTHER READING

De Bono, E., 2008. Dr Edward de Bono explains how errors in perception can be avoided through training in his Direct Attention Thinking Tools (DATT). [Online] Available at: <https://www.youtube.com/watch?v=-SGsnZk4kXo> [Accessed 25 October 2018].

De Bono, E., 1993. Serious Creativity: Using the Power of Lateral Thinking to Create New Ideas. s.l.:HarperBusiness.

TEMPLATES

Choose one of your lecture topics and insert the details of it into the template below under “directions” for your students to complete an individual PMI worksheet. Follow the 9 steps outlined in this strategy.

**Topic Sheet
For Lateral or
Creative Thinking**

Course	
Module	
Topic	
Lesson	No: _____
Directions	Using numbered bullet points list what you think are Pluses , Minuses and Important points about _____ _____ _____ _____

	Pluses	Minuses	Important/Interesting Points

05

Active learning strategy

ACTIVE LEARNING STRATEGY 05

Case Studies

Barry Thompson

Durham College

THE STRATEGY:

CASE STUDIES

Case studies describe a sequence of events or a problem situation that asks students to analyse a problem and provide recommendations or solutions based on their experience, prior learning, course content and other resources (McKeachie, 2002; Renner, 2005). Case studies adopt a 'Problem-Based Learning' (PBL) approach whereby learning is based on real-life, authentic and complex problems. Case studies often present a multitude of solutions where the solution is not necessarily the only goal but rather the skills developed while working towards a solution, which can often be of more benefit to students.

The scenarios presented in a case study can be real-life cases from the field of study or may be carefully crafted fabrications to better illustrate a particular issue or problem. In either case, whether real-life based or carefully fabricated, case studies provide contextualised learning where the students use the material, concepts and skills from the course to enhance their ability to solve problems (McKeachie, 2002).

Case studies can be presented as a teaching strategy that brings real-life scenarios into the classroom or as a teaching strategy to deliver relevant course material, advance course concepts and develop problem-solving skills.



Image 1: A group of students participating in a Case Study

Depending on the learners' prior experience, additional scaffolding may be required to support learners, while the activity can be adapted to suit first-time students if needed. Case studies require careful analysis of the problem/issue and an appreciation that there may be many valid and viable solutions. Small group discussion can be used to share, elaborate and refine solutions while also offering opportunities for students to view the problem/issue from a range of perspectives.

Case studies have been used in medicine, business, psychology, and law programmes for many years but are becoming a ubiquitous teaching strategy in a variety of disciplines since they encourage student engagement in the subject matter (McKeachie, 2002). Regardless of context or subject discipline, instructional design such as that employed in case studies should always begin with some form of audience or learner analysis (Cranton, 2000; Morrison, Ross, Kalman, & Kemp, 2011; Reigeluth & Carr-Chellman, 2009).

RESOURCES

- Selection of case studies.
- A PC and projector to model the case study process.
- A paper copy of a case study for each small group.

WHAT YOU CAN DO TOMORROW

A case study activity can be facilitated very easily and requires very little preparation. By simply relating a situation or story from the teacher's own experience that is relevant to the current learning, students can be tasked with problem-solving activities that require

the formation of new or alternative solutions. In fact, a case study is simply a story and Renner (2005) suggests that presenting or writing a case study in the form of a story with named characters and conversations is good practice and helps to capture the student's imagination.

STEPS FOR IMPLEMENTATION

Prior to full implementation, it is important to ensure that the students have been sufficiently prepared for the activity. This may involve trial and smaller supported activities that model how the learning strategy is employed.

STEP 01

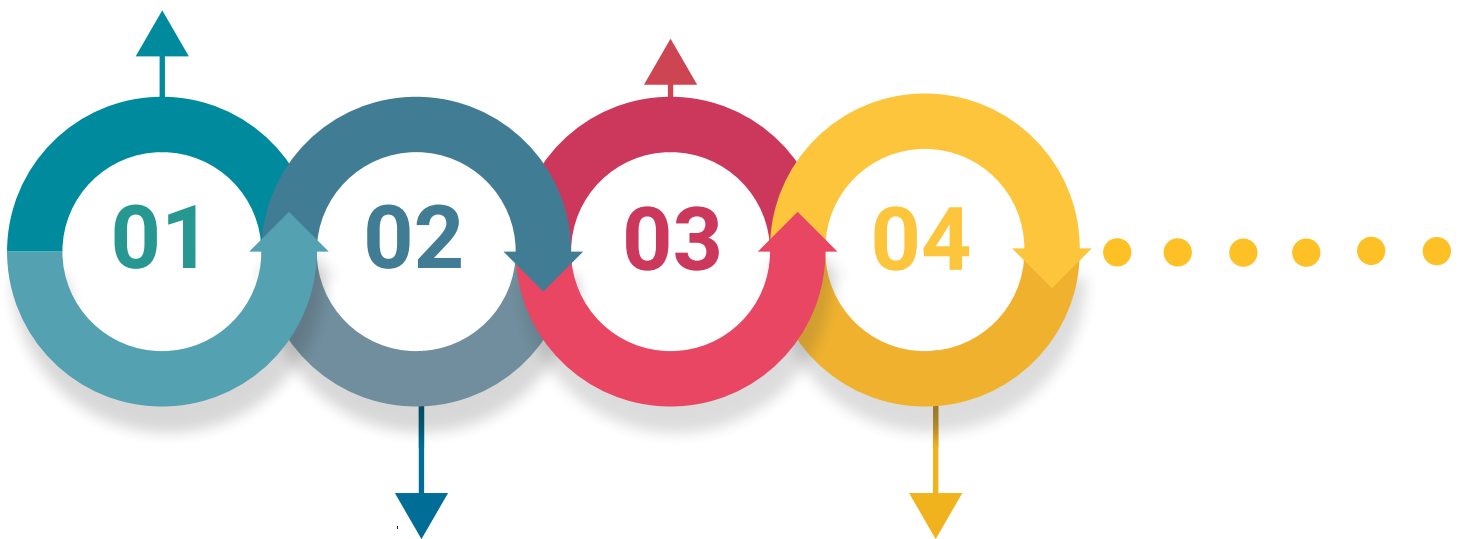
DEVELOP CASE STUDIES

Create a range of authentic case studies that relate to a particular concept that you wish the students to explore in detail, for example, belt driven power transmission fundamentals. The number of case studies required will be dependent on the class size and the variety/broadness of topic.

STEP 03

ARRANGE CLASS GROUPS

Divide the class into small groups of four. As the instructor gives each group their individual case study, they will briefly describe the case study to the class as a large group. This will prepare the students for Step 6 where all of the case studies are discussed and summarised. The classroom furniture may be rearranged to facilitate more efficient communication between students in each group.



STEP 02

PREPARE THE STUDENTS

Schedule the case study activity at a point in the course where the students have been exposed to the knowledge, concepts and skills from the course needed to engage with and solve the problem presented.

STEP 04

GROUP DISCUSSION/ PROBLEM-SOLVING

Groups discuss the merits and consequences of possible solutions presented by participants and record the outcome of their deliberations.

STEP 05

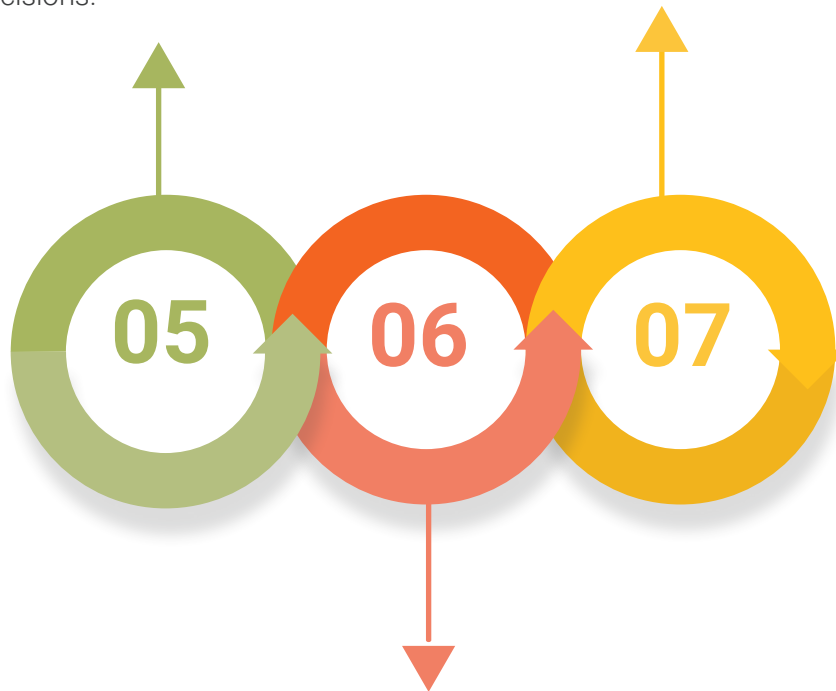
STUDENTS PRESENT CASE STUDY SOLUTIONS

Each group is invited to describe the specific case study and outline their most preferred solution and the rationale supporting their decisions.

STEP 07

EVALUATE

Case studies that are representative of the course material, concepts and skills can be used in tests. In addition, formative or summative quizzes performed either in-class or within the Learning Management System that address the concepts targeted in the case studies can be used to provide evidence of individual learning.



STEP 06

LARGE CLASS DISCUSSION

The instructor summarises the important findings from the collective case studies and initiates a larger group discussion and/or debate.

OVERCOMING PUSHBACKS

IT'S TOO SIMPLE (OR IT'S TOO HARD)

An experienced group of older apprentices would need less background and detail in a case study than, for example, a group of students just out of high school. Depending on the student level of experience, a case study presented to one cohort may be easy to solve while another may find it impossible.

Proper programme planning will ensure that the content of case studies is appropriately tailored to suit the characteristics of participating students (Cranton, 2000; Morrison et al., 2011; Reigeluth & Carr-Chellman, 2009).

I JUST WANT A LECTURE

In many cases, students can be averse to teaching and learning strategies that diverge from the 'traditional' lecture. In my experience, students prefer teaching scenarios which require little effort on their behalf other than to passively absorb information required

to pass the course. Instructors can justify case studies by explaining that they simulate exposure to real-life workplace experience and that the students may face problems similar to those presented in the case studies.



Image 2: Students in a traditional lecture

CASE STUDY

OF THE CASE STUDY (TEACHING STRATEGY)

The case studies employed when using this teaching strategy are based on authentic workplace scenarios which occurred during my time in industry. Describing such authentic experiences helps to connect students with real-life workplace scenarios and assure participants of the legitimacy and relevance of case studies as an effective learning strategy.

The case study described was conducted with a group of post-secondary students enrolled in the two-year Mechanical Technician and Millwright diploma in a mid-sized Ontario college in Canada. Participants had recently completed high school, were in their late teens and had no previous industry experience relating to a trade workplace environment.

In designing the case study for this student demographic, a range of factors were considered to ensure that participants could understand, relate to and engage with the content. It was important to:

- Include rich detail to compensate for a lack of industrial experience.
- Avoid making assumptions about trade knowledge and explain important details in full.
- Include an engaging storyline to enhance the real-life dimension of the case study.
- Include named characters and dialogue that is typical of the industrial and maintenance workplace.

- Describe characters that have distinct personalities and are representative of the characters that students may meet in industry.

The sample case study (Figure 1) is based on a real-life experience involved in diagnosing pump or valve-related failures in industry. There are several possible solutions or actions that may be arrived at and the outcome of which is informed by course material, suggested resources and the information contained within the case study.

The class is divided into small groups to work on their assigned case study. Upon completion, each group presents an agreed solution to the case study which feeds into a larger class discussion related to the issues identified. Students are rewarded for reasoned, informed responses..

The students' engagement with the case studies is always positive and the results are surprisingly accurate considering their level of industrial or maintenance experience. This is a good place to mention that the students gain a certain amount of experience during shop labs. These are second year students, so they have had a full year of shop classes where they disassemble, reassemble and perform basic maintenance tasks on various pieces of industrial equipment including pumps and valves.

Case Study 6 Lead Strip Rolling Mill Cooling Pump

You are a millwright in a lead-acid automotive battery factory. Lead is formed to make the plates found in the battery. Plastic is moulded to form the case and the lead plates and sulphuric acid fill the case to make an automotive battery. You have been called by Joe Forthright, the maintenance supervisor, to the Lead Strip Rolling Mill. Joe yells in the radio, as he always does when he is under pressure, “get down to the Lead Strip as soon as you can, they are moaning and groaning about the temperature again!” Joe means to say that the production operator has reported that the temperature of the finished lead strip exiting the mill is above quality standards.



Figure 1: Coolant Pump

The lead mill, is a progressive series of paired rollers, that squeeze the one-inch thick lead bar produced by the lead strip casting operation down to the prescribed thickness required for the lead-acid battery produced in the plant for this particular model. The temperature is important to the quality of the lead strip because if it is too cold it is not malleable enough for the next operation. If the strip is too hot it will break or tear in the next operation.

You arrive at the Lead Strip Rolling Mill where you find Jane Smith, the production operator who runs the rolling mill. Jane says that “The strip is way too hot and I am going to shut it down soon because the expander people are saying that the strip is breaking at the coining press.” Jane also adds, and you observe, that the volume of coolant flow that washes over the lead strip between mill rollers is less than normal. This is the main problem. You need to look at the coolant pump.

You ask Jane where the coolant pump is located and she says that “It’s down in the pit with the rest of this area’s pumps and stuff. You will have to get security to sniff the pit because it is a confined space.”

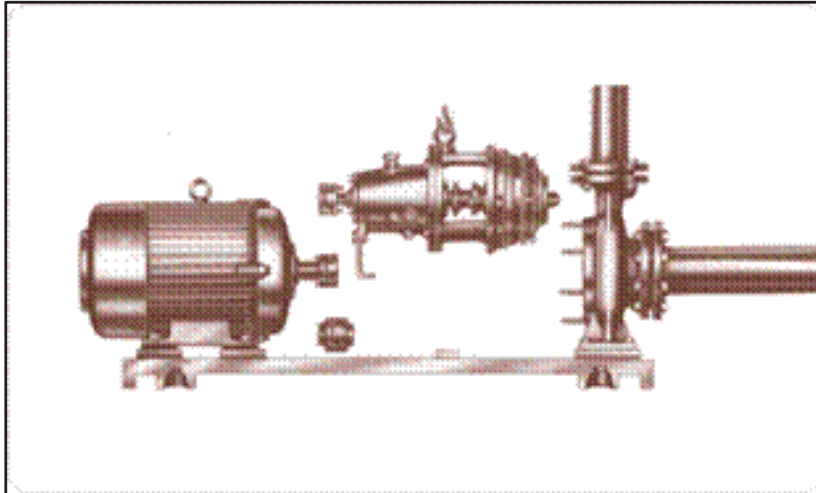


Figure 2: Back pull-out centrifugal pump design.

After security has sampled the air quality (sniffed) in the pump pit and you have followed the confined space entry procedure you enter the pit to find:

1. The pump is one of twenty other process pumps in the pit and this particular pump is a horizontal centrifugal pump with end suction. See Figure 1.
2. The pump has back pull-out (BPO) design meaning that it can be easily repaired and disassembled in place without removing a great deal of pipework. See Figure 2.
3. It has a 3" diameter discharge, 4" diameter intake and a 13" diameter closed impeller that produces 600 gallons per minute to a height of 150 feet.
4. The pump has mechanical packing that is leaking slightly. Mechanical packing has to leak to a certain degree to lubricate, seal and cool the packing rings.
5. It is an Ingersoll-Rand pump and this name brand taken in conjunction with the other features already observed indicates to you that this is a high-end, high-volume, expensive and reliable pump.
6. The coolant reservoir is located above the inlet of the pump meaning that suction is probably not a factor due to the positive inlet pressure at the pump.

Your observations and troubleshooting so far:

1. The coolant pump runs cool, quiet and smooth.
2. The mechanical packing was found to be leaking slightly but your adjustment to decrease the leak (remember that it must leak slightly!) does not increase volume of the coolant upstairs.
3. All of the auxiliary system components like inlet and outlet valves, inlet strainers and piping are operating normally and have no blockage.
4. The amperage reading for the coolant pump observed on the main Pump Control Panel indicates normal draw for this size of pump, motor and operating conditions.
5. Maintenance records indicate that the pump has been in operation fifteen years.

Use the information above, the Centrifugal Pump Troubleshooting Chart found in the Millwright Manual of Instruction and our course notes to date to diagnose and solve this problem.

Answer the questions or address the issues below as a framework to help you and your group find appropriate solutions:

1. What is the problem?

2. Develop ideas about what causes the problem.

3. What evidence supports or refutes your ideas?

4. What conclusions can be drawn?

5. What are your recommendations?

TOP TIPS FOR SUCCESS

The experience and level of knowledge within the class group should be considered in the design of the case study while Renner (2005) suggests that case studies should be presented like a story with named characters and dialogue.

Case studies should begin with rather simplistic situations with few details but progressively become more detailed and more difficult to solve.

Subsequent cases can scaffold knowledge and progressively develop levels of understanding related to more complex concepts and skills.

Introduce case studies gradually by initially providing higher levels of learner support and modelling/demonstrating critical concepts when exploring the feasibility of successful outcomes.

SUMMARY

Case studies can be a very effective teaching strategy to introduce real-life issues or problems into classroom-based activities. The activity can be conducted on an individual or group basis while case studies can be fabricated or based on real-life experiences.

The use of case studies in apprenticeship training provides a glimpse into the student's future workplace and helps to develop individual and team problem-solving skills required in their future careers.

FURTHER READING

Renner, P. (2005). *The art of teaching adults: How to become an exceptional instructor and facilitator*. Vancouver, BC: Training Associates.

McKeachie, W. J. (2002). *McKeachie's teaching tips: strategies, research, and theory for college and university teachers* (11th ed). Boston, MA: Houghton Mifflin Company.

TEMPLATE

Case Study Name: _____

Case Study Description: _____

Case Study Details: This section may be quite extensive and needs to include the background information relating to the situation being examined. The problem will need to be clearly stated. It is important that this section has enough detail that the students will be able to solve the problem.

Instructions: Answer the questions or address the issues below as a framework to help you and your group find appropriate solutions presented by the case study:

1. What is the problem?

2. Develop ideas about what causes the problem.

3. What evidence supports or refutes your ideas?

4. What conclusions can be drawn?

5. What are your recommendations?

Case Study Template



06 Active learning strategy

ACTIVE LEARNING STRATEGY 06

Think, Pair, Share

Joe Smith

TU Dublin

THE STRATEGY:

THINK PAIR SHARE

Think Pair Share is a three-step activity whereby students work on a given problem individually for a few minutes, then compare solutions with a partner before presenting to the class. The amount of time allowed depends on the

complexity of the problem. It is a useful alternative to the traditional classroom scenario whereby the lecturer asks a question and a student answers. The strategy adopts the following sequence:

THINK

Utilising this strategy provides students with the opportunity to take some time to work on their own and to think about possible solutions before formulating their answer instead of being put on the spot for a spontaneous reply.

PAIR

Time is then given for the students to work with a partner comparing and discussing answers. They are encouraged to come up with an agreed solution.

SHARE

For the final step, one or two pairs of students are selected to present their solution to the class. The class can then compare the presented solution with their own. The students are encouraged to ask questions. This in turn leads to a class discussion during which all solutions are investigated.

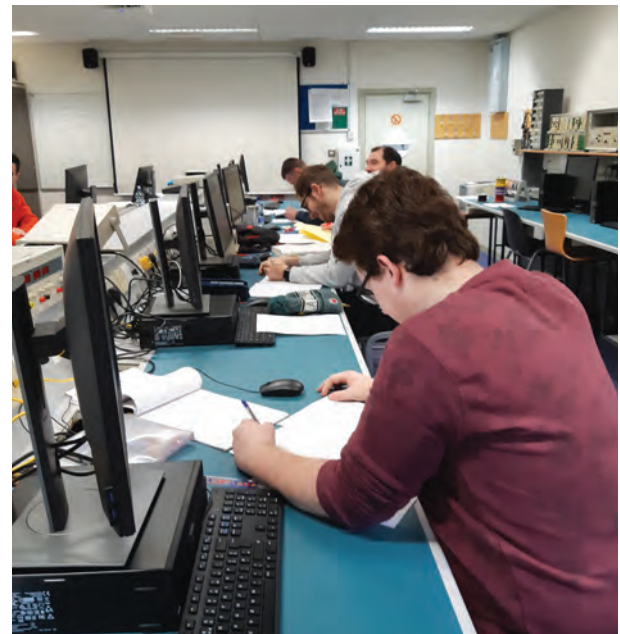


Image 1: students taking part in a Think, Pair, Share, activity

Some of the benefits of Think Pair Share are as follows:

- The time allocated to work alone usually generates better quality and thought out answers.
- It encourages more student participation in classroom discussions.
- It can be used for a number of different situations.

RESOURCES

- Blank sheets of paper
 - A PC and projector to model the case study process.
 - Coloured pens
-

WHAT YOU CAN DO TOMORROW

Implementation of Think Pair Share doesn't involve a large amount of work. It is better suited to lab/tutorial sessions where there are smaller numbers present than for a lecture with large numbers. In preparation, identify a few key learning points or items students need to learn or can find challenging.

- Have the necessary materials available (blank pages and coloured markers).
 - Explain the approach to the students and the benefits that may be achieved and encourage them to participate as directed to get the most from the session.
 - Monitor the students as they work and encourage them to find their own answers to the problem.
-

FULL IMPLEMENTATION

In preparation for the lesson, it is important to identify the key learning points and establish which ones are most suited to the Think Pair Share method. Also, make sure to have the necessary materials available to run the session. Think Pair Share is best suited to a group of no more than 20, which would often be a lab session or tutorial. The reason for this is that it can be difficult to control what is going on with larger groups and to ensure that everyone is engaged.

Explain to the class what you are going to do and what it is envisaged that the session will achieve. Pose a problem for the students or ask the group a question. Make sure the students have the necessary information to solve the problem and explain what they should be doing at each stage. Emphasise the importance of following the steps.

STEPS FOR IMPLEMENTATION

STEP 01

INTRODUCTION

Advise the students to use the information they have available, such as lecture notes/books, and to work quietly on their own for a few minutes.

STEP 03

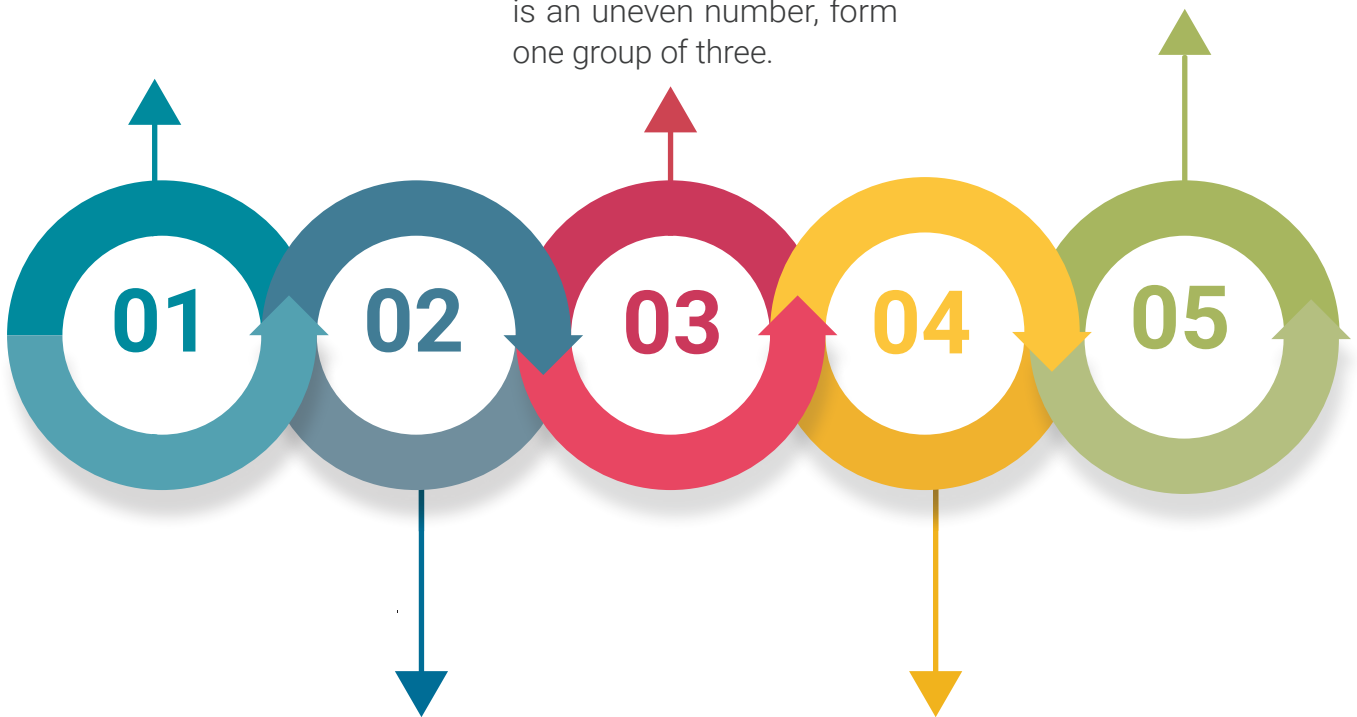
RESOURCES

At this point place a blank sheet of paper and some coloured markers between every two students. If there is an uneven number, form one group of three.

STEP 05

AGREEMENT

Inform them that they both must agree on the answer they provide on the blank sheet of paper supplied.



STEP 02

WORKING INDIVIDUALLY

Students are allocated time to work alone and to think through their answers.

STEP 04

PAIRING

Pair off the students and ask them to compare their answers.

STEP 07

SHARING

Look for volunteers to go first to get this part started. If there are no takers, try encouraging people to give it a go. If this does not work, just pick someone at random.

STEP 09

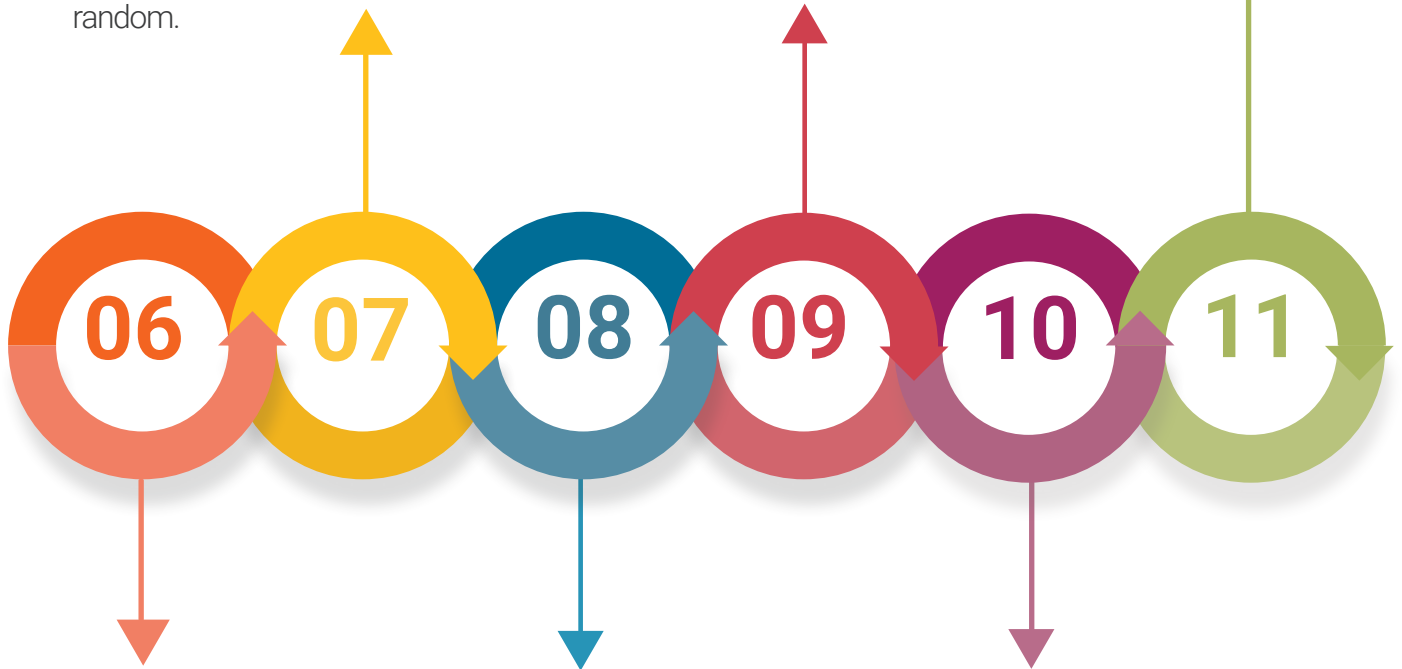
GROUP DISCUSSION

Once the first presentation has finished, do not correct or comment on what is right or wrong. Ask the class to suggest any alternative solutions.

STEP 11

SUMMARISE

The lecturer summarises all answers presented and presents the correct solution to the class.



STEP 06

PROPS

Advise them that they will be presenting their solution to the class so to make sure that what they draw/write is large enough for everyone to see and to use colour.

STEP 08

SUPPORT

Support and encourage the students while they are presenting. This lets the others see that you are there for them and can create an environment where they are comfortable talking in front of the group.

STEP 10

SHARING (AGAIN)

Encourage students suggesting alternative answers to explain how they arrived at their solution. This can be by way of further presentations and thus explores a number of possible solutions.

OVERCOMING PUSHBACK

Typical pushback encountered with the Think Pair Share method includes:

- Students talking to each other during the time allocated to work individually – remind them that they will get a chance to discuss with a partner and the group, but that at this time working alone is important, as each individual answer is valuable.
- Students not wanting to or being shy about sharing with the group – this can happen but can be addressed with some encouragement and support from the lecturer during their presentation to help reduce fear and anxiety.

CASE STUDY

INTRODUCTION

Students studying engineering at ITB are allocated four hours of maths classes per week, consisting of two one-hour lectures (approximately 50 students) and a two-hour tutorial for smaller groups of about 12 students. The lecture is designed to introduce a topic and explain how it works. Although questions are encouraged, the large number of students

present can be an obstacle for some quieter students getting involved. The tutorial is where students complete a worksheet based on the lecture and, as the groups are smaller in size, a more personal approach is possible. It is also a good opportunity to try alternative teaching methods. The Think Pair Share method is very suited to this type of class.

THE PROBLEM

From experience of teaching maths to engineering students for several years, I observed that most students could use the sine and cosine rules to solve problems that are drawn out for them but can struggle when there is a need to plot the problem themselves. A good example of this is vector problems.

The following case study concentrates on the plotting part of solving vector problems.

To solve a vector problem, students are encouraged to use the head to tail method, which involves joining the head of one vector to the tail of another, or the parallelogram method, which involves drawing lines parallel

to the two vectors given and joining the diagonal that goes from the tail of one to the head of the other. A typical problem is shown in the figure below. It shows vector a and vector b and the student is required to plot the two vectors and show the resultant vector of $a + b$.

i.e. If vector a is x long and in the positive direction on the horizontal axis and vector b is y long and at θ° to the positive horizontal axis. .

When plotting most can manage to plot and solve $a + b$.

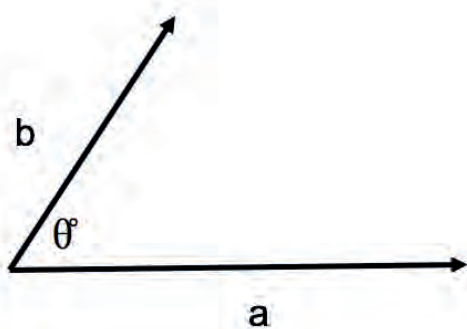


Figure 1: Vector a and vector b

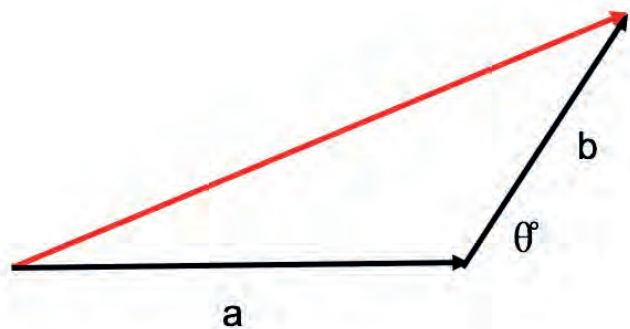


Figure 2: Tail of vector b joined to head of vector a

The head to tail method involves either joining the head of vector a to the tail of vector b (figure 2) or the head of vector b to the tail of vector a (figure 3).

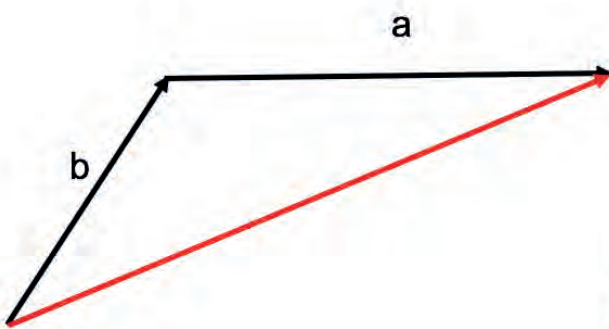


Figure 3: Tail of vector a joined to vector b

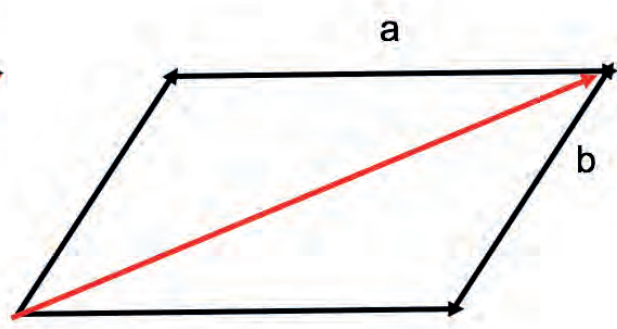


Figure 4: Parallelogram method

The parallelogram method (figure 4) involves drawing lines parallel to vectors a and b to form a parallelogram.

It can be seen from the diagrams above that it does not matter what method is used, the solution will always be the same.

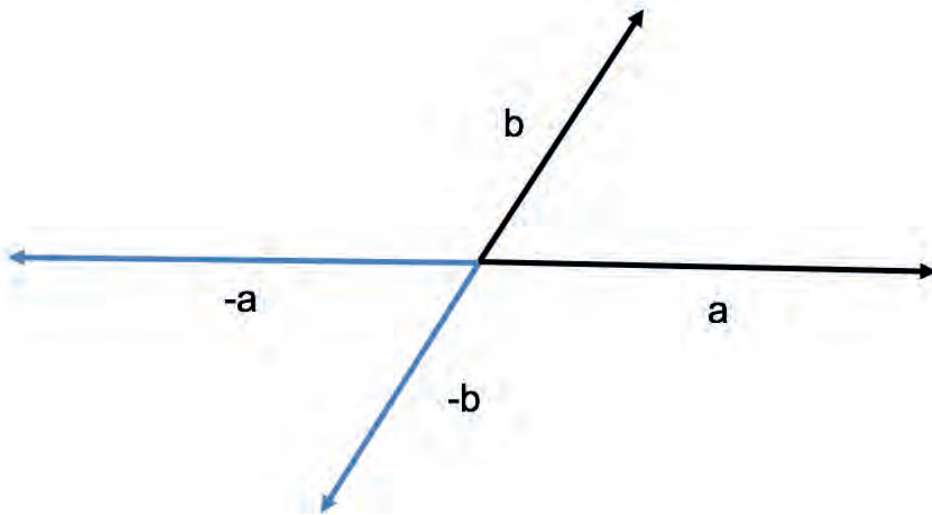


Figure 5

If vector a is of a certain length and going a given direction, then $-a$ is the same length but in the opposite direction. In figure 5 above vectors a and b are represented by the black arrows and their negative is the blue arrow. Understanding the above helps when

plotting other combinations of the vectors. Again, using either the head to tail method or the parallelogram method these vector problems can be plotted and then once plotted correctly they can be solved.

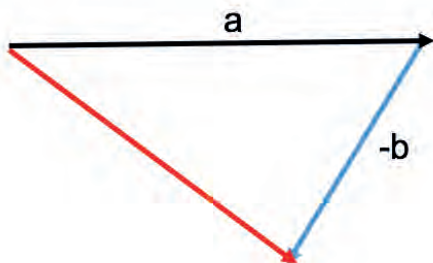


Figure 6: $a - b$

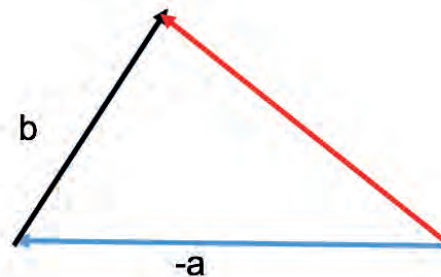


Figure 7: $-a + b$

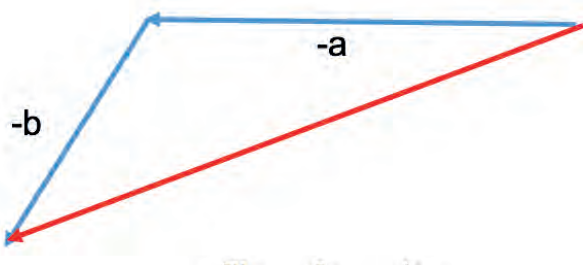


Figure 8: $-a - b$

The resultant of the plots is the magnitude and direction of the red line.

Students commonly encounter problems when asked to plot $a - b$, $-a + b$ and $-a - b$. Think Pair Share was employed to help overcome these difficulties as follows:

THINK

Firstly, the students were asked to plot $a - b$. They were encouraged to solve the problem on their own and given time to do this. While they were working, blank A4 sheets of paper

and some coloured markers were placed between each two students. As there was an uneven number, one group of three was created.



Image 1: Students working individually in the THINK stage

PAIR

In their pairs, the students were given the following instructions:

- Compare solutions with their partner.
- Agree on a solution (if they are both the same there may be little discussion, but if they are different work through both solutions and then choose one) and put this on the blank page provided.
- Display the agreed solution on the blank sheet of paper, make sure it is large enough for the class to see and use colour to highlight important points.
- Each pair could be asked to share their solution with the class.



Image 2: Students working in PAIRS stage

SHARE

The group was asked if anyone wanted to go first to present their solution to the class. Once the first pair presented their solution, the class were asked if they agreed with what had been presented. Where some students

had different solutions, they were asked to share this with the group. After the whole group discussion, the facilitator worked through the correct solution on a whiteboard, explaining each step clearly to the group.



Image 3: Students working in SHARE stage

SUMMARY

Breaking from the traditional classroom methods can be a little nerve-wracking but it can also be liberating for both teachers and learners. For a first run, try out the activity for the last part of a session to see how it goes. It is important that students work in silence for the individual part of the lesson.

For the subsequent parts, discussion is good as long as it is focused on the problem at hand. Encourage good-sized images and colour for the presentation as this improves clarity and can help develop the presentation skills of the students.

FURTHER READING

Lyman, F. (1981). "The responsive classroom discussion." In Anderson, A. S. (Ed.), *Mainstreaming Digest*, College Park, MD: University of Maryland College of Education.

Lyman, F., 1987, Think-Pair-Share: An expanding teaching technique: *MAA-CIE Cooperative News*, v. 1, p. 1-2.

07 Active learning strategy

ACTIVE LEARNING STRATEGY 07

Four Corners

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Institute of Technology

THE STRATEGY:

FOUR CORNERS

Four corners may be used at any point during a lesson or workshop to promote meaningful conversation. The strategy requires minimal preparation and gets students moving, so it may be used as an energiser as well. In addition to being an active learning strategy, four corners can also be used as a formative assessment technique, allowing the instructor to gauge student understanding.

For this strategy, students are presented with a question (or statement) to consider. In each corner of the room, pre-set answers or responses to the question are posted by the facilitator, and students are asked to select one of the posted responses and stand next to it. They are then encouraged to participate in group discussions, explaining to others at

their corner why they selected their chosen response. Thus, this activity allows students to develop richer rationales through collaboration, explain their ideas to their classmates and brainstorm with one another to generate new ideas, thereby learning from one another. It promotes listening, communication, problem solving, and reflection.

This strategy may be used as a warm-up activity by asking students to respond to a question or statement that they will encounter in the lecture. It may also be used as a check for understanding after a particular concept has been covered, in order to clarify difficult concepts or address common misconceptions.

RESOURCES

- 4 sheets of letter-sized or A4 paper (one for each answer option that will be placed around the room). *Optionally, if you prefer to use larger sheets of paper to improve visibility in larger spaces, you may hand-write or draw answer options.*
 - Roll of masking tape/blue tack for posting four sheets of paper around the room.
-

WHAT YOU CAN DO TOMORROW

Print the letters A, B, C, D on four separate pieces of paper in large font and distribute them near each of the four corners of the classroom (or in any four convenient locations). Create one or more multiple choice questions, with four alternative answer options, and type each question with all options (A–D) on a separate slide to display on the screen during the exercise. Poll students in class by having them get up off their seats and stand next to the

letter that corresponds to the answer they believe is correct. Ask students to discuss their rationale for selecting their answer within their groups and invite each group to nominate a spokesperson to explain to the rest of the class why the group believes their answer is correct. You can then announce the correct answer, explaining why the other choices are not correct.



Image 1: Group work

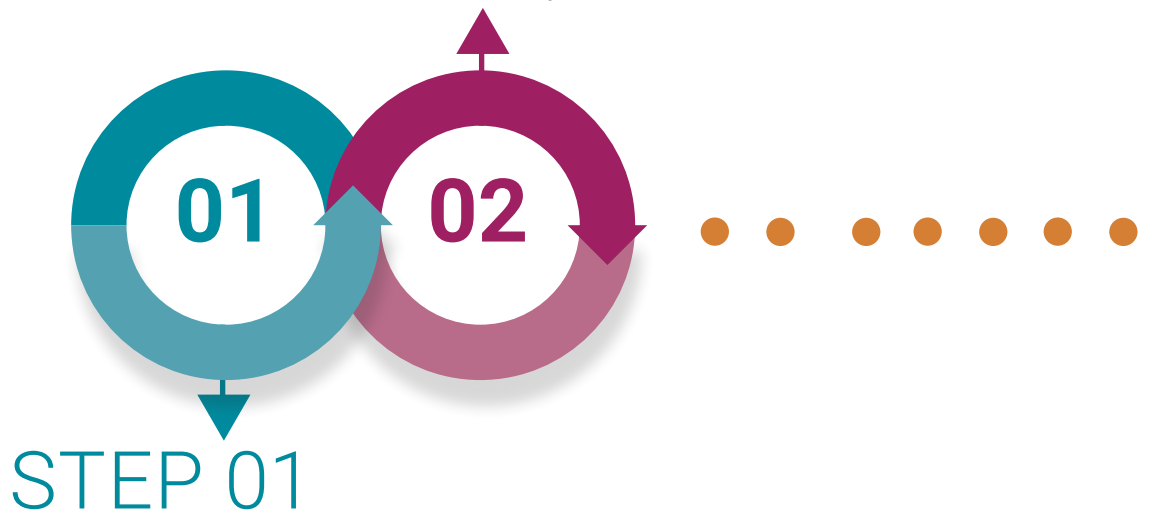
FULL IMPLEMENTATION

The full implementation of four corners requires some additional time to generate creative options for the students to select. These may be controversial or insightful in nature. The four alternatives selected are not confined to letters; they can be words, images, symbols, or even objects placed at various locations around the room. Steps one through four below are adapted from 'Four Corners', The Teacher Toolkit (n.d.):

STEP 02

DISPLAY THE QUESTION

Display the question on the screen and read it out loud, allowing students time to process it. Ask students to jot down the answer they would select and provide a rationale. Then display the four answer choices on the screen. Read them out to the class and ask students to select the option they believe to be correct.



WRITE THE QUESTION

Prepare a thought-provoking question or statement that is aligned to the learning objectives for your lesson or the overall unit. Write four answer options related to the question or statement on four separate pieces of paper to place around the classroom space (ideally at four separate corners). If you are planning to ask more than one question, the answer options may be displayed on the screen as multiple choice questions with the letters A, B, C, D printed on four pieces of paper and posted in four different areas of the room.

The following are sample options that may be used:

- Strongly disagree, disagree, agree, neutral
- Red, blue, yellow, white (to represent various feelings such as anger, sadness, happiness, neutral)
- Yes, no, sometimes, unsure
- Pictures or objects that represent four different answer options (examples: emotions/reactions, sports, roles, categories)

STEP 04

PROMOTE DISCUSSION

Encourage students to discuss why they selected that answer option with other members of the group. At this point, you may permit students to change groups if they like. Allow two to five minutes for discussion. Once you notice discussions are quieting down or are becoming off-topic, call on students within each group to present a summary of their discussion points, explaining why they believe their selection is correct.



STEP 03

INVITE STUDENTS TO MOVE TO A CORNER

Tell students to go to the corner of the room in which their answer option is posted.

STEP 05

DEBRIEF

Facilitate a discussion of the motivation for the students to go to a specific corner. If there is one correct answer, take up the problem, ensuring that everyone understands why it is the correct choice.

OVERCOMING PUSHBACK

There may be instances where students resist in participating in active learning activities such as four corners. There are a variety of factors that can impede the successful implementation of this activity; however, we as facilitators can help create a space that encourages student participation in this activity.

INSECURE ABOUT ANSWER CHOICE

Some students may wish not to participate in four corners because they lack confidence in their answer choice. Create a safe space where students feel comfortable taking risks and selecting the incorrect answer (if there is one). Be sure to value your students' responses, even if they are not correct, and explain that this activity will help the facilitator understand what concepts should be reinforced in class. If students know that it is okay for them to select the incorrect answer, they will be more likely to participate, even if they are insecure about their answer choice. Also, if the questions are of a sensitive or controversial nature, consider providing a 'not sure/prefer not to respond' option or let students know they can pass on certain questions if they prefer.

STUDENTS NOT WANTING TO GET OUT OF SEATS

Some students attend class expecting that they will be passive participants; that is, they will simply watch and listen to the facilitator deliver content to them. It is important to convey your expectations to the class early on in the course/module and begin implementing active learning strategies as soon as possible. If a student still resists getting out of their seat, consider allowing students the ability to pass on the activity if they are not comfortable or able to participate.

STUDENTS NOT STAYING ON TOPIC DURING THE DISCUSSION

Setting a time limit can help focus the discussion that takes place at each of the four corners. Additionally, students can be warned that they should assign a spokesperson who will summarise key points from their corners. This way, they will feel accountable and will be more likely to remain on-task.

CASE STUDY

As part of an onboarding training session for a group of approximately 20 new instructors, the four corners strategy was implemented to get participants out of their seats and moving around the room at the halfway point of a full day training session. The strategy

was also used as a means of dividing participants into groups of individuals with varying communication styles. These groups would eventually work together to discuss case studies exploring challenging communication scenarios.

Four different quotes were selected to represent four different communication styles (see Figure 2). Each quote was placed on a single sheet of paper and printed in large text, so it would be clearly visible to participants as they walked around the

room. This particular session was held in a large room with plenty of space to freely move around. That said, this could have been facilitated in a smaller classroom space, as long as all learners could move around the room.

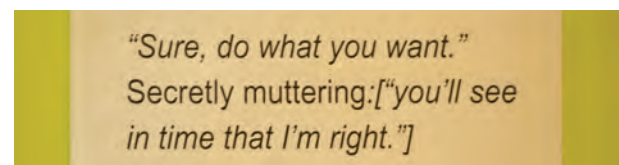
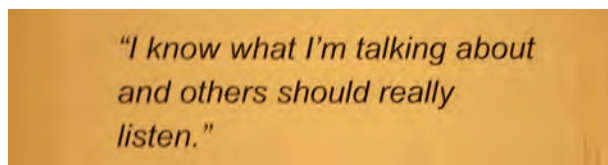
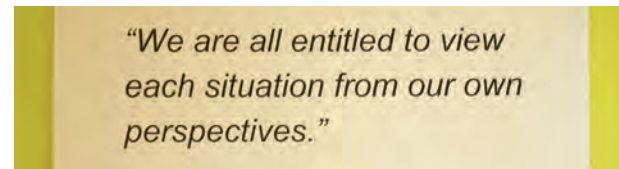
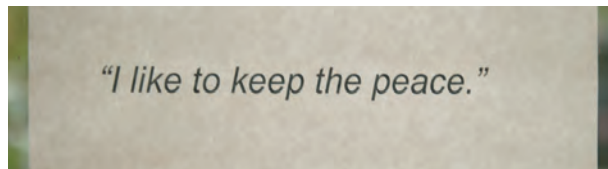


Figure 1: Images of four quotes adapted from Karell (2018) '4 Types of Communication Styles'

Learners were asked to circulate the room to read each quote and then stand by the quote that best represented their general communication style. The facilitators assured the group that there were no correct

answers and that they should not overthink the exercise. This was intended to encourage the learners to be comfortable to choose any of the four corners.



Image 2: Participants selecting which corner best represents their communication style

Visiting each of the four corners to read the quotes got everyone moving around the room and discussing why they chose to stand where they did with minimal prompting from the facilitators. This particular group included learners who were self-starters and easy to engage in discussion. If the group had been less engaged, the facilitators planned to have everyone discuss their reasons for selecting their chosen statement to others in the same corner. They would have then invited participants in each corner to summarise the discussions from their respective corners. Additionally, if the questions were more of the goal of the session, the facilitators would have spent more time debriefing on the learners' answer selections.

It took less than five minutes for learners to decide which of the four corners had

the quote that best represented their communication style. In this activity, there were approximately five individuals at each corner (some corners had fewer or greater than five participants). Once movement had settled in the room, each of the participants in corner 1 were given a different case study (identified as Case Study A–E in the table below). Likewise, each of the participants in corner 2 were given a different case study, which was also the case for participants in corners 3 and 4. For corners that consisted of more than 5 participants, two members received the same case study (such as in Corner 3 in the example below), and for corners with fewer than five participants, not all worksheets were distributed (as in Corner 2 in the table below).

Corner 1	Case Study A	Case Study B	Case Study B	Case Study D	Case Study E	
Corner 2	Case Study A	Case Study B	Case Study C	Case Study D		
Corner 3	Case Study A	Case Study B	Case Study B	Case Study D	Case Study E	Case Study A
Corner 4	Case Study A	Case Study B	Case Study B	Case Study D	Case Study E	

Figure 3: Schematic representation demonstrating how participants in each of the four corners were divided into different groups based on their communication style

Once all participants received their handout, they formed groups with others that had the same case study. The case studies presented challenging situations an instructor could face and focused on effective communication techniques. Thus, the four

corners technique allowed facilitators to create groups comprised of individuals with varying perspectives and communication styles. It was also a way to introduce members of the group to colleagues whom they may not have had the chance to meet.



Image 3: Members of each group had diverse communication styles and completed an effective communication case study together

SUMMARY

The four corners strategy may be used to poll students and gain an understanding of their thoughts, perspectives and/or opinions. It allows students to move around the classroom and engage in discussions with like-minded peers. Questions may be simple multiple choice types with one, or

even several correct answers. Alternatively, they can be open-ended, thought-provoking or controversial. Four corners can therefore be used in a wide variety of contexts and disciplines and can provoke deeper learning and discovery through thoughtful group discussions.

FURTHER READING

Boud, D., Cohen, R., & Sampson, J. (2014). Peer learning in higher education: Learning from and with each other. Routledge.

Discovery Education Europe. (n.d.). Spotlight on Strategies: 4 Corners.

Retrieved from <https://www.discoveryeducation.co.uk/spotlight-on-strategies/try-a-strategy/item878998>

TEMPLATE

Lesson	
Learning outcome of activity	<hr/> <hr/> <hr/> <hr/> <hr/> <hr/>
Question	<hr/> <hr/> <hr/> <hr/> <hr/>
Alternatives	1 <hr/> <hr/> 2 <hr/> <hr/> 3 <hr/> <hr/> 4 <hr/> <hr/> <hr/> <hr/>

08 Active learning strategy

ACTIVE LEARNING STRATEGY 08

Jigsaw

Mark Keyes

TU Dublin

THE STRATEGY:

JIGSAW TEAMWORK

Cooperative learning is an instruction method that encourages small groups to work together to maximise the collective learning of the group (Johnstone et al., 2008). The 'Jigsaw Method' is one form of a cooperative learning strategy and is designed to facilitate individual and group learning activities in education. The strategy requires that the learning is initially shared among the group and provides everyone in the class with an understanding of the entire topic or concept. For the activity, the class is divided into small 'Jigsaw' groups. The main topic is divided into several sub-topics which are then assigned to students within each

group. Individual students must research their assigned sub-topic before joining up in expert groups with students who have been assigned the same sub-topic. The expert group allows students an opportunity to share and learn from one another and clarify any misconceptions garnered during the individual research stage.

The original Jigsaw groups are then reformed with an 'expert' from each sub-topic. Experts take it in turn to teach the group about each sub-topic, allowing the group an opportunity to piece together the parts of the 'puzzle' that contribute to the overall understanding of the main topic.

LEARNING THEORY UNDERPINNING THE STRATEGY

Jigsaw learning activities were introduced by Elliot Aronson in 1971, originally with the objective of addressing racial tensions and improving learner engagement in schools (Aronson, 2018). The strategy, like many others that incorporate group work, is supported by Russian psychologist Lev Vygotsky's social development theory. Vygotsky determined that a learner's development improved 'through problem solving under adult guidance or in collaboration with more

capable peers' (Vygotsky, 1978, p. 86).

However, Jigsaw activities are relatively complex and may be more suited to students that are familiarised with group work (Clarke, 1994). Learning in groups is subject to a range of complex elements including individual characteristics, group dynamics and interaction theory (Jacques & Salmon, 2000). Clarke suggests that less confident learners may be paired within groups to help them overcome their anxieties.

RESOURCES

- Room setup to accommodate group breakout (any room with flexible seating arrangements or clear floor space can be utilised) Pen and paper (for student/group notes)
- Projector and screen or whiteboard to introduce the activity
- Flipchart, paper and markers for group reporting
- Assessment/Feedback/Quiz

WHAT YOU CAN DO TOMORROW

You can use this shortened and simplified version of Jigsaw as part of any lesson to gradually introduce students to the strategy:

1. With thirty minutes remaining in a lesson, take any topic that you have just covered during class and divide it into 3-4 sub-topics (for speed, decide on your topic/sub-topics ahead of class).
2. Divide the class into small (Jigsaw) groups whereby the number of students in each group matches the number of sub-topics.
3. Allocate a different sub-topic to each member in the group and allow 5 minutes to individually write down 2-3 bullet points they believe capture the main attributes of the group
4. Reform the groups as 'Experts' allowing 10 minutes to share, confer and agree on a single list of 2-3 bullet points covering the sub-topic.
5. Collect the completed lists from the expert groups and use the information to summarise the lesson while also affording an opportunity to clarify any remaining misconceptions.
6. Explain that you intend to use an expanded version of the activity in future lessons and emphasise the benefits of this approach such as:
 - a. Facilitating more active student participation
 - b. Opportunity for deeper individual understanding
 - c. Foster teamwork and an opportunity to learn and help each other.

STEPS FOR IMPLEMENTATION

In preparation for this activity, the tutor should select a main topic in advance and divide it into several sub-topics which will be assigned to students. The number of sub-topics will determine the size of each 'Jigsaw group' by allowing one learner per sub-topic. The following steps will help you with the structure and sequencing of the activity.

STEP 02

Within each of the Jigsaw groups, assign a sub-topic to each student. You should now have several Jigsaw groups with each member taking responsibility for researching one of the sub-topics (Figure 1).

STEP 04

Expert groups should then be formed consisting of students nominated to research each sub-topic. The expert groups are allotted sufficient time to discuss their understanding of the sub-topic and prepare material/information to present to their own Jigsaw group. This group discussion usually results in a deeper understanding of the sub-topic through peer learning (figure 2 denotes 3 Expert groups covering 3 sub-topics).

STEP 06

It is a great idea to close the activity with a team quiz or task. This allows the learners to test their knowledge and incentivises participation by introducing an element of competitiveness between the teams. As with all learning activities, it is good practice to finish with a debriefing exercise whereby learners have an opportunity to provide feedback and suggestions for future improvements.



Divide the students into Jigsaw groups of 3 – 6 learners. It is preferable to have the groups as diverse as possible with mixed genders, ethnicities and levels of ability. This promotes greater levels of learner integration and reduces the possibility of cliques or weaker learning groups.

Students are provided learning material for individual sub-topics and a fixed period of time allocated to researching in preparation for expert group collaboration and discussion.

Students return to their original Jigsaw groups where each expert in turn presents what they have learned to the other Jigsaw group members (Figure 3). It is important to encourage questions and group discussion at this stage while also ensuring that all group members are engaging.

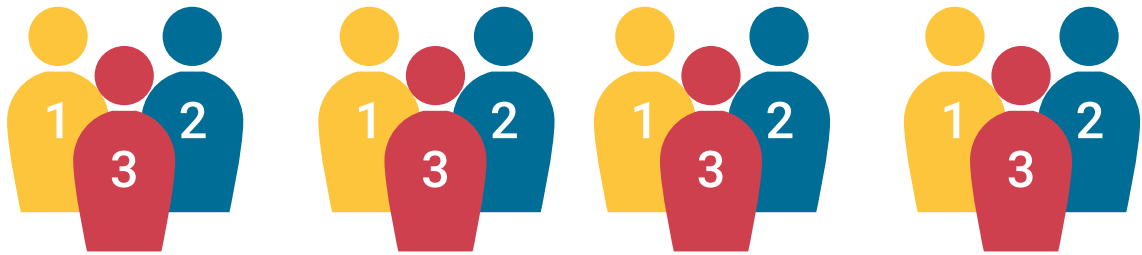


Figure 1: Jigsaw groups – 4 groups allocated 3 sub-topics

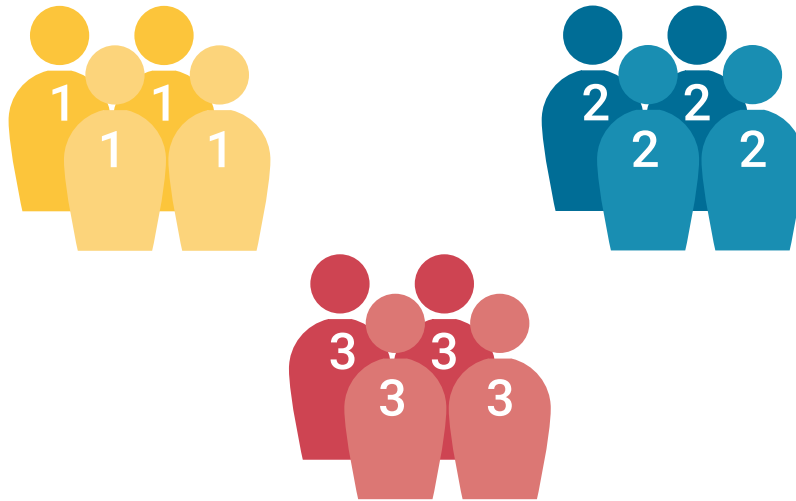


Figure 2: Expert groups discussing 3 different sub-topics



Figure 3: Expert presentation in Jigsaw group

OVERCOMING PUSHBACKS

Group learning is subject to a myriad of problems that can reduce the effectiveness of learning activities. The following examples highlight issues that may arise during a Jigsaw learning activity:

1. THE DOMINANT LEARNER

There is always the possibility that dominant personalities will try to take over the activity, to the detriment of other learners. It is your responsibility as facilitator to supervise the activity and ensure that all learners have equal opportunity to contribute. Fortunately, the nature of this activity requires that each learner present material and usually groups recognise the value of individual contributions.

2. THE BORED LEARNER

While boredom is a common problem in education and training, active learning is only effective if a learner engages. Sometimes stronger students can become bored with group work if they perceive that they are above the level of learning. In the case of Jigsaw learning, this may be overcome by emphasising for these students the challenge of becoming 'teachers' for their peers. The

use of team quizzes or tasks can also be a motivational factor for competitive students.

3. THE QUIET LEARNER

Learning groups usually include quieter, shyer participants who are often reticent in coming forward with contributions. The very nature of Jigsaw learning is helpful with this, as there are individual as well as group tasks. Often, the quieter learners will struggle most with having to present in front of their peers. You should actively supervise group work to ensure that other students are not talking over or disrupting another individual's presentation.

4. THE SLOW LEARNER

In any learning group, there will typically be different levels of learners. Jigsaw activities offer very strong opportunities for peer learning. However, it is crucial that you monitor the activity closely, particularly during the Expert group discussions. It is important to ensure that slower learners are taking on board feedback and suggestions from the other 'Experts' in their group..

CASE STUDY

OVERVIEW

This Jigsaw activity was run with a group of Year 3 Horticulture degree students studying a module on project management. It is worth noting that this group was in the advanced stages of group development (see chapter on group work) and had previous experience with group learning activities.

The main topic of this lesson was 'The Role of the Project Manager'. This 2-hour lesson was conducted with a group of 11 students. The classroom had a traditional lecture theatre layout, with tiered/fixed seating. This provided clear floor space and whiteboard/wall space for students to work in groups and present their findings.

A flipped classroom approach (Bergmann and Sams, 2014) was adopted for the lesson whereby students were provided with course materials for the topic prior to the lesson via the Institute's VLE. The materials included videos and worksheets which students had to watch and complete prior to the classroom workshop.

At the beginning of the session the students were given a 5-minute briefing describing how the session would be conducted and also outlining three sub-topics that were to be explored throughout the activity.

THE ACTIVITY

Students were divided into Jigsaw groups and allocated a number to correspond with a sub-topic. With an odd number of students (11), the groups were arranged to ensure each group would have at least one expert for each of the sub-topics (Figure 4).

INDIVIDUAL RESEARCH

30 minutes were allocated for students to individually research their allocated sub-topic using their pre-completed worksheets and pre-lesson material as a useful reference point. Although this section of the activity was conducted in relative silence, some peer-to-peer discussion could be heard and was not discouraged.

Having completed their individual research, expert groups were formed grouping all identical sub-topic researchers together (Figure 5).

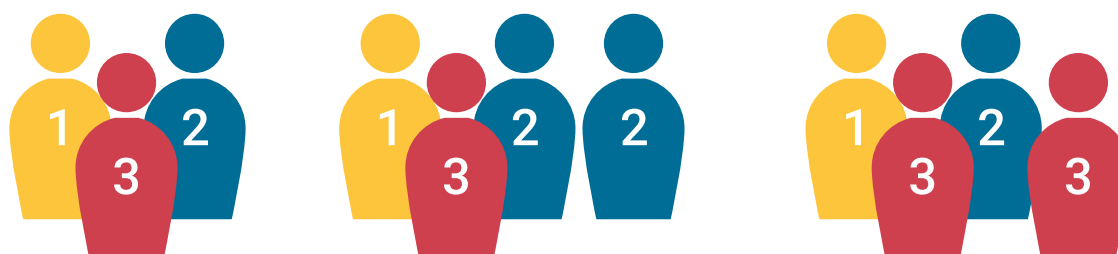


Figure 4: Jigsaw groups based on class group of 11 students

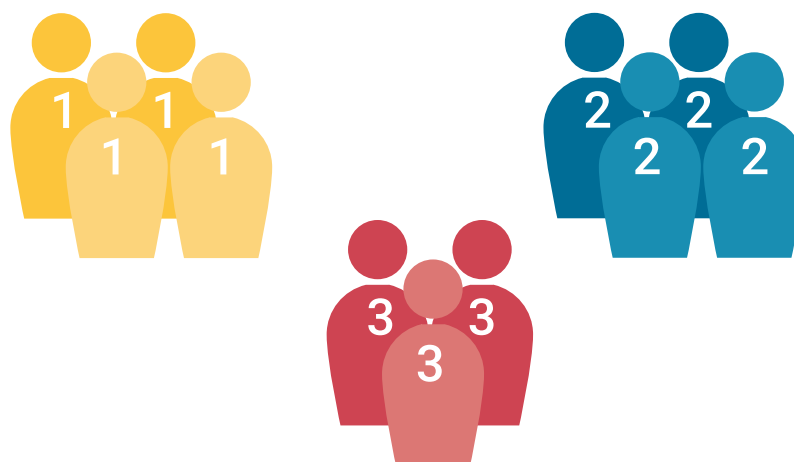


Figure 5: Expert groups based on class group of 11 students

EXPERT GROUP

Expert groups were instructed to work together for 40 minutes and tasked with producing a common A3 poster. The poster would be used to present the information to the other members of the Jigsaw group and should illustrate the outcomes of their combined research related to their specific sub-topic. At this stage the activity became more dynamic, with healthy discussion among the 'experts' as they came to a common agreement on the content of their posters (Image 1).

The tutor fulfils a facilitator role during this part of the activity, dividing time between the different groups to provide guidance and encouragement. This allows the tutor the opportunity to ensure that information on posters is accurate and that everyone is contributing to the activity.

JIGSAW GROUPS

Students were invited to return to their original Jigsaw groups and display their posters on a wall space (Image 2). Each 'expert' was allowed ten minutes to present the information from their individual sub-topic to their group. Where there were two experts in a group, the presentation duties were shared.

TEAM QUIZ

The activity was concluded with a 10-minute team MCQ test which captured aspects of all the sub-topics covered in the lesson. This was an excellent way for the tutor to gauge whether the learning outcomes of the lesson had been met and provide an opportunity for students to clarify any outstanding misconceptions. The students were motivated by the competitive element of the task, i.e. wanting to have the most correct answers in the team quiz.

STUDENT FEEDBACK

The students were invited to reflect on the activity at the end of the session and provide feedback to compare it with a previous group activity where whole-group presentations were required. The following were the main points of feedback:

- Everyone had something to do.
- Collaboration was strong in the Expert groups as consistency in the poster information was required.
- More involvement from the tutor to guide and explain would be welcome.
- The activity was more intimate than larger group activities.
- There was a good 'buzz' in the room.
- It was easier and less formal to present to a small number of peers rather than a large group.



Image 1: Expert groups working on the design of a common poster



Image 2: Students in their Jigsaw group with 'Expert' presenting

TOP TIPS FOR PRACTITIONERS

The following may be helpful if you are trying this strategy for the first time:

1. This is a relatively complex cooperative learning activity (with transitions between Jigsaw and Expert groups) so it may be more appropriate to use with students that are already comfortable with group learning strategies.
2. Try a simplified/abridged activity to see how your learners react and to get more comfortable with the format yourself.
3. Be observant and stay involved. While the students may appear to be active and engaged, it is important that you monitor their progress and provide explanations and encouragement when appropriate.
4. Informing the students that there will be an MCQ at the end of the session, keeps them motivated and focused, ensuring that they fully understand each of the expert presentations.
5. Do not be restricted by the teaching space available. While a flexible classroom layout is desirable, any clear floor and wall space can be utilised to accommodate this strategy.
6. Do not be afraid to mix it up. Jigsaw activities do not need to be standalone, they can be integrated with your existing teaching approaches, e.g. flipped learning can be used to prepare for the activity outside of class time.

FURTHER READING

Aronson, E. (2018). The Jigsaw Classroom. Social Psychology Network. Retrieved June 2, 2018 from <https://www.jigsaw.org/>

Clarke, J. (1994). "Pieces of the puzzle: The jigsaw method" In Sharan, S. (Ed.), Handbook of cooperative learning methods. Greenwood Press.

TEMPLATE

Course		
Module		
Topic		
Lesson	No:	
Directions	<ol style="list-style-type: none"> 1. One member from each jigsaw group will join an expert group. 2. Each expert group must research, discuss and create an individual poster (identical content on all posters) based on the corresponding topic outlined in the table below. 3. Each expert group member will then present their findings to their original jigsaw group. 	
Jigsaw Group 1	Jigsaw Group 2	Jigsaw Group 3
1 2 3	1 2 3	1 2 3
Expert Group 1	Expert Group 2	Expert Group 3
<p>Subtopic 1 e.g. describe, discuss, outline, identify, explain etc</p> <p>1 1 1</p>	<p>Subtopic 2 e.g. list the sequence required, using examples present 5 reasons for, categorise or summarise.</p> <p>2 2 2</p>	<p>Subtopic 3 e.g. draw a diagram showing, calculate, review.</p> <p>3 3 3</p>
Jigsaw Group 1	Jigsaw Group 2	Jigsaw Group 3
1 2 3	1 2 3	1 2 3

MCQ Template: <https://templates.office.com/en-us/Multiple-choice-test-or-survey-3-answer-TM02808005>

09 Active learning strategy

ACTIVE LEARNING STRATEGY 09

Town Hall

Robert Savelle

Durham College

THE STRATEGY:

TOWN HALL MEETING

The purpose of this strategy is to have students become familiar with procedural decision making through democratic processes in the context of their course topics and themes. For most students, their previous experiences in making decisions have most likely been personal, individual, and short-term in nature; however, major societal decisions typically tend to be public, collective, and with a more long-term focus. Depending on their age, the majority of students in post-secondary institutions have not yet had the opportunity to participate in a formal democratic voting process and, as a result, this limits their experience in relation to the decision-making process in both public institutions and private enterprises. A key objective in many town hall meetings (or shareholder meetings for private enterprises), particularly at the local level, is to elicit feedback or suggestions to specific problems or proposals that impact stakeholders. 'Experts' in the field will often be present to provide their opinion and insight.

However, others in attendance may not share the same level of knowledge; rather, they are 'experts' in other fields, from their chosen professions to their personal experiences. Public or shareholder consultation is required as part of the decision-making process and to endorse final outcomes. This aspect of the process requires a consensus agreement and will likely be one in which most stakeholders will have to make concessions to accommodate others.

This activity creates a scenario in the classroom similar to that of the town hall meeting whereby students are required to assume roles with which they may not be familiar or may not agree. By the end of the activity, students should recognise that the most effective way to make large-scale decisions is not to convince others of your own point of view, but to use all perspectives to arrive at a reasonable consensus upon which most can agree.

RESOURCES

- Roll playing cards/sheets
- Pen and paper (for student/group notes)
- Town Hall meeting case study (optional)
- Decision-making exemplars

WHAT YOU CAN DO TOMORROW

While this exercise can be delivered tomorrow, it does require some preparation beforehand to be effective. Keeping up with current trends in the industry or field is important, so that context can be appropriately discussed during the decision-making process of the town hall. Researching some examples of

well-known modern case studies, even if unrelated to the topic, is useful as it helps to stress the decision-making steps with topics familiar to the students. It can be beneficial to have outcomes from both successful and unsuccessful decisions on hand which can be used as exemplars when appropriate.



Image 1: Group brainstorming on how they will present their case

STEPS FOR IMPLEMENTATION

STEP 01

RESEARCH THE TOPIC IN THE FIELD

Depending on the subject matter, it is good to provide a true case study (contemporary or from the past) that can be modified to suit a relevant topic for the class. This can include controversies, future project proposals or adapting to new government regulations, etc.

STEP 03

GROUP FORMATION

Depending on the size of the class, organise students into groups based on the number of stakeholders (Table 1 below). Every member of the group should receive a stakeholder sheet allowing participants an opportunity to interpret the stakeholder's position from individually reading the task.

STEP 05

FEEDBACK

The instructor should make rounds to each group during the brainstorming step to check on progress while providing support and guidance on how to approach their stakeholder's arguments.



STEP 02

STAKEHOLDERS & THEIR POSITIONS

From the chosen topic, consider the project from the viewpoint of each of the different stakeholders and the potential impact of each decision. The stakeholder's identity may be taken directly from the case study or imagined based on the context of the town hall. The number of stakeholders required for the activity is dependent on the class size with a higher number of stakeholders when accommodating larger class sizes.

STEP 04

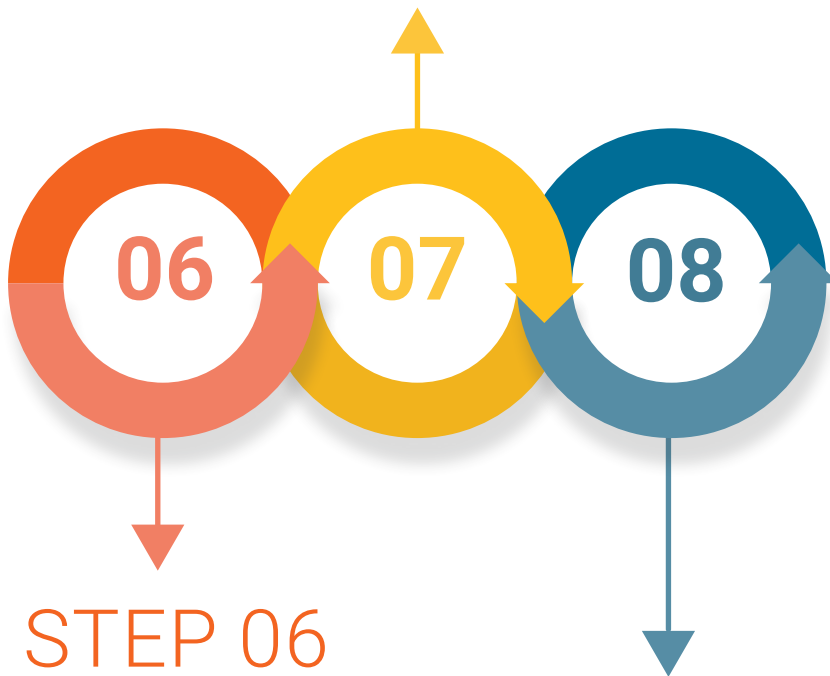
BRAINSTORMING

In groups, students should spend 5–10 minutes brainstorming how they will present their case in the Town Hall meeting, including any facts or arguments that they might come up with, which should be jotted down on the stakeholder page.

STEP 07

SOLUTIONS

Based on the key points recorded, the class group is provided with an opportunity to argue in support of or against elements of a proposed solution that should be discounted or those that should be salvaged. It is key for students to recognise that few, if any, stakeholders will be completely satisfied, with some being completely dissatisfied, thus highlighting the difficulty of getting policies implemented.



STEP 06

TOWN HALL

At this point, a speaker is nominated from each group to present each stakeholder's argument based on notes they have taken during the previous brainstorming discussion. The instructor should record the most significant points outlined by each speaker on the board to identify the key points that might be agreed upon, as well as highlighting the dissenting views.

STEP 08

INDIVIDUAL RESEARCH

From the ideas identified during the Town Hall activity, students may be asked to research a project or controversy in their field and identify the potential stakeholders and how they may be impacted by their proposals.

OVERCOMING PUSHBACKS

Group work is a common source of pushback in a higher education setting which may be alleviated somewhat by issuing clear instructions and utilising smaller group sizes. Facilitating this task as a formative exercise and as a collaborative strategy encourages learner involvement and allows students the freedom to express ideas openly without fear of formal assessment grading.

The content of the activity can be a source of pushback as the topics may not be entirely familiar to students, particularly if it is a current event or a specific case study that

is not well known. This highlights the fact that although experts are involved in discussion at high level decision-making processes, many of the participants involved are not experts and rely on their own judgment, collaboration and the testimony of others. Introductory discussions related to the election process, for example, can be used to highlight how few voters truly know all the details of the platforms or, in the case of industry, how shareholders generally know little of the actual company and how decisions are made based on the bottom line.

CASE STUDY

The Town Hall strategy has been used on many occasions during Ethics in Science classes at Durham College in Oshawa, Ontario, while this case study focuses on biotechnology and the issues that surround its implementation. The topical case study relates to using pig cell transplants as a potential cure for type 1 diabetes, which has been modified from an existing activity from the Science Learning Hub based in New Zealand. Although the details of the technology are not important to the activity, I provide a summary of recent developments at a very basic level. Most students are not familiar with this emerging technology and I used this as an opportunity to explain that

knowledge in the field does not present any additional advantage in conducting the exercise.

After a brief overview of the topic, I present the Town Hall activity and justify its place in society as described earlier. As we are in Canada, I situate the Town Hall meeting into a Canadian context and use examples of how this process works at the local level. For this specific activity, I suggest that the Town Hall meeting is to come together to decide if this technology should be accepted into Canada. I then have students form into 8 stakeholder groups based on the identities outlined below and distribute stakeholder sheets to all participants.

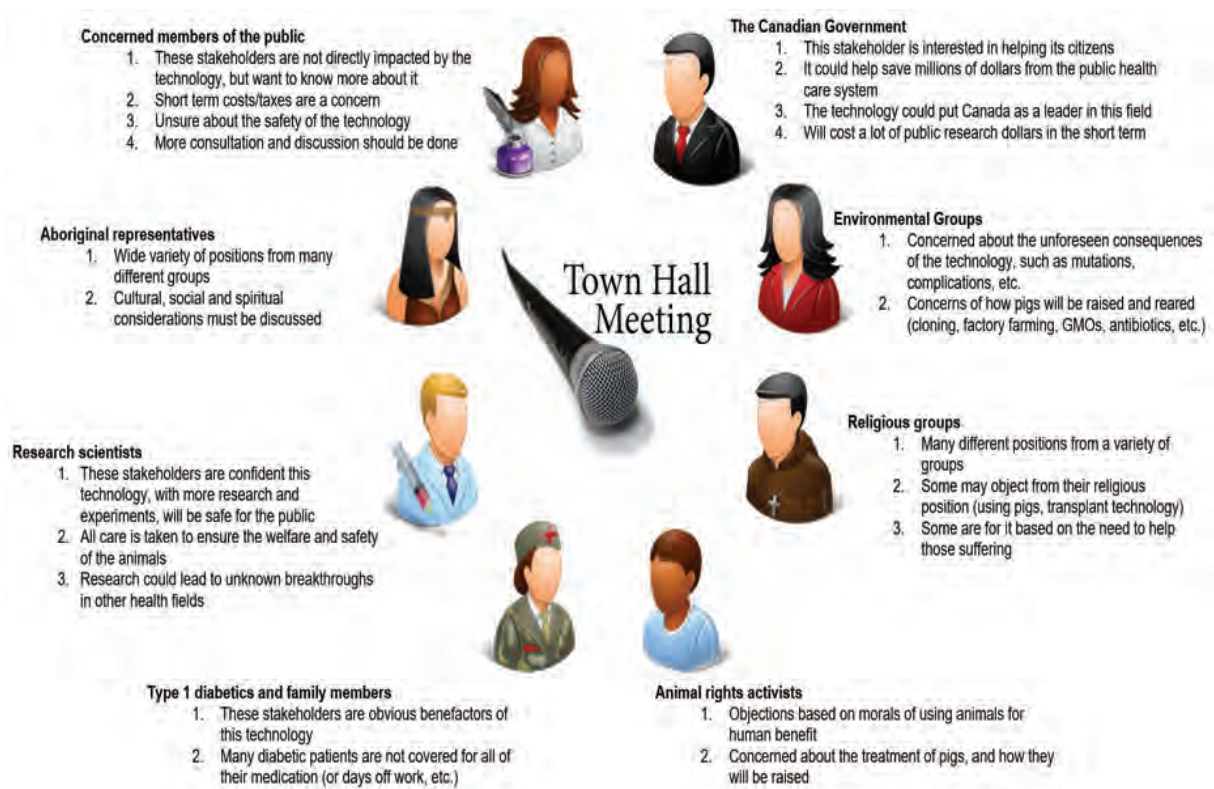


Figure 1: Stakeholder identities

As each group discusses the topic from the perspective of their allocated stakeholder, I walk around to clarify their stakeholder, see what ideas are being generated, and suggest alternative ideas that might be considered. The timing of this aspect depends entirely on how the discussion is evolving; normally 10–15 minutes is suitable. Once the group discussions are complete, ideas from each group are presented by a nominated speaker with the outcomes recorded and collated in table format. Student responses are categorised by those in favour of the technology and those against the technology which helps to identify areas of

commonality and areas of concern between stakeholders.

When all groups have finished presenting their arguments, each stakeholder is discussed in turn to consider alternative opinions to that recorded. During this part of the discussion, students are given an opportunity to present their own points of view, outside that of their nominated stakeholder. Having been presented with the views from all the stakeholders, the class group must vote on whether to proceed with the technology right away, wait for more consultation, or vote against the proposal.



Image 2: Students taking part in a town hall meeting

After the exercise, class discussion is focused especially on the merits of process and how it might be improved rather than on the topic or outcome. This part of the discussion is often the most interesting as there are so many different opinions of how it could be improved. Key to this aspect of the exercise is students being able to recognise the variety, veracity and relevance of opinion, particularly when it is different to their own. The final element of this Town Hall meeting is for students to individually research a case

study related to the topics from the class (in this case, applications of biotechnology), and write a brief 1–2-page paper on the summary of the research, and the potential stakeholders involved. Students are able to choose any case study they want, but it is important to come up with at least six stakeholders that might be affected by the real-life situation and create a few points to consider for each (as demonstrated from the example from the Town Hall meeting).

Course	General Arts and Science		
Module	Issues and Ethics in Science		
Topic	Xenotransplantation		
Lesson	Town Hall Meeting – The Ethics of Pig Cell Transplants		
Directions	Based on the topic and given stakeholder persona brainstorm your ideas including any facts or arguments		
Stakeholder 1 Canadian government	Stakeholder 2 Type 1 diabetics and family members	Stakeholder 3 Research scientists	Stakeholder 4 Animal rights activists
<ul style="list-style-type: none"> • Could increase international investment in the technology • Long-term benefits to health care system, saving the cost of current treatment options • Economic benefits as patients are more productive • Could put Canada 'on the map' with cutting edge research (political prestige) • Initial government investments may be high 	<ul style="list-style-type: none"> • Improved quality of life and life expectancy • More productive economically, more energy, improved family relationships, etc. • Reduced costs of medication (particularly those without insurance) and their side effects • Reduced time lost with doctor visits • Small risk of complications • Need to be monitored over lifetime for unpredicted issues 	<ul style="list-style-type: none"> • Can help solve the organ deficit problems in Canada • Pigs are already used for food, so this can save lives • Increased research grants and career opportunities for new scientists in the field • Improved facilities at hospitals and universities • Improved research decreases risks 	<ul style="list-style-type: none"> • Objects testing and researching on animals on moral grounds • Concerns about the treatment of the pigs and how they are treated • Increased chance of animal to human diseases (ie-mad cow disease) • Increases healthcare costs in the long run • Expense of the pig cell transplants
Stakeholder 5 Concerned members of the public	Stakeholder 6 Religious organizations	Stakeholder 7 Aboriginal representatives	Stakeholder 8 Environmental Groups
<ul style="list-style-type: none"> • Not directly affected by the technology, but want to know more about it • Short-term costs are a concern • Unsure about the safety of new technology • Keen to see more consultation and education on the technology • Privacy concerns 	<ul style="list-style-type: none"> • Many different positions from varied religious groups • Some feel that all should be done to save lives • Some are concerned about the moral implications of xenotransplantation as a way of 'playing God' • Some groups restrict the consumption of pork, so issues with using them may go 	<ul style="list-style-type: none"> • Wide variety of positions • Cultural, social and spiritual considerations • Safety and wellbeing are key to discussion • Input and consultation from Indigenous are important when discussing important federal decisions 	<ul style="list-style-type: none"> • Concerned about the unforeseen consequences of the technology, such as mutations, complications, etc. • Concerns of how pigs will be raised and reared (cloning, factory farming, GMOs, antibiotics, etc.) • Environmental implications from farms and the pig waste into local water bodies

Image 3: Town Hall Stakeholder template

SUMMARY

In the end, this exercise has proven to be successful for encouraging students to think deeply about a topic. The choice of topic is suited towards the theme of the class, and the wider learning of the decision-making process is valuable, particularly for students who are mostly in their late teens (and who may never even have had the chance to vote up to that point). The activity is versatile enough to put it into different course contexts, as every programme of study will eventually lead to fields in which effective, collaborative decision making can be of vital importance.

FURTHER READING

Glazier, R. A. (2011). Running Simulations without Ruining Your Life: Simple Ways to Incorporate Active Learning into Your Teaching. *Journal of Political Science Education*, 7(4), 375-393. DOI: 10.1080/15512169.2011.615188

Science Learning Hub. (n.d.). Ethics and Pig Cell Transplants. Retrieved from <https://www.sciencelearn.org.nz/resources/912-ethics-and-pig-cell-transplants>

TEMPLATES

The worksheet templates I have used have been modified from the Science Learning Hub (<https://www.sciencelearn.org.nz/resources/912-ethics-and-pig-cell-transplants>).

Course				
Module				
Topic	Town Hall Meeting -			
Lesson				
Directions	Based on the topic and given stake holder persona brainstorm your ideas including any facts or arguments			
Stake Holder 1 Persona	Stake Holder 2 Persona	Stake Holder 3 Persona	Stake Holder 4 Persona	
Stake Holder 5 Persona	Stake Holder 6 Persona	Stake Holder 7 Persona	Stake Holder 8 Persona	

10 Active learning strategy

ACTIVE LEARNING STRATEGY 10

Dynamic Problem Based Learning (dPBL)

Barry Ryan

TU Dublin

THE STRATEGY:

DYNAMIC PROBLEM BASED LEARNING

Problem Based Learning (PBL) is based on real-life, authentic and complex problems to which there is rarely a singular 'correct' solution. This can challenge students as the majority of their learning may have previously been focused on terminal exams and getting the correct answer onto the exam paper. Another issue is the use of group work which can present challenges to students, particularly those who prefer to work alone and wish to maintain control on individual grades. For the academic, these additional challenges add further complexity to the assessment of PBL-based modules...so why bother?

Quite simply, both staff and students benefit immensely from a (dynamic) problem-based learning environment (dPBL). Presenting a relevant problem in a contextualised scene, combined with a careful adjustment of the lecturer's role, enhances the learning experiences of all students, while

simultaneously offering a stimulating teaching environment for the academic. Adopting a (d)PBL approach allows the students to see both the macro and micro interconnections during the problem-solving process and how the problem could be directly related to their everyday experiences. Inclusion of dynamic changes (e.g. through dPBL) to the scenario during the problem-solving process mimics the fluxing real world environment and can result in enhanced engagement, deeper learning and a more meaningful experience.

The three pillars of (d)PBL are absolute requirements in adopting this teaching and learning approach: the problem, the tutor and the assessment (Strobel & van Barneveld, 2009). Each of these need to be carefully considered and can be adopted to align with the length of time allocated to the activity and the level of assessment.

RESOURCES

(d)PBL is best carried out in a non-tiered classroom setting while flexible furniture configurations allow participants to move freely and engage with each other more effectively. The scenarios and problems that will drive student learning should be provided in written format to each group. Students could be encouraged to use their

own Internet-enabled devices (e.g. phones, tablets, laptops) and connect to the local WiFi during the (d)PBL session. If a 'Bring Your Own Device' (BYOD) approach is not suitable, access to breakout Internet-connected computer rooms should be made available. Beyond this, very few other resources are needed to run a (d)PBL session.

WHAT YOU CAN DO TOMORROW

Develop a small scenario-based problem, which will stretch students a little beyond their current understanding. The problem should be a real-life problem, or life-like at least, in order to capture the student's interest. Initially provide students with an opportunity to work individually and to develop their own solution to the problem. Following this, allow students to form into groups of their own choosing (pairs, threes, fours and some larger groups should naturally form) and give time for each student to pitch individual solutions for the problem to their new group.

Once the pitching process is completed, ask each group to design a group solution to the problem adopting elements from the individually pitched ideas. Groups are then required to present the group solution to the rest of the class. Seek feedback (perhaps using the Two Stars and a Wish approach: two positive comments and one suggestion for improvement) from the class on each group's solution. If time allows, the facilitator could 'talk aloud' their approach to solving the problem so as to offer insight into an experienced problem-solver's mind.



Image 1: Working in pairs.

STEPS FOR IMPLEMENTATION

A (d)PBL approach can be adopted into any classroom, for any discipline, and can be executed by following these steps:

STEP 01

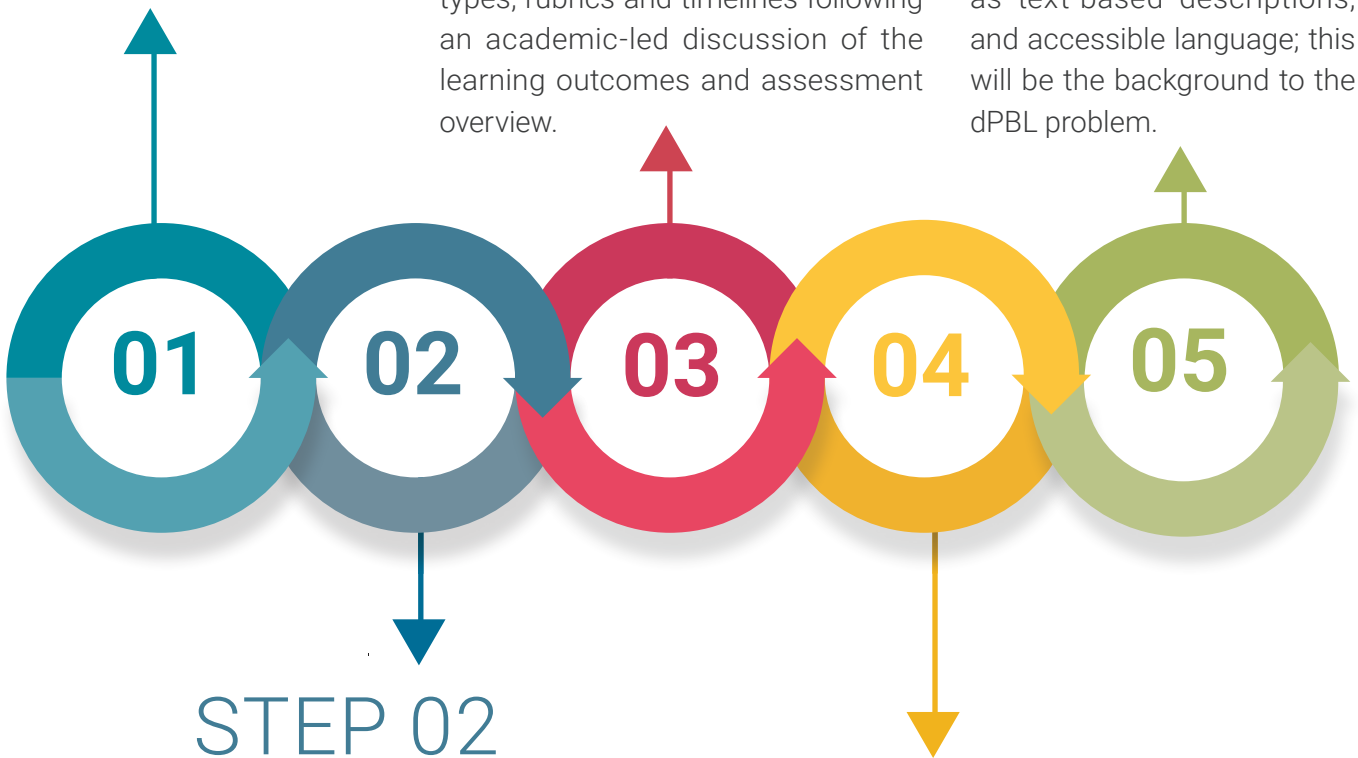
Introduce the concept of (d) PBL to the cohort and allocate time to discuss the approach including barriers, pros and cons.

STEP 03

Centralise the students in all decision-making processes once the groups are formed. This can include, where possible, the co-design of the assessment strategy, whereby the academic and the student groups negotiate appropriate assessment types, rubrics and timelines following an academic-led discussion of the learning outcomes and assessment overview.

STEP 05

Present a relevant real-life (or life-like) scenario in the context of your module using judicious presentation, including multimedia as well as text-based descriptions, and accessible language; this will be the background to the dPBL problem.



STEP 02

Form student groups that will work together to solve the (d)PBL problem. Groups can be pre-selected by the academic in a targeted (e.g. based on student position in the class) or random (e.g. based on a lottery) fashion. Alternatively, a student-centred approach to group selection can be used whereby the students self-select/create groups (Tuckman and Jensen, 1977).

STEP 04

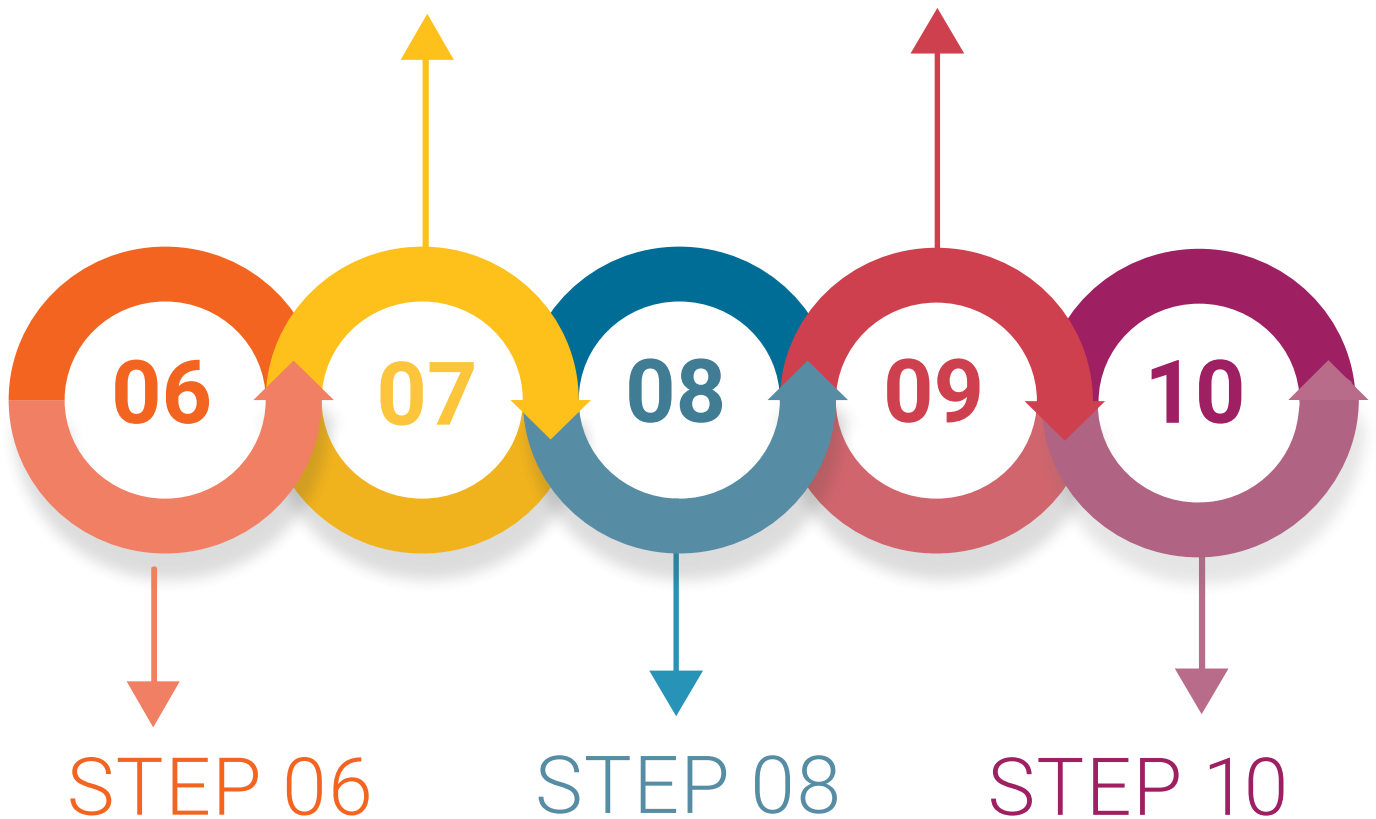
Ensure the problem-solving process, as well as the 'solution', is clearly valued in the agreed assessment strategy and grading rubric (Glasgow, 1996, as cited in Tai & Yuen, 2007).

STEP 07

Pose directional questions to guide students beyond their knowledge gaps towards a deeper understanding of the problem and potential solutions. An example of this would be to ask student groups 'why' to push students beyond their existing knowledge (White, 2006; Azer 2005). Allow students to make mistakes, to fail and to struggle.

STEP 09

Introduce an additional challenge to the original problem to maintain the momentum and energy of (d) PBL over time. This will force the students to reflect on their decision pathway to the point of change.



STEP 06

Ask the students to use their prior knowledge to identify the current limitations of their knowledge and how to go about filling in these gaps in order to address the dPBL problem.

STEP 08

Give students appropriate time to think, reflect and discuss with their peers to help students to overcome particular areas of confusion; however, set a limit on this 'thinking time' so the students can work towards an actionable end-point (Croom & Stair, 2005).

STEP 10

Celebrate student achievement, through group presentations or ePortfolios for example, highlighting the learning gains achieved by the students and their proposed solutions to the problems.

OVERCOMING PUSHBACKS

STUDENTS DO NOT ENGAGE WITH THE PROBLEM

Students can struggle with the open-endedness of the problem. The introduction of a dynamic change can further challenge students and may lead to further alienation and disengagement from the problem. One approach to overcome this apathy is to ensure a tangible output is the focus of each scaffolded activity. Each activity brings the student groups closer to their solution to the problem and the output will only come to fruition if the group works together. There may be gaps in both the individual student's and group's knowledge, and although the initial sense of hopelessness will be evident, guided scaffolding of student discussion can help ensure that the outcome represents the best combined efforts of the group (Hakkarainen, 2011).

STAFF BELIEF THAT STUDENTS CAN'T SOLVE COMPLEX PROBLEMS

Following on from the student fear of open-ended problems, with no 'correct' answer, teaching staff may also struggle with how to facilitate a class that is based on (d)PBL. Attempting pseudo-PBL by designing a problem that would eventually converge on the same 'correct' answer may be an attempt to design a standardised learning event and protect participants from the complexity of real-life problems. Forcing each student to think, imagine, conceptualise and theorise in the same way is not possible, and does not develop critical and independent learners. The diversity within student groups should be embraced, along with celebrating each student's own personal (and group) abilities to solve complex problems.

STUDENTS DO NOT ENGAGE WITH GROUP WORK

Central to successful (d)PBL is the integration of group work as core to the problem-solving process and subsequent individual learning and personal development (Savery & Duffy, 1995) while the two most important aspects of (d)PBL are the group process and self-knowledge (Fenwick, 2002). During (d)PBL the development of self-knowledge is seen to mirror group work with key elements including learning to understand different perspectives within the group, to cooperate, to lead small groups and to manage conflict within groups. At an undergraduate level the development of these soft skills is an absolute requirement, and oftentimes lecturers can struggle to find suitable ways to teach and assess these soft skills (Kumar & Hsiao, 2007). Compounding this is the general aversion to group work by undergraduate students.

In order for a (d)PBL approach to be most effective, each group must be capable of juggling multiple projects, thinking critically, writing academically and working as a coherent group. These are skills that staff can struggle to 'teach' and students equally can struggle to 'learn' but they are the skill set that employers require in graduates. This tangible link to employment may be used as a lever to encourage student engagement with their groups. Additionally, modern modes of communication and technology, e.g. group wikis and cloud-based presentation tools, can be used by students and staff to maintain communication outside formal face-to-face events, further enhancing the student skill set.

STUDENTS QUESTION THE ASSESSMENT APPROACH

In (d)PBL, the process involved in attempting to solve the problem is as important as the outcome or final solution. As such, it is important to monitor and assess both aspects of the activity. Additionally, group work is pivotal to the success of (d)PBL. However, this can cause tension during assessment and grade allocation. Clarity and fairness are required to engage students in the assessment strategy and aspects of the process/product and group/individual need to be equally valued. For example, the individual learning journey can be

documented and examined through the use of (e)Portfolios (e.g. Liu et al., 2009), while reflection is best reviewed through personal and critical reflective writing (e.g. Brears et al., 2011). The group learning journey can be detailed in a wiki (e.g. Xie & Kim, 2012) and the group collaboration vetted by a suitable peer assessment (e.g. Papinczak et al., 2007). Several other alternative product and process assessment methodologies are discussed by MacDonald (2005) through a comprehensive description of various case studies.

CASE STUDY

OVERVIEW

In a final year Advanced Bioprocessing module (5ECTS), students were taught through an immersive, scenario-driven dynamic problem-based learning approach. In this approach students were emailed weekly memos from a fictitious biopharmaceutical CEO that challenged them to design the company's new blockbuster drug. Along with developing a novel stream for the company, the students were asked to create their bioprocess (including industry standard piping and instructional diagrams), establish standard operating procedures to support the company's manufacturing operations, and complete their due diligence in terms of patent licence and market opportunity. Each week the memo guided the students towards a set of goals that, cumulatively, brought the students from the initial extremely open-ended question through a set of smaller problems. As the initial problem was so open, the final product of the dPBL approach

is different for each student cohort and therefore the groups learn from each other throughout the module.

The class was delivered as a back-to-back two-hour double session in a traditional tiered lecture theatre to a mixed class of approximately 35 students. The students were a mixture of food and pharmaceutical disciplines. The students' first problem was to form cohesive working groups around common areas of interest (i.e. independent of discipline background). This allowed students who would not normally work together to form new groups around a common goal. This generates strong buy-in from the student cohort; the groups are self-selected around a topic they want to explore. They determine what they want to learn and how they want to learn it through the scaffolding of the weekly memos (see Table One).

Table One: An overview of the weekly memos and the tasks/problems each memo asked the student group to address.

Memo No.	Topic of Memo
One	Form group + review current research areas (peer reviewed literature)
Two	Prepare presentation on new target product
Three	Develop digital portfolio to document development
Four	Prototype logistics for small scale production
Five	Annotated Review of a process related publication and SOP creation
Six	Market comparison and patent database review
Seven	Science communication for product marketing

A typical learning week soon took on a common trend for each of the groups as they tackled each memo (see Figure One). The weekly problems were too big for anyone member of the group to complete alone; therefore, the students had to work together. As a group they determined how best each group member could contribute

to their group's advancement of the weekly problem, and therefore the larger, overarching problem. This allowed the weekly face-to-face classes to mimic a collection of 'working group' meetings common in the industry and were chaired and coordinated by the students.



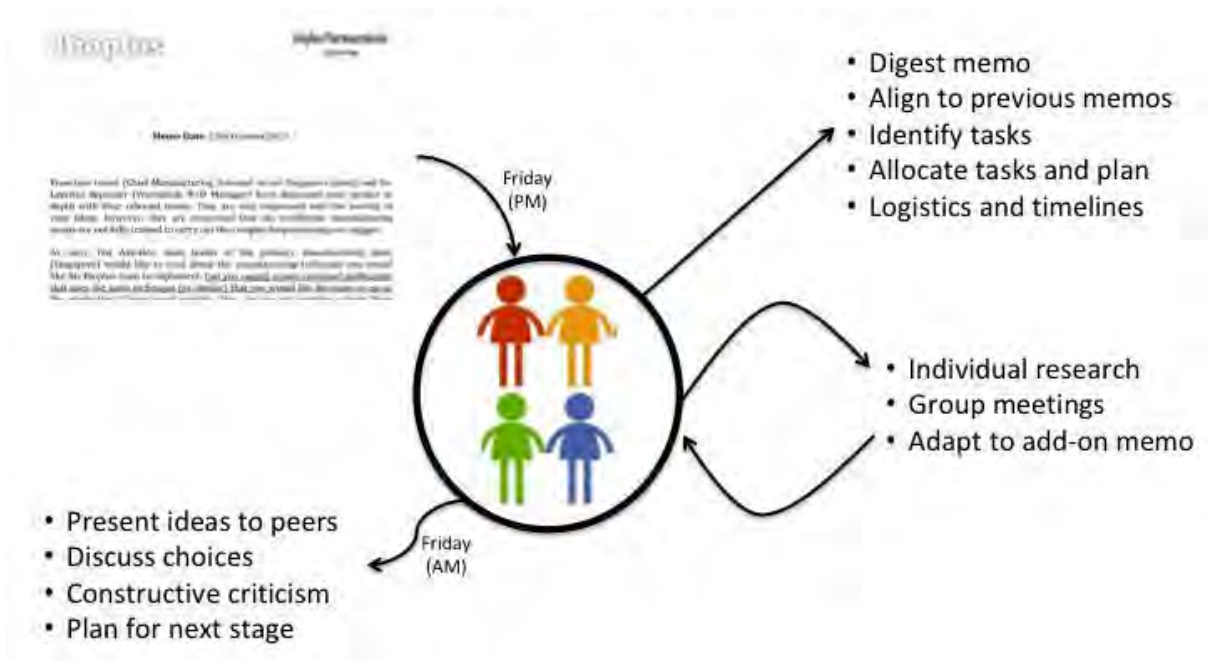


Figure 1: The typical weekly cycle for the dynamic Problem Based Learning Approach.

Figure 1: The typical weekly cycle for the dynamic Problem Based Learning approach to teaching Advanced Bioprocessing. The cycle is initiated by the release of the memo to the group (noted as occurring on Friday evening). The group then rotates through the various learning activities comprising both individual and group activities. The cycle concludes at the next class (denoted as Friday morning in this case) where the student groups present their process progress, discuss and provide peer feedforward for future development.

Once the students were familiar with the arrangement of the student-centred learning, and all groups had actively taken responsibility for their learning, dynamism was introduced to reflect real-life challenges faced in the biopharmaceutical manufacturing industry. These dynamic challenges were often released between classes and the student cohort was expected to have prepared a response for the next face-to-face class. These challenges reflected topical issues pertinent at the time to add to the realness of the scenario; for example, pirate attacks on cargo shipping around the east coast of Africa was particularly problematic during one iteration of this module and

this was included as a challenge (i.e. the ship containing a key raw material for each student bioprocess had been hijacked so the students needed to consider an alternative manufacturing strategy). All problems were themselves scaffolded by the 3C3R approach and this allowed for a transparent and fair assessment to be developed and executed. The 3C3R model consists of two classes of components: core components and processing components. Core components include content, context, and connection, and are used to support content/concept learning; processing components, composed of researching, reasoning, and reflecting, concern the learners' cognitive processes of learning and problem-solving skills (Hung, 2009).

The assessment strategy examined both the process (blogs, reflective essay) and the product (ePortfolio, annotated review, teaching class, infographic) as part of a 100% continual assessment (CA) approach. The assessment approach, which was as both individual and group based, was designed by the student cohort and facilitated by the academic (see Table Two).

Component	Weighting (%)
Blogs (do 10, top three graded)	15%
Reflective Essay	15%
Annotated Review	10%
ePortfolio	35%
Teaching Class	15%
Infographic	10%

Table Two: Agreed assessment approach table

Table One: Student-designed CA approach. Items noted in bold were group-based CA (typically groups of three) and those in regular font were individually completed CA.

The module was evaluated by the student cohort and the key emergent themes of student responsibility, group-based learning, industrially relevant learning, personal development and reflection emerged. The students took ownership of their groups project; however, they were willing to support their peers in a constructive

learning environment. Through ongoing and committed reflection, each student identified their strengths (and weaknesses) and integrated their skills into their groups weekly workflow in order to maximise the productivity of their group. In doing so, the members of each group assisted each other as part of a dynamic, functional group that mimicked a real industrial setting in the safe environment of the classroom. Student groups were free to make mistakes, learn from them and to build their solution to the open-ended problem.

SUMMARY

This chapter outlines an incremental approach to traditional problem-based learning where the initial problem is structured into sequential and logical sub-problems that can be perturbed by the inclusion of unforeseen change. This dynamic element allows further contextualisation to be brought to the problem-solving journey, while simultaneously mimicking real-life settings that the student will likely encounter once they graduate. Exposing the student to these situations in a safe environment allows

the student to develop confidence in their problem-solving abilities, learn from their mistakes, and also enhance their soft skills through continuous critical reflection, group work and peer dialogue.

There are barriers to the adoption and integration of (d)PBL and these tend to focus on assessment and group work. To address these issues, clear and fair assessments (and guidelines) must be utilised, perhaps with the inclusion of the student voice during the design, focusing on

the individual and group contribution to both the problem-solving process as well as the final 'answer' (i.e. the product). The design of a good problem for (d)PBL oftentimes results in a problem that has no correct answer. As such the journey can be enlightening and rewarding for the students and staff as they explore together the possible 'correct' avenues, and, through self-directed learning, academic facilitation and peer dialogue, deep learning can be achieved.

FUTHER READING

General reading on PBL with multidisciplinary exemplars of best practice
Barrett, T. & Cashman, D. (2010). A Practitioners' Guide to Enquiry and Problem-based Learning. Dublin: UCD Teaching and Learning. Freely available from <https://www.ucd.ie/t4cms/UCDTLI0041.pdf>

Magennis S. & Maguire, M. (2015). An Introduction to Enquiry/Problem based Learning. Freely available from http://eprints.maynoothuniversity.ie/6824/1/NUI_Aishe_Booklet_PBL.pdf

Dynamic Problem Based learning example (Chemistry specific).
Overton, T. L., & Randles, C. A. (2015). Beyond problem-based learning: using dynamic PBL in chemistry. *Chemistry Education Research and Practice*, 16, 251-259

TEMPLATE

Template One: (d)PBL design

Hung (2009) describes a nine-step approach to problem design based on the 3C3R concept (3Cs = content, context, connection and 3Rs = research, reason, reflection). Incorporating this model into your problem design will ensure that your problems are designed to challenge, motivate and encourage students to learn through tutor-guided questioning and self-directed research and reflection. Use the template below to structure your (d)PBL design.

The 3Cs: these are the concepts and content that the problem will focus on.	
Component	Relate this component to your (d)PBL problem
Content	
Context	
Connection	
The 3Rs: these are the cognitive processes of problem solving	
Component	Relate this component to your (d)PBL problem
Research	
Reason	
Reflection	

TEMPLATE

Template Two: Process Assessment Guide

Assessing the Process component of (d)PBL can be one of the more challenging aspects for staff and worrisome for students. This component needs to be fairly and authentically assessed. One simple but effective method is that of Tai & Yuen's (2007) which is based on a three-pronged assessment approach. Tai & Yuen (2007) describe the use of a multiple mixed assessment methodology to assess the students' ability to apply acquired knowledge and skills in a variety of authentic contexts and work collaboratively to solve complex problems (termed Performance Assessment), to examine the students' ability to document their learning journey (termed Portfolio Assessment) and evaluate the students' autonomous learning through critical self-reflection (termed Reflection and Self-Assessment).

Component	Where in your process assessment design is this component noted?	Is it authentic and why?	How will it allow students to display their achievement of the learning outcomes fairly?	What type of assessment will this be (e.g. written, oral etc.)?
Self-Reflection				
Peer's Reflection				
Task Completion Reports				

Group Work

Group Work
Mark Keyes
Richie Ryan
TU Dublin

INTRODUCTION

Many active learning strategies, including a number of the ones you will find in this handbook, involve group work/teamwork. Learning in groups is subject to a range of complex elements including individual

characteristics, group dynamics and interaction theory. To assist practitioners who are relatively unfamiliar with group learning, this chapter has been included to provide some straightforward guidance.

RESOURCES

An important feature of most face-to-face teaching is that it takes place with a group/cohort of students. However, formal lecture settings often remove the group learning dimension, with an emphasis on the teacher as the fountain of knowledge. Group learning is an important teaching/learning technique that can be used to enhance active participation and facilitate peer-to-peer learning.

In a group setting, learners are provided with an opportunity to interact with each other to acquire, practise and test new information in an often more meaningful way than they do individually in traditional passive learning environments

The following sections consider the stages of group development and how learners behave in groups. They also explore techniques for managing group learning activities with a variety of learner types to ensure that a focus is maintained on learning objectives.

THE STAGES OF GROUP DEVELOPMENT

Group learning is not always familiar to students and it can take time for individuals to become comfortable enough to interact meaningfully with their peers in a formal learning setting. The length of time this takes depends on factors such as group size, frequency of interaction, and structural features. Seminal works on the development of learning in groups reveal a wide range of models concerning developmental processes.

Probably the most widely recognised model of the developmental process of groups is that of Bruce Tushman (1965), which he based on an analysis of group models which had previously been developed.

Tushman contends that group development follows a number of incrementally progressive stages. Though originally developed as a four stage model (i.e. forming, storming, norming, performing), this was further refined to include an adjourning stage (see Figure 1).

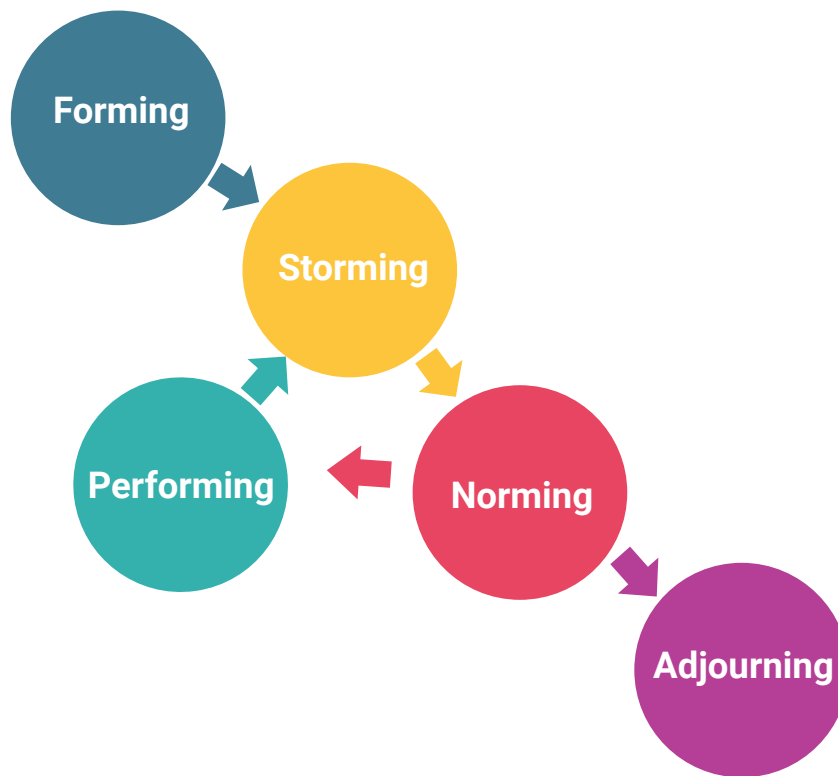


Figure 1: Five Stages of Group Development

STAGE 1: FORMING

In this stage, there is a sense of exploration as group members get to know one another. Individuals tend to focus on similarities and differences with their peers and first impressions are key as they try to figure each other out. Group members are also inclined to identify a group leader who can provide guidance and direction. Orientation is an important task in the forming stage. Members attempt to become orientated to the tasks as well as to one another.

It is also helpful to set ground rules for the group at the forming stage, which are expectations about how the group will interact. For example: task division, how decisions will be made, and how people will treat each other.

The main characteristics of the Forming Stage are:

- Exploration
- Focus on similarities and differences
- First impressions are key
- Confusion/anxiety
- Lower productivity
- Issues of inclusion, leadership, developing trust
- Open communication is a must

To progress to the next stage, group members must be assured enough that they are in a non-threatening environment and are prepared to accept the possible risk of disagreement. One way of initiating and supporting the forming stage is through

ice-breakers. An ice-breaker is a short activity designed to encourage participants to talk to one another and to share some limited information about themselves. Ice-breakers can be as simple as asking students to turn to one another and introduce themselves to the people sitting next to them, or they

can be complex lengthy activities where students can find a lot out about each other. Ideally there ought to be a fun aspect to the activities in order to provide participants with some shared history that they can discuss later and, where possible, a relevance to the upcoming learning activity.

STAGE 2: STORMING

At this stage, as group members get to know each other better, conflicts can emerge in the group relationships arising from issues relating to tasks and responsibilities.

As the group organisation begins to take form, individuals may have to move out of their comfort zones and be challenged to adjust their beliefs, feelings and attitudes. If they resist this adjustment then conflict can often follow.

Relationships may become strained and differences uncomfortable. It is important that the facilitator observes closely to identify and resolve any issues arising as early as possible. If left unaddressed, they may lead

to anger and hostility, causing the group to become unproductive.

In order to progress beyond this stage, group members need to move from a 'testing and proving' mentality to a problem-solving mentality. The most important factor in enabling groups to move forward is addressing problems such as conflict within the group, poor communication styles, and learning to appreciate the differences in personalities within the group.

Defining characteristics of the Storming Stage are:

- Competition between members
- Strained relationships
- Leadership challenge
- Tension and disunity
- Ensuing differences become uncomfortable

STAGE 3: NORMING

In the norming stage, the group begins to become effective. Group members become aware of their role within the group and become comfortable in working on and maintaining the group dynamics.

At this stage group members develop trust in their peers, becoming more open-minded and forming the basis for true collaboration. The facilitators focus should now be on how to strengthen relationships, maintaining open communication and providing positive and constructive feedback.

The group now focuses more on cooperation and team goals. However, group members may lapse back into behaviour from the Storming Stage and still need to be observed closely and corrected when necessary.

Characteristics of the Norming Stage are:

- Increased cohesion and collaboration
- Emerging trust in each other and comfort in providing constructive feedback
- Appreciation of intrinsic differences that may prevail
- Individuals develop an improved commitment to team objectives

STAGE 4: PERFORMING

Groups that reach the Performing Stage are typically filled with enthusiasm and focused on creative problem solving in an interdependent way.

Characteristics of a group at the performing stage include harmony, productivity, and effective problem solving and full development of the potential to leverage the individual strengths within the group.

In this stage, learners can work independently, in subgroups, or as a combined unit. Their roles adjust to the changing needs of the group and individuals. Individual members have become self-assuring, and the need for

group approval is less significant. Leadership is shared and participative, and the group leadership role is mainly delegation. The overall goal at this stage is productivity through problem solving and work.

Defining characteristics of the Performing Stage are:

- Harmony
- Productivity
- Problem solving
- Shared and participative leadership
- Full development of potential

STAGE 5: ADJOURNING

Adjourning is the final stage and only occurs when a group has fulfilled its goals and objectives. This stage may come relatively quickly for a temporary group engaged in a classroom based task, though a more permanent form of group might function for a long period of time without reaching the adjourning stage.

This stage is also referred to as the Mourning Stage as group members may feel a sense

of loss and their motivation may decline when the group's work comes to an end.

At the Adjourning Stage it is important to achieve closure for the group on a positive note, usually by providing recognition for their participation and accomplishments and celebrating the group's overall success. This can enhance a positive perception of working in groups and encourage future participation in similar activities.

TOP TIPS

The following guidance may help you as a facilitator to successfully navigate a group through each stage of group development (Tuckman & Jensen, 1977):



GROUP PERFORMANCE

A useful tool to support the work of facilitating groups is the team performance model developed by Drexler et al. (2009). In this model, seven stages are identified that describe a team's evolution from formation through to task completion and renewal (Figure 2).

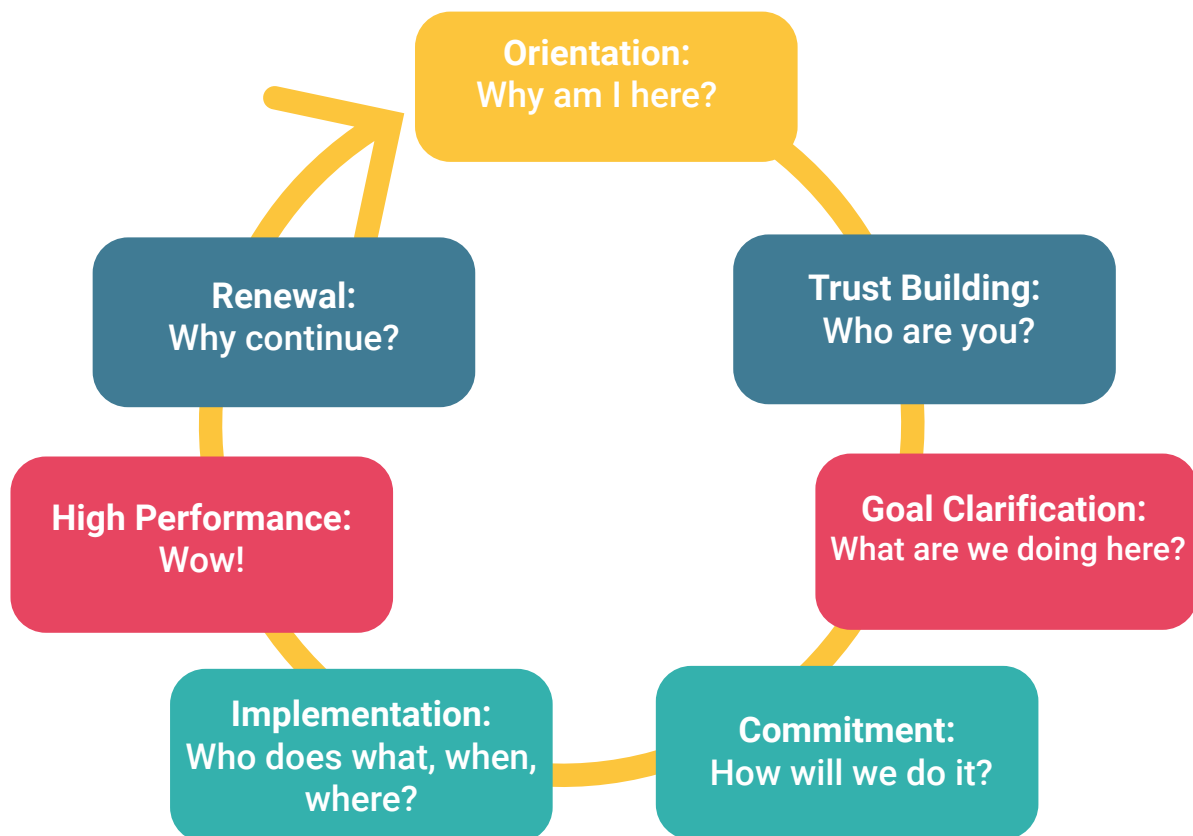


Figure 2: Seven Stages of Team Performance (adopted from Drexler et al., 2009)

1. ORIENTATION

Group members need to be aware of the value of working in groups, the leveraging of diverse strengths and how they themselves can contribute to achieving team goals. This will help with an understanding that a team can collectively accomplish something worthwhile that is significantly more difficult for an individual working alone.

Learners are likely to ask questions such as:

- What will these group sessions be like?
- Will I be able to succeed in this environment?
- Do I know enough to be successful here?
- How will this approach help me?

At this stage a learner may need answers to these questions as there is a risk they may disengage from the group activities. A facilitator should make every effort to explain how the activity links with positive outcomes for the learner. This link is fundamental in providing motivation for an individual to take the risk of engaging with group work if they are reticent or apprehensive.



2. TRUST BUILDING

Group members need to believe that they can trust others and feel trusted themselves. When team members trust each other, the feedback is more open and honest. Members can come to recognise that their own risk-taking builds this trust.

Learners are inclined to ask questions like:

- How am I like other people here? Am I different from them?
- Will they like me? What will happen if they don't accept me?
- Will I look stupid? Will I embarrass myself?

If a learner fails to reconcile these questions, they are less likely to be trustful of their peers. They may not relax within the group and often feel isolated. Consequently, they may at this stage decide to disengage. If they receive satisfactory answers, they are more likely to feel comfortable and ready to engage with this type of learning. A key function of a facilitator is to develop trust within a group.



3. GOAL AND ROLE CLARIFICATION

Group members need to be clear on the specific goals and objectives of the group learning activity. It is important that they understand what is within their area of control and what is not, along with their own role and responsibilities with respect to the group goals. Agreement on the purpose of the group and roles of the members needs to be agreed before meaningful work can be undertaken by the group.

If learners are not clear on their responsibilities, they are likely to either fight for their role or become quiet and disillusioned. The facilitator should endeavour to diffuse any concerns by communicating clear answers to the above questions. This will assist each member of the group to be clear on their role and the expectations of their contribution to the overall objectives.

Learners are likely to question:

- How will this group be different from my daily interactions with others?
- What risks will I have to take?
- If I'm asked to do things, will others see how nervous I am?
- What will happen if I'm asked to do something and I don't succeed?
- How important will I be in the group?

4. COMMITMENT

Group members need to be clear on how they will work together. It is important that they have a shared understanding of how decisions will be made, how resources will be allocated and how dependent they are within the group on each other's application to the goals of the group (interdependency).

If a learner does not feel valued or adequately supported at this stage, they may begin to question their position within the group. For the group to be successful at this stage, everyone in the group needs to have a shared vision of the direction and be understanding and accepting of the role each person will play in achieving the goals of the group. Resources should be distributed to help them achieve their aims.

Learners commonly question the following:

- How are we going to achieve our goals?
- Who decides how we arrive at decisions?
- What is my role and the role of others in the context of the overall goals?

5. IMPLEMENTATION

Members of the group should have a clear vision of the overall process for the group to successfully achieve its goal. It is important that they understand how individual and combined contributions impact on the success of the process.

At the implementation stage, the group puts plans into practice. Members get the opportunity to carry out the roles that they envisaged for themselves in the previous stages. Everyone should have a clear sense of who should be doing what, where and when.

Some issues that may arise at this point if the team is not well evolved include:

- The group project plan is likely to be highly confused.
- Group members may work to a schedule that suits them, rather than the group task.
- Group members question their commitment to the group.
- The members may start to renegotiate on their role in the group, and wonder about their possible contribution.

A well-developed process will result in a group that is highly motivated. This should enable all members to contribute to the achievement of group goals during the implementation stage and result in a strong sense of satisfaction for all.

6. HIGH PERFORMANCE

Only teams which become highly interdependent, highly interdisciplinary and creative in problem solving achieve this high performance level. At this stage, all team members are working in unison towards group goals. An important benefit is that successful, high performing groups are often highly motivated to take on other projects of a similar nature in order to exercise their expertise. If this stage is not well managed by the facilitator, the group can begin to suffer from the fatigue of working at this high performance level.

Overload can sometimes lead to lower performance levels and missed deadlines. The group may regress to the previous stage, and may need to reorganise its implementation process. However, if the group has a well thought out implementation plan, the bond between the members of the group can become even more cohesive. The group can develop a strong sense of each other's abilities and weaknesses, enhancing their ability to adjust roles and responsibilities to leverage the strengths of the individuals.

7. RENEWAL

From time to time, individual group members may need to recommit themselves to the work of the group or decide to leave the group. At this stage, members can decide that they have achieved the purpose of the group, celebrate the completion of the project and disband. If they feel that the group still has value, it allows for a refocus on future projects for the group.



SUMMARY OF DREXLER'S SEVEN-STAGE MODEL

Drexler's seven-stage model (Drexler et al., 2009) focuses mainly on the energy level of the group. Even assuming positive intent on the part of the participants, the journey from a group to a team can face many obstacles

A skilled facilitator will need to guide the group through the seven development stages so that they may become a group in the truest meaning of the word, as opposed to a collection of individuals.

It is important to remember that as the group moves towards its goal of 'high performance' it may regress by a stage before moving forward again.

GROUP DYNAMICS

Group dynamics have a major influence on the success of learner groups, through all stages of development. Not only do the different type of participants have an impact, the nature of hierarchies in groups are also a major factor and this element may be influenced by the facilitator.

There are three types of hierarchy in group learning decision making:

1. **Autocratic:** The facilitator decides everything, without any consultation.
2. **Consultative:** The facilitator consults with the learners about their needs and what ideas they have. However, the final decision remains with the facilitator.
3. **Cooperation:** Here, the focus is on partnership between the facilitator and the learners.

The adoption of one of the decision making approach within the classroom warrants

consideration in light of potential impact on behaviour of the three typical types of learners as described below:

1. **The dominant learner:** Dominant behaviour can often disrupt the dynamics of a group and the synergy of a group learning environment. Individuals may dominate activities or discussions to such an extent that others may be left feeling excluded
2. **The passive learner:** The passive or non-participating individual needs the intervention of a facilitator in order to encourage them to participate. Individuals may be passive for a variety of reasons such as boredom, anxiety or shyness.
3. **The resistant learner:** A learner may display resistance to group learning for a number of reasons. These include past experience, personal problems, literacy problems, feeling overwhelmed or resentment because they have to attend training.



HANDLING OF DIFFICULT PARTICIPANTS

Although the preceding section describes three generic types of learners, it is worthwhile to further explore the characteristics of disruptive learners. Pike and Arch (1997) describe a number of different types of participants and how they can disrupt the group dynamic (Figure 03).



- **The late-comer.** One-time offender or chronically late. Beginning of session or after break.



- **Pre-occupied.** Play games on computer, read or write letters or read the newspaper during sessions.



- **Mobile phones.** Obvious.



- **The Prisoner.** Those who 'have' to be there. Passive (and apathetic) or aggressive (angry and hostile).



- **Introvert.** Very little energy — may be shy or may be intimidated by others in the group.



- **The elder.** Struggles with self-confidence 'with all this new stuff'.



- **Know-it-all.** Expert on everything that is discussed. Distinguish those who really are experts and those who spoof.



- **Socialiser.** Does not stick to task and easily moves to gossip, etc.



- **Apple-polisher.** Those who praise you and want to be on your good side.



- **The Bored.** They don't want to be here, or they have done it before. Their eyes glaze over.



- **The confused.** People who do not follow what is going on, and are wondering what the whole exercise is about.



- **The Unqualified.** Those who do not quite know what is going on, or are very dependent on directions and want answers. Their interventions annoy others.



- **The sleeper.** Someone falls asleep during the session, or is struggling not to nod off, and distracts you.

Figure 03: Types of group participants (adopted from Pike and Arch (1997))

It is important to consider the motivations for people behaving in particular ways. The following are a number of common reasons:

1. **Attention craving** They need to be recognised and hope that someone in the group, especially the facilitator, will give them a little extra attention
2. **Fear of failure** Some learners are afraid that they may be asked to do things that they are unable to do, or will make them look foolish. They may attempt to cope with this by engaging in distracting behaviour.
3. **Gaining status** This is basically a power issue. The learner may need to be confronted about this behaviour.
4. **They have very difficult personality traits**, which may need professional help. Sometimes learners have behavioural problems that are not feasible for a facilitator to cater for in a group learning environment.

APPROACHES FOR HANDLING DIFFICULT PARTICIPANTS

In order to deal with the diversity of personalities within groups, Pike and Arch (1997) described a set of general approaches to handling issues arising, and particularly difficult participants!!!

FACILITATOR LED ACTIVITIES

These are actions taken by the facilitator to deal with the participant. This may include approaches such as varying the pace, raising your voice, using humour. Standing close to or making frequent eye contact with a difficult participant can often help.

Breaking up a learning session with focus groups or brainstorming can help to keep learners engaged. Sometimes, an individual will need to be dealt with privately, so as to avoid embarrassing them in the group setting.

'it wasn't the presence or absence of structure and authority which was the issue....
....it was its appropriateness to the task and the group'
Atherton J S (2013)

Adequate preparation by the facilitator can help to limit disruptive behaviour. In theory, this planning needs to take into account the individual needs of the learners, but can be difficult to cater for in short learning sessions such as single day events. Again in these situations, the facilitator can employ humour, frequent opportunities for learner engagement, group exercises and feedback sessions to overcome pushback.

GROUP WORK

While the learners are engaged in group work, the facilitator can organise the session to limit the impact of disruptive individuals by:

- Rotating membership of small groups.
- Building in incentives for success, which often helps concentration.
- Rotating roles in groups – leader, recorder, time keeper, etc. (the rationale for this is explained in more detail in the following section).

An important outcome of group work for students is learning to be adaptable and how to deal with change. Therefore, it is a disadvantage for individuals to become fixed in their role within a group.

If provided the opportunity, individuals may attempt to take up the same role in every group session. Some steps the facilitator can take to avoid this include:

- Asking quiet members of a group for a specific contribution, e.g. ensuring that all members contribute in questions and answers.
- Deliberately selecting quiet or shy learners to lead groups.
- Being careful to correct inappropriate behaviour by anyone including the 'good' learners.



Figure 04: Students engaged in group work

HANDLING EXTREME CASES OF DISRUPTION

A facilitator may have to deal with extremely disruptive behaviour from time to time. Several techniques can be employed. However, a facilitator should only intervene when there is a danger of a participant getting the group completely off track. The following are a number of suggested approaches:

- Ask the individual to stop their behaviour and take up the issue with them after the session.
- Engage the individual and ask them to explain their behaviour.
- In serious cases, it may be necessary to instigate formal disciplinary procedures.

SUMMARY

■ In a group setting, learners are provided with an opportunity to interact with each other to acquire, practise and test new information in an often more meaningful way than they do individually in traditional passive learning environments.

■ Bruce Tuchman proposes that group development evolves over five distinct stages – forming, storming, norming, performing and adjourning. A solid understanding of this model can help a facilitator to improve the potential of group learning in a classroom.

■ A skilled facilitator may guide a group through Drexler's seven stages of group performance:

1. Orientation
2. Trust building
3. Goal clarification
4. Commitment
5. Implementation
6. High performance
7. Renewal

This model is useful for building strong group cultures where individuals recognise the benefits of cooperation to leverage the collective strengths.

■ Approaches such as varying the pace, raising your voice and using humour can be effective when dealing with disruptive participants.

■ Breaking up a learning session with focus groups or brainstorming can help to keep learners engaged. Sometimes, an individual will need to be dealt with privately, so as to avoid embarrassing them in the group setting.

An important outcome of group work for students is learning to be adaptable and how to deal with change. Therefore, it is a disadvantage for individuals to become fixed in their role within a group. A facilitator should be cognisant of this and be strategic in rotating roles and responsibilities.

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