Learning Activities

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Learning Activities to develop elements of the learning frameworks

Mindful Agency/Reflection/Resourcefulness

- Reflection
  - http://www.visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03c_Core_routines/UsedToThink/UsedToThink_Routine.htm

  - What?/so what?/now what? Reflection framework

  - see Kaya Prpic's model: http://cmapspublic.ihmc.us/rid=1PC8NRGW0-2BL1DL-2GNL/ReflectiveLearningSpiral-JKayaPRPIC.cmap

  - Go8 Case study:
    - What in the profile do you think isn't reflective of you as a learner?
    - What in the profile is reflective of you as a learner?
    - What experiences of learning have helped shape your profile?
    - Which learning dimension/s is/are important for you to improve?
    - What activities and/or approaches might you undertake or initiate to begin this improvement?
    - How could you use your learning power strength to improve your learning and performance?

  - Reflective thinking for structural engineers: http://www.structural-safety.org/media/395491/scoss-alert-reflective-thinking-final-.pdf

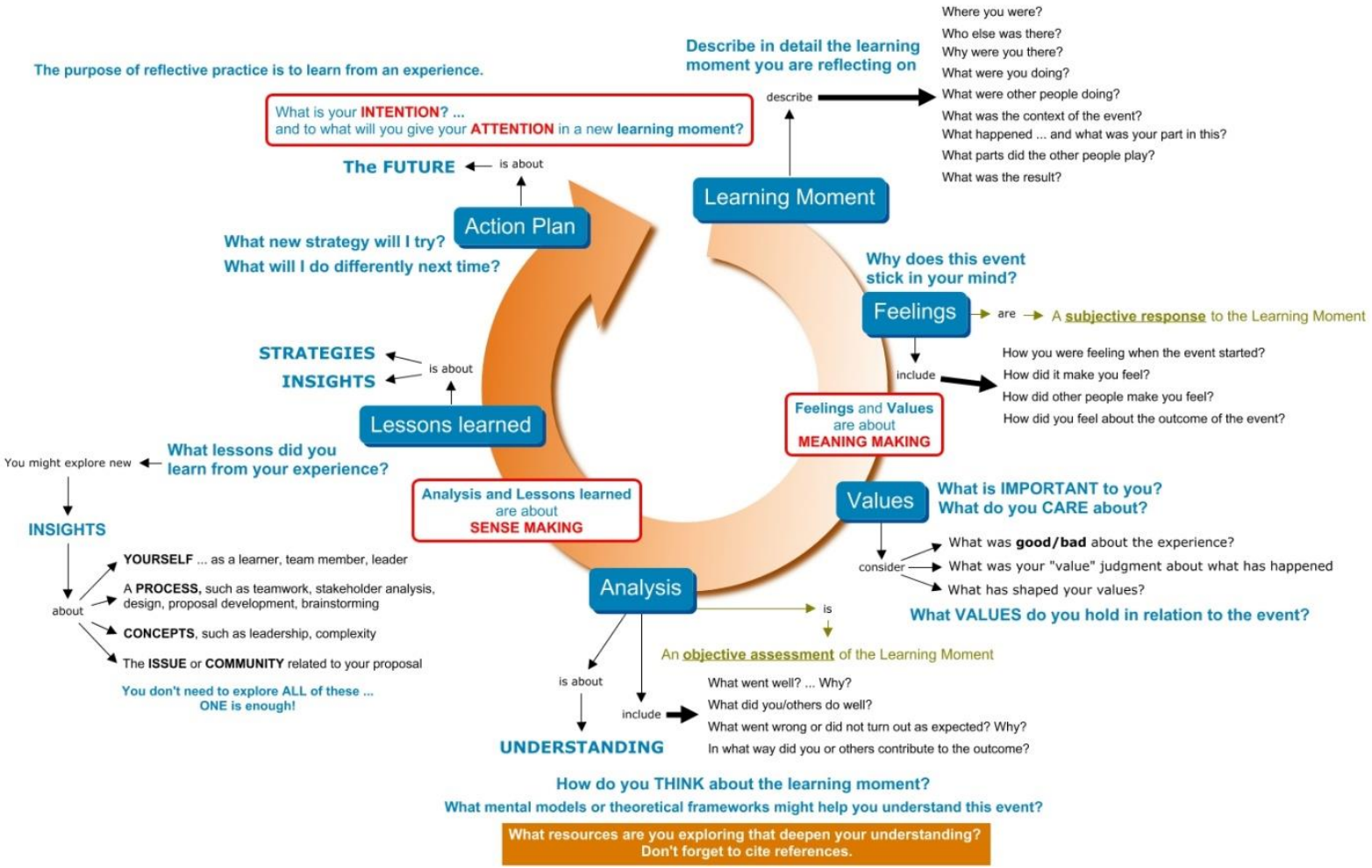
Reflective Learning Spiral

J. Kaya Prpic

Engineering Learning Unit, The University of Melbourne

jprpic@unimelb.edu.au

I have developed the Reflective Learning Spiral to use with my students.
I am currnetly preparing a paper about the Reflective Learning Spiral and will add details in due course.



Structural-Safety

Incorporating SCOSS and CROSS

Topic Paper

SCOSS TOPIC PAPER
Reflective Thinking

December 2016

WHO SHOULD READ THIS TOPIC PAPER?

Structural and civil engineers in practice, teachers and students in universities and other further education organisations concerned with structural analysis and design.

BACKGROUND

Reflective thinking is a constant drive to ask questions and to make appropriate responses to them. It is characterised by a healthy scepticism about all inputs to processes, about the processes themselves and about the outcomes from processes.

It is a pervasive activity in all risk reduction strategies such as: using the design process, using predictive models, using codes of practice, adopting an ethical approach.

Some engineers adopt a reflective approach naturally. They may look at a drawing, for example, and quickly identify faults in a design. It need not, however, be a tacit skill. It can be and needs to be fostered.

REFLECTIVE THINKING IN DOING STRUCTURAL ENGINEERING CALCULATIONS

Structural calculations are dominantly concerned with predictive modelling. This is the use of mathematical or heuristic models to estimate the behaviour of systems and components. The two main types of predictive model in structural engineering are:

- Structural analysis (or analysis modelling) where mathematical representations are used to predict displacements, internal force actions, etc. of structures
- Technical assessment i.e. uses of codes of practice (and other rule sets) that involve mathematical models (e.g. for bending) and heuristic models (i.e. empirical rules such as for concrete cover for reinforcement).

In 2002 the Institution of Structural Engineers published *The use of computers for engineering calculations* [1]. Although now out of print it was a landmark publication in that it introduced the concept of a formal modelling process and gave significantly improved definitions of validation and verification that are central issues in the process.

In the pre-computer era, the focus was on processes for the implementation of calculations that were determinate i.e. the processes had unique solutions. Calculations are now dominantly implemented by computer and the scope of structural analysis models is now much more extensive. The basic problem has moved from doing calculations to controlling them; from contexts that were determinate to contexts that are non-determinate (i.e. they do not have unique solutions). The 2002 publication provided a framework for operating the latter type of context but it appears that the philosophy outlined in that document has not been adopted in education and the analysis modelling process tends not to be treated explicitly in practice.

To illustrate this point, consider validation. In structural analysis the validation question: “Is the model capable of satisfying the requirements?” tends not to be used explicitly by engineers. Likewise, the validation question for use of a code of practice: “Is the design context within the scope of the code of practice?”, also tends not to be used in a formal way. But this type of reflective question is critical in reducing risk in structural design. The root causes of major structural failures tend to be more a result of decisions about what calculations should be done (validation) rather than due to errors in carrying out the calculations (verification).

References 2 and 3 give an overview of current reflective thinking in structural engineering.

ARE STRUCTURAL ENGINEERS GOOD AT REFLECTIVE THINKING

The low rate of failures of structural systems shows that, in general, the methods used to control structural safety are effective. But evidence suggests that many engineers are either not good at reflective thinking or that the range of questions that they work with is too narrow. There have been failures in many spheres of engineering whose root cause has been a lack of understanding of fundamental principles. Major failures have been seen in infrastructure systems and in building structures; sometimes with considerable loss of life. Concerns which could have resulted in collapses had they not been recognised are given in publications by Structural-Safety[4]. Studies of these can help to learn lessons from the actions of others and help with the development of reflective thinking.

HOW CAN ENGINEERS BECOME MORE REFLECTIVE

Viewed as a main strategy for reducing risk, reflective thinking needs to be much more explicit and more dominant in professional engineering practice.

Teachers and supervising engineers do encourage students and colleagues to be reflective but there is much scope for extending such activity.

The introduction of computers has fundamentally changed engineering processes. Contexts have become more complex and the need for the special power of the brain to identify patterns, to ask questions, to generate hypotheses has intensified. While software can be programmed to flag up potential errors, we are not yet close to simulating the thinking power of a human brain. As processes become integrated in computing environments (stimulated by BIM) the need for alert engineering control at all stages is essential. Reflective thinking is at the heart of such activity.

Engineers in practice need to improve their own ability to be reflective and to encourage those whom they supervise to develop such skill.

Engineering teachers need to require evidence of reflective thinking in student project outcomes by, for example, requiring the submission of reports on: validation, verification, stability, option assessment, etc.

Especially in innovative situations, engineers need to formulate reflective questions that are specific to a context.

EXAMPLES OF REFLECTIVE THINKING

Of necessity the examples given are for events that took place some years ago. Some more recent cases cannot be published for legal reasons.

The design process
Studies of how engineering design is carried out lead to a conclusion that the following reflective questions, for example, are important in achieving satisfactory outcomes:

- Has all necessary information about the design context been gathered?
- Have all the design requirements been identified? This infers that the requirements have been formally established.
- Has a suitable range of options been identified?
- Is the information about the options sufficient for an assessment?
- Is the process used to assess the options fit for purpose?

Analysis modelling
Reflective questions for analysis modelling include:

- Is the model capable of satisfying the requirements? (the validation question)
- Is the model the most appropriate in the context?
- Has the software been validated and verified?
- Has the model been correctly implemented? (the verification question)

For example, classic structural failures such as the Hartford Connecticut Civic Center collapse (1978) and the failure of the Sleipner Platform (1991), were due to inadequate validation of analysis models.

Technical assessment - i.e. use of codes of practice
Reflective questions in technical assessment include:

- Have all the relevant design issues been identified?
- Do the code provisions adequately address the issues? (validation)
- Have the code provisions been correctly implemented? (verification)

The Ronan Point collapse (1968), for example, resulted from lack of attention to the first two of these questions.

SUMMARY

A fundamental objective of Structural-Safety is to provide information that will help to answer the reflective question: 'Have we identified and addressed all the issues that may cause less than satisfactory performance of the structure being considered?' This should be borne in mind by all designers.

REFERENCES

1. Institution of Structural Engineers, The use of computers for engineering calculations ISBN 0901297208, 2002
2. Macleod I A, Time to reflect: a strategy for reducing risk in structural design The Structural Engineer, March 2016
3. MacLeod I A and Weir A, Principles for computer analysis of structures, Institution of Structural Engineers, in press
4. www.structural-safety.org

Sensemaking

http://www.visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03d_UnderstandingRoutines.html

WHAT MAKES YOU SAY THAT?

Interpretation with Justification Routine

1. What's going on?
2. What do you see that makes you say that?

Purpose: What kind of thinking does this routine encourage?

This routine helps students describe what they see or know and asks them to build explanations. It promotes evidential reasoning (evidence-based reasoning) and because it invites students to share their interpretations, it encourages students to understand alternatives and multiple perspectives.

Application: When and where can it be used?

This is a thinking routine that asks students to describe something, such as an object or concept, and then support their interpretation with evidence. Because the basic questions in this routine are flexible, it is useful when looking at objects such as works of art or historical artifacts, but it can also be used to explore a poem, make scientific observations and hypothesis, or investigate more conceptual ideas (i.e., democracy). The routine can be adapted for use with almost any subject and may also be useful for gathering information on students' general concepts when introducing a new topic.

Launch: What are some tips for starting and using this routine?

In most cases, the routine takes the shape of a whole class or group conversation around an object or topic, but can also be used in small groups or by individuals. When first introducing the routine, the teacher may scaffold students by continually asking the follow-up questions after a student gives an interpretation. Over time students may begin to automatically support their interpretations with evidence with out even being asked, and eventually students will begin to internalize the routine.

The two core questions for this routine can be varied in a number of ways depending on the context: What do you know? What do you see or know that makes you say that? Sometimes you may want to preceded students' interpretation by using a question of description: What do you see? or What do you know?

When using this routine in a group conversation it may be necessary to think of alternative forms of documentation that do not interfere with the flow of the discussion. One option is to record class discussions using video or audio. Listening and noting students' use of language of thinking can help you see their development. Students words and language can serve as a form of documentation that helps create a rubric for what makes a good interpretation or for what constitutes good reasoning.

Another option is to make a chart or keep an ongoing list of explanations posted in the classroom. As interpretations develop, note changes and have further discussion about these new explanations. These lists can also invite further inquiry and searches for evidence. Other options for both group and individual work include students documenting their own interpretations through sketches, drawings, models and writing, all of which can be displayed and revisited in the classroom.

CONNECT / EXTEND / CHALLENGE

A routine for connecting new ideas to 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?

Purpose: What kind of thinking does this routine encourage?

The routine helps students make connections between new ideas and prior knowledge. It also encourages them to take stock of ongoing questions, puzzles and difficulties as they reflect on what they are learning.

Application: When and where can it be used?

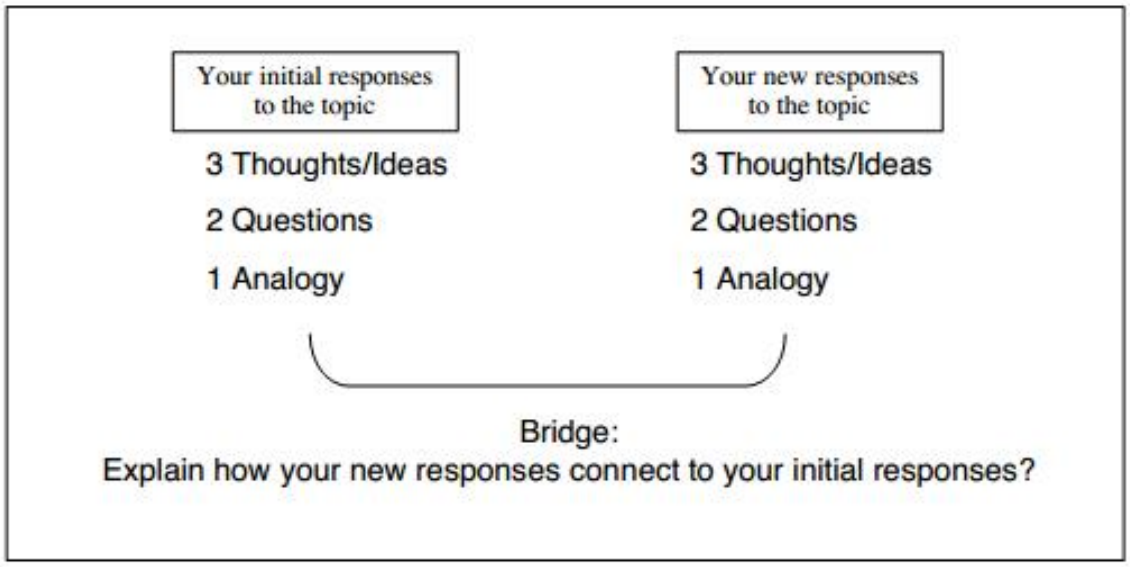
The natural place to use the Connect-Extend-Challenge routine is after students have learned something new. It doesn't matter how *much* they have learned – it can be a lesson's worth, or a unit's worth. The routine is broadly applicable: Use it after students have explored a work of art, or anything else in the curriculum. Try it as a reflection during a lesson, after a longer project, or when completing a unit of study. Try using it after another routine!

Launch: What are some tips for starting and using this routine?

This routine works well with the whole class, in small groups or individually. Keep a visible record of students' ideas. If you are working in a group, ask students to share some of their thoughts and collect a list of ideas in each of the three categories Or have students write their individual responses on post-it notes and add them to a class chart. Keep students' visible thinking alive over time: Continually add new ideas to the lists and revisit the ideas and quetions on the chart as students' understanding around a topic develops.

3-2-1 BRIDGE

A routine for activating prior knowledge and making connections



Purpose: What kind of thinking does this routine encourage?
This routine asks students to uncover their initial thoughts, ideas, questions and understandings about a topic and then to connect these to new thinking about the topic after they have received some instruction.

Application: When and where can it be used?
This routine can be used when students are developing understanding of a concept over time. It may be a concept that they know a lot about in one context but instruction will focus their learning in a new direction, or it may be a concept about which students have only informal knowledge. Whenever new information is gained, bridges can be built between new ideas and prior understanding. The focus is on understanding and connecting one's thinking, rather than pushing it toward a specific outcome.

Launch: What are some tips for starting and using this routine?
This routine can be introduced by having students do an initial 3, 2, 1 individually on paper. For instance, if the topic is "democracy," then students would write down 3 thoughts, 2 questions, and 1 analogy. Students might then read an article, watch a video, or engage in an activity having to do with democracy. Provocative experiences that push students thinking in new directions are best. After the experience, students complete another 3,2,1. Students then share their initial and new thinking, explaining to their partners how and why their thinking shifted. Make it clear to students that their initial thinking is not right or wrong, it is just a starting point. New experiences take our thinking in new directions.

THE EXPLANATION GAME

A routine for exploring causal understanding

The routine focuses first on identifying something interesting about an object or idea:

I notice that….

And then following that observation with the question:

Why is it that way? or Why did it happen that way?

Purpose: What kind of thinking does this routine encourage?

This is a routine for understanding why something is the way it is. This routine can get at either causal explanation or explanation in terms of purposes or both.

Application: When and where can it be used?

You can apply it to almost anything: a pencil, cell phones, forms of government, historical documents, and events. Students can work in pairs or groups of larger size, even a whole class. The explanation game can also be used solo. The first time the routine is used, the teacher may need to take an active role in scaffolding the conversation and modeling how to ask questions of explanation and clarification if others. Over time, students can begin to emulate the conversational moves and questioning they have seen modeled.

Launch: What are some tips for starting and using this routine?

Begin with something "on the table"—an object like a cup or a compass, a document like a poem, a picture, an historical event, a scientific theory, etc. The first person (this might be the teacher initially) points out an interesting feature of the object: "I notice that…. That's interesting. Why is it that way?" or "Why did it happen that way?" (or some similar why question). The other people in the group try to answer the question or at least to propose possible explanations and reasons. As these students share their ideas, the person asking the original question follows up by asking, "What makes you think so?" The group works together to build explanations rather than merely deferring to an outside source, the teacher or a textbook, to provide an answer.

Student questions and explanations become visible to the class as they are shared. Responses to the routine also can be written down and recorded so that there is a class list of evolving ideas. A few key issues or puzzles might then be chosen for further investigations. A conversation could also be recorded as a chart with four columns representing the key structures of the conversation: 1) the *Observation* that is initially made, 2) the *Question* that comes out of that observation, 3) the various *Explanations/Hypotheses* that the rest of group puts forth, 4) the *Reasons/Justifications* that are given in support of the explanations.

Generate, Sort, Connect, Elaborate: Concept Maps

A routine for organizing one's understanding of a topic through concept mapping

Select a topic, concept, or issue for which you want to map your understanding.

- Generate a list of ideas and initial thoughts that come to mind when you think about this particular topic/issue.
- Sort your ideas according to how central or tangential they are. Place central ideas near the center and more tangential ideas toward the outside of the page.
- Connect your ideas by drawing connecting lines between ideas that have something in common. Explain and write in a short sentence how the ideas are connected.
- Elaborate on any of the ideas/thoughts you have written so far by adding new ideas that expand, extend, or add to your initial ideas.

Continue generating, connecting, and elaborating new ideas until you feel you have a good representation of your understanding.

Purpose: What kind of thinking does this routine encourage?
This routine activates prior knowledge and helps to generate ideas about a topic. It also facilitates making connections among ideas. Concept maps help to uncover students' mental models of a topic in a non-linear way.

Application: When and where can it be used?
This routine can be useful as a pre-assessment before the beginning of a unit of study if students already have a lot of background information about the topic. Conversely, it can also be useful as a post or ongoing assessment to see what students are remembering and how they are connecting ideas. Individual maps can be used as the basis for construction of a whole classroom map. Maps can also be done progressively, with students adding to their maps each week of the unit.

Launch? What are some tips for starting and using this routine?
Depending on how much familiarity students have with concept maps, you may need to demonstrate making a concept map using this routine with the whole class. However, if students are relatively familiar with the idea of concept maps, you can launch right into the routine explaining that students will be making concept maps but in a structured way. Give time for students to complete each step of the routine before moving on to the next step. It isn't necessary that students generate an exhaustive list of all their ideas initially, but make sure they have time to generate a rich and varied list before moving on. Tell students that at any point they can add new ideas to their list and incorporate them into their map. If you are adding to a map over time, you might want to have students use a different color pencil each time they make additions. Explaining and discussing maps with partners helps students to consolidate their thinking and gain other perspectives.

HEADLINES ROUTINE

A routine for capturing essence

This routine draws on the idea of newspaper-type headlines as a vehicle for summing up and capturing the essence of an event, idea, concept, topic, etc. The routine asks a core question:

1. If you were to write a headline for this topic or issue right now that captured the most important aspect that should be remembered, what would that headline be?

A second question involves probing how students' ideas of what is most important and central to the topic being explored have changed over time:

2. How has your headline changed based on today's discussion? How does it differ from what you would have said yesterday?

Purpose: What kind of thinking does this routine encourage?

This routine helps students capture the core or heart of the matter being studied or discussed. It also can involve them in summing things up and coming to some tentative conclusions.

Application: When and where can it be used?

This routine works especially well at the end of a class discussion or session in which students have explored a topic and gathered a fair amount of new information or opinions about it.

Launch: What are some tips for starting and using this routine?

The routine can be used quite effectively with think-pair-share. For example, at the end of a class the teachers can ask the class, "Think about all that we have been talking about today in class. If you were to write a headline for this topic or issue right now that captured the most important aspect that should be remembered, what would that headline be?" Next, the teacher tells students, "Share your headline with your neighbor." The teacher might close the class by asking, "Who heard a headline from someone else that they thought was particularly good at getting to the core of things?"

Student responses to the routine can be written down and recorded so that a class list of headlines is created. These could be reviewed and updated from time to time as the class learns more about the topic. The follow-up question, "how has your headline changed or how does it differ from what you would have said? can be used to help students reflect on changes in their thinking.

Understanding Map

'Peeling the Fruit' – A Map for Tracking and Guiding Understanding

1. Put some version of the map up in a convenient location or give learners copies. See example below and notes about different ways of using the map.
2. Briefly state that the group will be tracking progress and planning with the map from time to time. Note how the map uses the metaphor of 'peeling the fruit', getting familiar with the surface of something, seeking puzzles and mysteries to investigate, and pursuing these in various ways to arrive at core understandings.
3. Refer to the map to choose next steps and mark progress from time to time during the exploration of a topic (no need to do everything every time). Use it as a way of thinking about what routines to use or simply what kind of conversation or other activity to have.
4. When the map is used collectively by a class, you may want to invite students to put up Post-its on the map over time to mark insights associated with any of the map elements.

Purpose: Why use this map?

We often want to develop learners' understanding of a complex topic over days or weeks. This map can help. It's not a routine but a way of planning and tracking over time the exploration of a topic. It can help in choosing good routines too.

Application: When and where can I use this map?

Whenever there's a topic that calls for a broad and rich understanding and learners have enough time to look at it in different ways – anything from a single long lesson to several lessons or a unit. You can use it with students collectively, to help them maintain a bird's eye view of progress through a topic and to make with them good choices about what to do next. You can use it yourself, to plan topics and to track progress. You can also give copies to students for their individual self-management in pursuing a general class topic or individual projects.

Launch: What are some tips for starting and using this thinking map?

Explain that the map is for tracking and guiding the exploration of the topic. Explain the metaphor briefly. Invite learners to help chart progress by using the map.

You can create a giant version of the map to put on the wall of a classroom (see diagram below), or just put labels up for the categories if it's easier to organize on the wall, or personalize the process in some other way. If you're tracking two or three topics at the same time or multiple groups you might: have two or three wall maps, color code paths on a single map, give learners page-size copies to track their own progress, or invent something else. Whatever works! The main idea is to make visible the developing understanding to mark progress and choose next steps.

It usually makes sense to start with the 'skin' and go to 'getting under the skin' with mysteries and then on from there to 'substance' and toward the 'core'. You need not use all of the 'substance' approaches – whatever fits – and there's no fixed order. You can go back to something and add at any time of course!

THINK PAIR SHARE ROUTINE

A routine for active reasoning and explanation

Think Pair Share involves posing a question to students, asking them to take a few minutes of thinking time and then turning to a nearby student to share their thoughts.

Purpose: What kind of thinking does this routine encourage?

This routine encourages students to think about something, such as a problem, question or topic, and then articulate their thoughts. The Think Pair Share routine promotes understanding through active reasoning and explanation. Because students are listening to and sharing ideas, Think Pair Share encourages students to understand multiple perspectives.

Application: When and where can it be used?

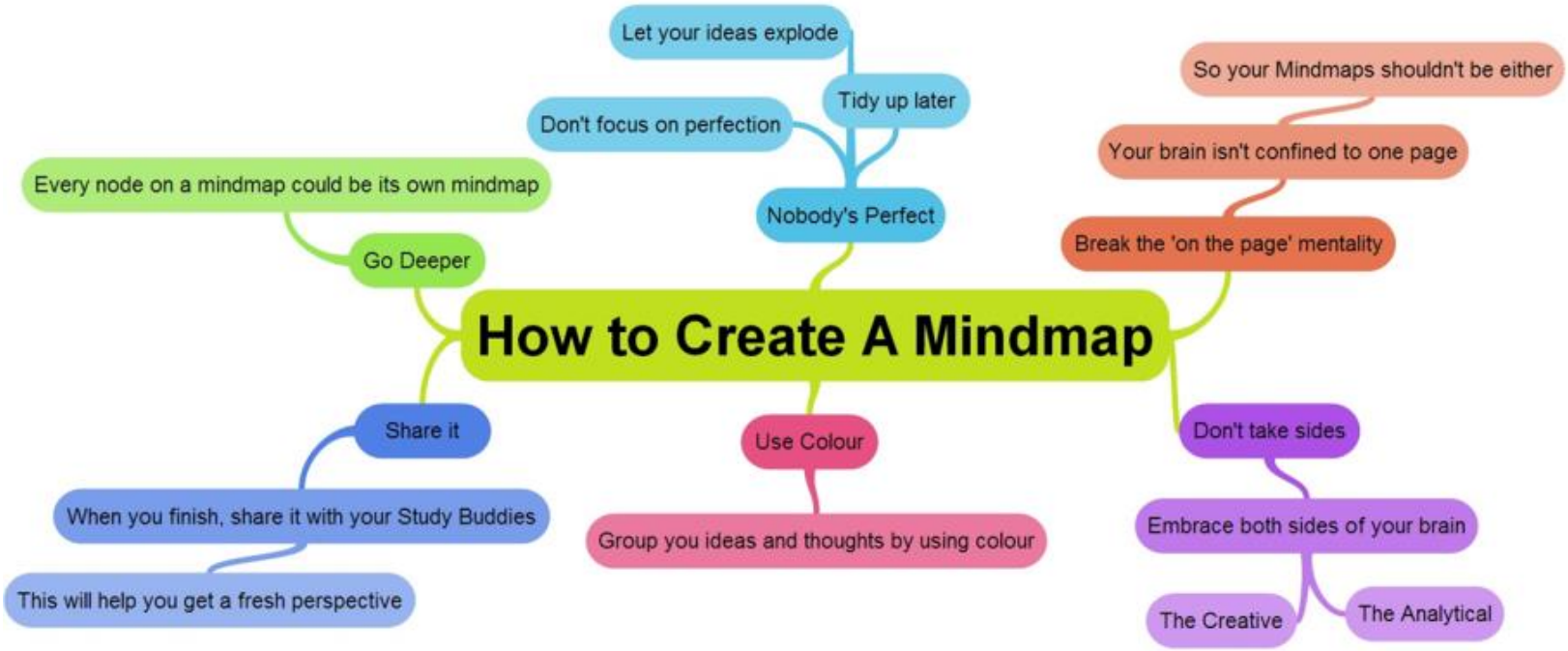
Think Pair Share can be applied at any given moment in the classroom. For example, when approaching a solution, solving a math problem, before a science experiment, or after reading a passage or chapter of a book you may ask students to take a moment to think about a particular question or issue and then turn to their neighbor and share their thoughts. Sharing can also be done in small groups. Some times you will want to have pairs or groups summarize their ideas for the whole class.

Launch: What are some tips for starting and using the routine?

When first introducing the routine, teachers may want to scaffold students' paired conversations by reminding them to take turns, listen carefully and ask questions of one another. One way to ensure that students listen to each other is to tell students that you will be calling on individuals to explain their partners thinking, as opposed to telling their own thoughts.

Encourage students to make their thinking visible by asking them to write or draw their ideas before and/or after sharing. Journals can also be useful. Student pairs can report one another's thoughts to the class and a list of ideas can be created in the classroom.

This routine is adapted from Frank Lyman: Lyman, F. T. (1981). The Responsive Classroom Discussion: The Inclusion of All Students. In A. Anderson (Ed.), Mainstreaming Digest (pp. 109-113). College Park: University of Maryland Press.


How to Create A Mindmap
Let your ideas explode
Tidy up later
Don't focus on perfection
Nobody's Perfect
Every node on a mindmap could be its own mindmap
Go Deeper
Share it
When you finish, share it with your Study Buddies
This will help you get a fresh perspective
Use Colour
Group you ideas and thoughts by using colour
So your Mindmaps shouldn't be either
Your brain isn't confined to one page
Break the 'on the page' mentality
Don't take sides
Embrace both sides of your brain
The Creative
The Analytical

Curiosity

THINK / PUZZLE / EXPLORE

A routine that sets the stage for deeper inquiry

1. What do you think you know about this topic?
2. What questions or puzzles do you have?
3. What does the topic make you want to explore ?

Purpose: What kind of thinking does this routine encourage?

This routine activates prior knowledge, generates ideas and curiosity and sets the stage for deeper inquiry.

Application: When and where can it be used?

This routine works especially well when introducing a new topic, concept or theme in the classroom. It helps students take stock of what they already know and then pushes students to identify puzzling questions or areas of interest to pursue. Teachers can get a good sense of where students are on a conceptual level and, by returning to the routine over the course of study, they can identify development and progress. The third question is useful in helping students lay the ground work for independent inquiry.

Launch: What are some tips for starting and using this routine?

With the introduction of new topic—for example, earth, leaves, fractions, Buddhism—the class can engage in the routine together to create a group list of ideas. Between each phase of the routine, that is with each question, adequate time needs to be given for individuals to think and identify their ideas. You may even want to have students write down their individual ideas before sharing them out as a class. In some cases, you may want to have students carry out the routine individually on paper or in their heads before working on a new area.

Keep a visible record of students' ideas. If you are working in a group, ask students to share some of their thoughts and collect a broad list of ideas about the topic on chart paper. Or students can write their individual responses on post-it notes and later add them to a class list of ideas.

Note that it is common for students to have misconceptions at this point—include them on the list so all ideas are available for consideration after further study. Students may at first list seemingly simplistic ideas and questions. Include these on the whole class list but push students to think about things that are truly puzzling or interesting to them.

QUESTION STARTS

A routine for creating thought-provoking questions

1. Brainstorm a list of at least 12 questions about the topic, concept or object. Use these question-starts to help you think of interesting questions:

Why…?	*How would it be different if… ?*
What are the reasons…?	*Suppose that…?*
What if…?	*What if we knew…?*
What is the purpose of…?	*What would change if…?*

2. Review the brainstormed list and star the questions that seem most interesting. Then, select one or more of the starred questions to discuss for a few moments.

3. Reflect: What new ideas do you have about the topic, concept or object that you didn't have before?

Purpose: What kind of thinking does this routine encourage?

This routine provides students with the opportunity to practice developing good questions that provoke thinking and inquiry into a topic. It also helps students brainstorm lots of different *kinds* of questions about a topic. The purpose of asking deep and interesting questions is to get at the complexity and depth of a topic. The purpose of brainstorming varied questions about a topic is to get at the breadth, and multi-dimensionality of a topic.

Application: When and where can it be used?

Use Question Starts to expand and deepen students' thinking, to encourage students' curiosity and increase their motivation to inquire. This routine can be used when you are introducing a new topic to help students get a sense of the breadth of a topic. It can be used when you're in the middle of studying a topic as a way of enlivening students' curiosity. And it can be used when you are near the end of studying a topic, as a way of showing students how the knowledge they have gained about the topic helps them to ask ever more interesting questions. This routine can also be used continuously throughout a topic, to help the class keep a visible, evolving list of questions about the topic that can be added to at anytime.

Launch: What are some tips for starting and using the routine?

Before using Question Starts, you might want to ask students what *they* think makes a good question. Then, when you show the Question Starts, explain that this routine is a tool for asking good questions. Start the routine by providing a topic– Stockholm, a compass, the Equator, good sportsmanship. Ask them to use the Question Starts to generate a list of questions about the topic. Initially, it's best to work together as an entire group. Once students get the hang of the routine, you can have them work in small groups, or even solo. Or mix it up. For example, do step 1 as a whole class, do step 2 in pairs, and step 3 as a whole class again.

Creativity

- http://www.visiblethinkingpz.org/VisibleThinking_html_files/03_ThinkingRoutines/03g_CreativityRoutines.html

- OLT Fellowship Prof Iouri Belski website with resources: https://emedia.rmit.edu.au/triz/node/1

Belonging

- Create an online learning space specific to your subject (LMS, Facebook etc)
    - You may have to seed it with interesting posts to get it started
    - For first year students recommend you moderate this forum

- If your university supports Peer Assisted Study Sessions I recommend establishing these for your subject – also has payoffs for other aspects such as openness to learning and sensemaking

- Use informal collaborative learning groups in class

Collaboration

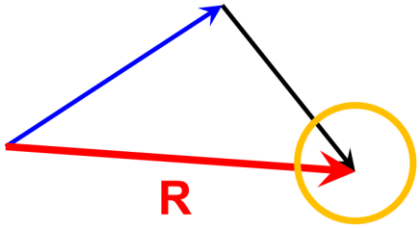
- Self and peer assessment of individual contribution to a group task
    - Use criteria that focus on process not product (it's your responsibility to mark the product)
    - Share all their ratings and feedback with students multiple times a semester so that they have time to change their behaviour before the end of the semester
    - Use SPARK^{PLUS}, WebPA or CATME to facilitate this in large classes.

- See the Graduateemployability 2.0 OLT Fellowship website: http://www.graduateemployability2-0.com/

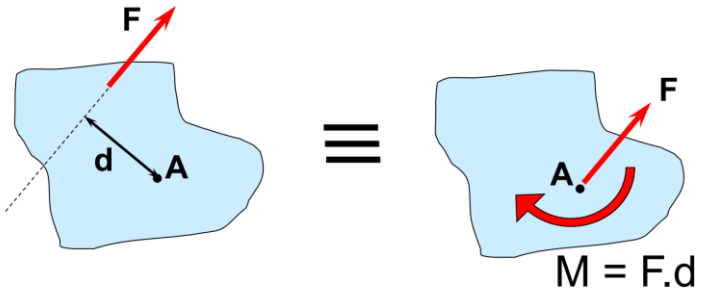
Hope and Optimism/Resilience

- Show progress through the semester. For example in an engineering mechanics class the various topics are phrased as questions and each time a new topic is started these topic questions are used to demonstrate where the class started at the beginning of the semester and where the class is now:

  - How can we add concurrent forces to get a resultant force?

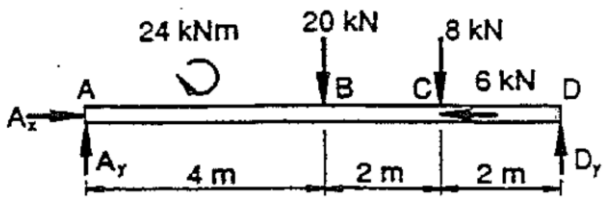


How can we add non-concurrent forces to get a resultant force and resultant moment?



Equivalent force/couple system

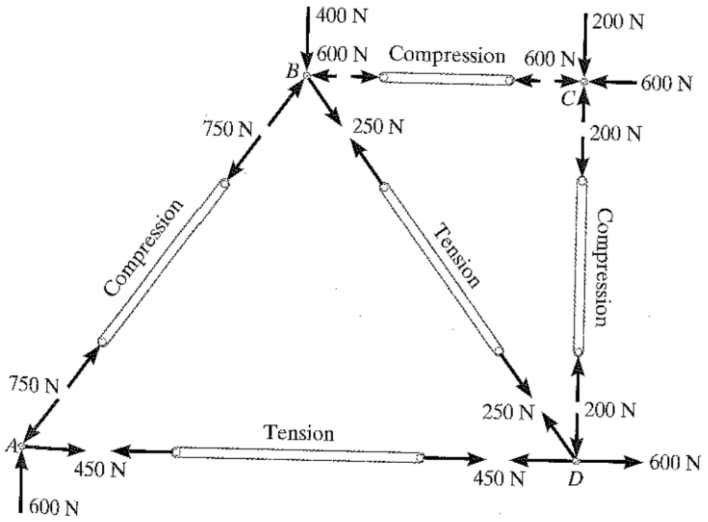
How can we determine reactions at supports generated by external loads?



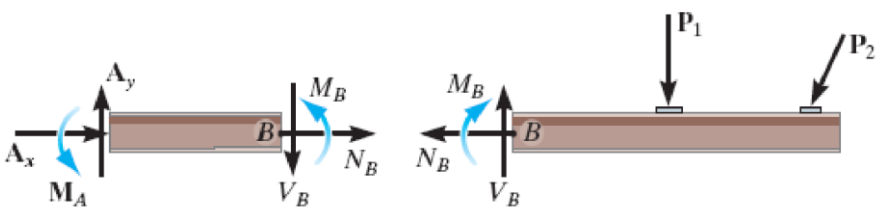
$$\Sigma Fx = 0 ; \quad \& \quad \Sigma Fy = 0$$

$$\Sigma M_{any} = 0$$

How can we determine the internal force in each member of a pin-jointed truss under the action of external loads?



- How can we determine the internal actions in a beam under the action of external loads?



Openness to learning/Openmindedness

- Use multiple perspectives to solve problems
    - In telecommunications solve problems using frequency domain, time domain
- Project-based learning

Ethical consideration

Engineers Australia code of ethics is here:

https://www.engineersaustralia.org.au/sites/default/files/resource-files/2017-03/199472%20-%20Code%20of%20Ethics%20A5%20brochure%204%20pg.pdf

The Royal Academy of Engineers also has useful material at:

http://www.raeng.org.uk/policy/engineering-ethics/ethics

Engineering ethics

Engineering ethics and the Academy

The Academy's work in engineering ethics began in 2003 when a working group on professional ethics was established. The Academy's work on ethics was stimulated by the Lloyd's Register lecture, *Do engineers owe duties to the public?* by John Uff CBE QC FREng. John Uff also published a number of articles in the Academy's journal, *Ingenia,* on ethics in engineering practice.

Issue 15 - The engineer's public duty - The role of the institutions (http://www.ingenia.org.uk/ingenia/articles.aspx?Index=211)

Issue 14 - Principles and cases (http://www.ingenia.org.uk/ingenia/articles.aspx?Index=198)

Issue 13 - Engineering ethics – Some current issues (http://www.ingenia.org.uk/ingenia/articles.aspx?Index=183)

The Academy held its first engineering ethics conference in October 2005, at which the original statement of ethical principles was launched.

The Academy has undertaken a range of collaborative activities on engineering ethics, bringing together the profession to agree a set of aspirational principles and working with engineering educators to explore ways of teaching engineering ethics.

The Academy's work on engineering ethics covers ethics in engineering education, ethics in practice and the issues surrounding emerging engineered technologies. Through events, publications and teaching resources, the Academy has sought to enrich thinking about engineering ethics and provide materials and inspiration for engineers interested in the wider impact of their work.

Statement of Ethical Principles (#statement)
Engineering Ethics in Practice (#ethicsinpractice)
Engineering in Society (#enginsoc)
Teaching engineering ethics (#teaching)
Ethics and emerging technologies (#technologies)

Example pre-class questions/activities

Outline the meaning of the following terms (with respect to thinking and learning):

- Metacognitive thinking
- Agency
- Self-efficacy
- Reflection
- Resilience

Bring your meanings to the next tutorial and be prepared to share them with your group.

At the start of a semester Lesley doesn't just enter the due dates for assignments she blocks out time in her diary to work on the assignments. Before she starts work on an assignment she looks at the feedback she got on the last assignment she did. Which of the CLARA learning dimensions is demonstrated by this behaviour?

A) collaboration

B) belonging

C) mindful agency

D) creativity

E) None of the other answers is correct.

Please explain why you chose that response.

Lesley has identified that she needs to improve her collaboration skills. Indicate which of the options below would give her more practice in collaborating with others.

A) working with other students enrolled in the same subject in the FLP

B) attending UPASS sessions

C) getting a part-time job

D) asking for feedback from other group members in a group assignment

E) All of the other answers are correct.

Managing your time, planning your study-related activities, and reflecting on how you solved problems. These behaviours are examples of:

A) curiosity

B) creativity

C) belonging

D) mindful agency

E) none of the other answers are correct.

Mindful agency involves:

A) Planning my learning journey
B) Knowing how I go about learning
C) Understanding and managing my feelings
D) All of the above

If I'm always wondering why and how I'm…

A) Collaborative
B) Creative
C) Curious
D) Reflective

Sense making is:

A) Taking risks and playing with ideas to create solutions
B) Using my intuition and imagination
C) Always wondering why and how
D) Making connections between what I know and new information.

Knowing how to manage emotions when learning is part of mindful agency.

A) True
B) False

Creativity involves making meaning by linking my story, my new learning and my purpose

A) True
B) False

Belonging is

A) Fitting in
B) Being part of a learning community
C) Using my intuition and imagination to generate ideas
D) Being able to listen and collaborate

Getting upset when learning is difficult is part of fragile dependence

A) True
B) False

Mindful agency is defined as

A) Having confidence
B) Taking responsibility for my own learning over time
C) Being mindful about things
D) Making sense of the world

Curiosity is making meaning by linking my story, my learning and my purpose.

A) True
B) False

Belonging means there is at least one person close to me who has helped me learn

A) True
B) False

Creativity is

A) Being part of a learning community
B) Being optimistic about learning
C) Using my intuition and imagination to generate new ideas
D) Taking responsibility for my learning

Collaboration is

A) Believing I can generate my own knowledge
B) Being able to listen and contribute to a team
C) Planning my learning journey carefully
D) Being sure my solution strategy is the right one.

Rigidly persisting involves giving up after a while.

A) True
B) False

Hope and optimism is having a growth mindset and believing you're getting better at learning.

A) True
B) False