BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(An Autonomous Institute under VTU, Belagavi, Karnataka - 590018)
Avalahalli, Doddaballapur Main Road, Bengaluru – 560064

ALTERNATE ASSESSMENT TOOLS (AAT)

With effective from 2021-22 (ODD Semester)

January – 2022

TABLE OF CONTENTS

CHAPTER - 1

INTRODUCTION TO ALTERNATE ASSESSMENT TOOLS (AAT)

Definition: Assessment refers to one or more processes that identify, collect, use and prepare data to evaluate the attainment of student outcomes and program educational objectives.

Preamble: Alternate Assessment refers to the type of assessment other than the traditional approach of assessing students. Effective assessment uses **direct, indirect, quantitative and qualitative** measures appropriate to the objective or outcome being measured. Appropriate sampling methods may be used as a part of an assessment process.

Assessment is the systematic collection, review and use of information about educational programs undertaken for the purpose of improving student learning and development. Assessment benefits to change the pedagogy, modify the course and redesign the curriculum for the continuous improvement of the program. Good assessment practices in OBE are fundamentally no different from good assessment practices in any other education system. We should use assessment procedures that are **transparent, valid and reliable**.

Three key features of outcomes-based assessment system are:

- **Transparent** – methods of evaluation should be clear to anyone who examines it and understood by everyone involved, including students. The assessment should not be influenced by irrelevant factors.
- **Valid** – must provide realistic proof of outcome to the specified standards
- **Reliable** – must ensure that assessors in different locations would make the same judgement about the same student based on the same evidence.

The evidence of outcome must be judged through the application of four rules that must be applied to the **knowledge, skills, and attitudes** on all occasions.

- **Valid** – the evidence must confirm that the student has actually performed and this is his achievement.
- **Authentic** – based on the validity, the evidence must confirm that the student himself has performed and achieved results, without assistance from others.
- **Current** – the evidence must prove that the student has achieved the outcome currently, not in the past.
- **Sufficient** – enough evidence is collected to demonstrate that the student has performed and achieved the outcome as per the performance criteria.

In outcome based education (OBE), assessment should always contribute to the goal of improving student's learning. If assessment is going to support learning, then assessment tasks must provide genuine opportunities for students to demonstrate what they have learned and to help them identify what is that they still need to learn. Because learning is a process of continually restructuring prior knowledge, not just adding to it, assessment should help students to connect what is being learned to their prior knowledge. This can be done, for example, by **using portfolios** as both a learning and assessment tool, by giving students marking guides in advance so that they will know how they will be assessed, and by allowing students to revise their initial responses to some assessment tasks. Of course, the results of assessment should always be conveyed to students clearly, as soon after the assessment as possible.

In the following section, we describe the various alternate assessment tools (AAT) available in the literature so that the course coordinator can adapt them in assessing the students.

CHAPTER 2 COOPERATIVE PROBLEM BASED LEARNING (CPBL)

I. Preamble: Problem based learning (PBL) is an inductive learning approach that uses a realistic problem as a starting point of learning. In a PBL model students engage complex, challenging problems and collaboratively work toward their resolution. PBL is about the students connecting disciplinary knowledge to real world problems. The motivation to solve a problem becomes the motivation to learn. Combining both cooperative learning (CL) and PBL results in a cooperative problem based learning (CPBL)

In PBL, unstructured problems are used as the starting point of learning, creating deep interest among students to learn new knowledge and integrate existing ones, and forcing them to think critically and creatively to solve the problem.

The PBL method can be easily adapted to address all the program outcomes defined by the national board of accreditation (NBA). In PBL entire courses and individual topics within courses are introduced, with complex open-ended focus problems whose solutions will require the knowledge and skills set forth in the course learning objectives.

In this section, the cooperative problem-based learning (CPBL) model is described. The CPBL model is a combination of PBL and CL to emphasize learning and solving problems in small student teams. The model requires the problem to be realistic, if not real with a scenario that serves to contextualize and immerse students in the problem.

II Integrating PBL and CL

A. Problem based Learning

PBL, which has constructivist underpinnings, is a philosophy that needs to be adapted to the specific condition and environment of the institution and the nature of the field in which it is applied. This can be seen in the different models of PBL implementation throughout the world.

The typical PBL cycle, as shown in Fig. 1, basically consists of the following phases:

Phase–1: Problem restatement and identification

Phase–2: Peer teaching, synthesis of information, and solution formulation, and

Phase–3: Generalization, closure and reflection

Despite variations in PBL implementation, these three phases are basically present in all the different models of PBL.

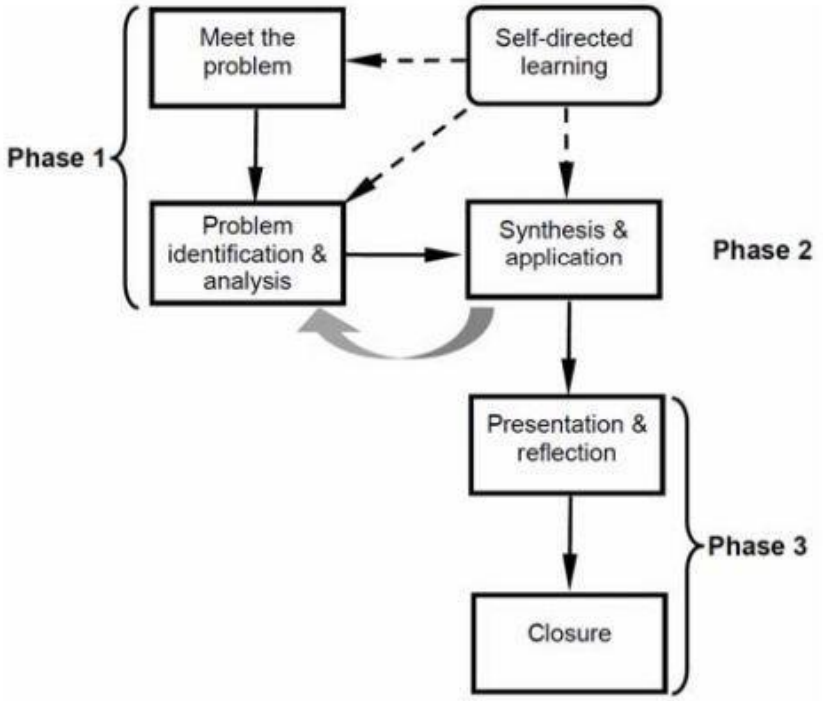


Fig. 1. Typical PBL Cycle

B. Incorporation of Cooperative Learning

Supporting and monitoring students' learning in small groups by a floating facilitator can be challenging in a typical class while implementing PBL. A functioning team is critical for students undergoing PBL because they need to rely on one another for support to go through the PBL cycle to learn and integrate new knowledge to solve the problem since there is no dedicated tutor for each group. Four types of learning group performance in the classroom are as described below:

1) Pseudo learning group: Group members do not want to work together and compete with each other. Group performance level is lower than if members work individually.

2) Traditional classroom learning group: Members accept that they have to work together, but do very little joint work together because assignments given can be broken up and done individually. Support among members is non-existent. Free-riders cause responsible members to feel burdened, resulting in low performance and morale. Group performance level is about the same as the level if members work individually.

3) Cooperative learning group: Members are relieved they can work together in a group, and understand that success depends on the effort of each member. Group performance level is higher than those of individual members.

4) High-performing cooperative group: In addition to meeting the criteria of Cooperative Learning group, members are committed to help each other and the group succeeds. Synergy is achieved resulting in a group performance level that is much higher than those of individual members.

Students typically resist working in groups, be it in laboratories or class projects, because of prior experiences working in a group that falls under the pseudo learning group or traditional classroom learning group categories. Therefore, for small groups in a medium to large class setting, the support needed does not only involve cognitive coaching at different PBL phases, guidance to develop team working skills in students is also essential. While it is challenging for a floating facilitator to monitor and support all groups closely, in a proper Cooperative Learning (CL) environment, part of the monitoring, support and feedback can be attained from peers, especially team members, instead of solely relying on the facilitator. In fact, support can be further enhanced by developing the whole class into a learning community. To achieve this, CL aspects are integrated, thus becoming Cooperative Problem Based Learning (CPBL). This is in line with the recommendation that the two methods be combined to take advantage of the natural synergy between them.

C. Cooperative Learning (CL)

CL, is proven, through various studies, to promote cooperation among students resulting in improved learning quality and skills, such as academic achievement, interpersonal skills and self-esteem. Social interaction among learners can create collaboration, leading to a significant positive impact on learning. To ensure good team working, the five principles of cooperative learning must be emphasized and promoted throughout the CPBL cycle. The five CL principles (C1 to C5) are:

- Positive interdependence (C1)
- Individual accountability (C2)
- Face to face interaction (C3)
- Appropriate interpersonal skills (C4)
- Regular group function assessment (C5)

Assigning students to work in groups does not mean that they are undergoing CL. Only when all five principles exist in the learning activity can it be classified as cooperative learning. The difference between CL and group-based learning can be clearly seen in part of the meta-reflection made at the end of the semester by a student who had undergone CPBL in their course.

Table 1 Teaching and learning activities and assessment tasks

CL Principles		Positive interdependence	Individual accountability	Face to face interaction	Interpersonal skills	Group function assessment
Phase 1 Problem restatement & Identification	Individual	Prepare to discuss with team	Submit PR & PI before discussions			
	Team discussion & consensus	Consensus to bring to whole class; may submit team PR & PI; assign learning issues for each team member	Start discussion based on individual answer; agree on learning issues to read and learn by each member	In- class discussion; assign roles for each team member during duration of problem	Reach consensus within given time	Overall observation of participation and body language
	Overall class discussion	Each team provide opinion	Anyone may be randomly called	In- class discussion	Proper etiquette in discussion, Q&A to reach overall consensus	Observation of participation
Phase 2 Learning, application & solution	Peer learning	Notes contain summary of concepts understood and questions on hazy points to help learning in team; assume role play	Individually prepare peer learning/teaching notes for team; submit individual peer learning notes; role play	Learn in team – explain concepts understood and ask those still hazy; overall class peer learning/teachin g/ discussion led by designated team	Reach consensus on understanding of concepts or learning issues and questions to ask during in-class session	Observation of participation during overall class peer learning/ teaching/ discussion
	Synthesis & application	Quiz or tutorial questions on important concepts; e-learning forum	Quiz or tutorial questions on important concepts	Out-of class sessions	Out of class sessions	Progress check
	Consensus on final solution	Submit 1 report for each team	Optional quiz, test/exam	Out of class sessions	Out of class sessions	
Phase 3 Generalization, closure & internalization	Presentation, reflection, team rating & feedback	Comparison of solution between different teams in class	Individual feedback from team members on performance	Presentation of final solution and discussion led by designated team	Sincere comments to help team improve	Peer rating and feedback on team members and team process
	Closure	Generalize concepts to other types of problems	Internalize lessons learned from content and process through written reflection	In-class closure session	Motivation on team working & conflict management	In-class session on improvement to be made

III. The CPBL Model

To develop the CPBL model, constructive alignment is used to formally integrate CL into the PBL cycle. Constructive alignment is based on two premises. The first premise is constructivism, where the learner constructs meaning through his learning activities, rather than what is transmitted by the course coordinator. The second is instructional design that aligns learning outcomes to teaching and learning activities, as well as assessment tasks. By integrating the two premises in constructive alignment, constructivism forms a basis to guide the design of instruction – from writing course outcomes to selecting the appropriate teaching and learning activities, and craft suitable assessment tasks that are well aligned to support learning.

From the PBL cycle shown in Fig. 1, the model evolves to the framework shown in Fig. 2 to emphasize the importance of ensuring cooperative work among students in the small groups and the whole class. The framework can be used

to visualize the CPBL process to support students in grasping the overall requirements of the whole process, as well as the significance of each step in terms of the outcomes and activities in each block as they go through each of the three phases in the CPBL cycle.

Phase 1: consists of the problem identification and analysis stage.

Phase 2: is the learning, application and solution formulation stage.

Phase 3: is the generalization, internalization and closure stage.

The teaching and learning activities, assessment and rationale for each block must be explained step by step as students undergo the process from one block to the next in each of the three main phases for students who are new to CPBL to develop the necessary skills.

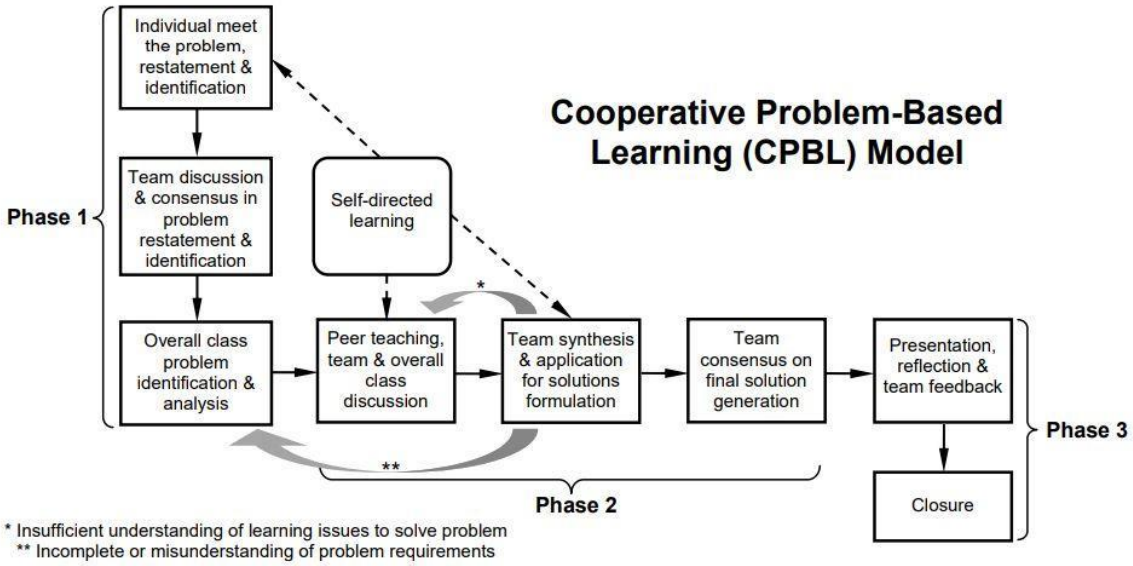


Fig. 2. The CPBL Framework

A. Phase 1: Problem Restatement and Identification

In Phase 1, the outcome is for learners to properly begin problem solving by understanding and analysing the actual problem, thus preventing them from rushing to find the solution. Table 2 summarizes the teaching and learning activities (TLA) and the corresponding CL principles covered by the activities in Phase 1. Referring to Table 2 and Fig. 2, students are required to individually write in their own words and submit a problem restatement and identification (PR & PI) to invoke construction of their own understanding before coming to class for discussions with their teammates. The problem is analysed by establishing the following categories of information:

- existing knowledge or information that is known or given in the problem (the springboard for the problem)
- further data and information needed to solve the problem (learners have the knowledge but lack the data or information)

- learning issues or new knowledge that must be learned to solve the problem.

Table 2 Phase – 1 Activities Mapped to CL Principles

	Teaching and Learning Activities (TLA)	**Cooperative Learning Principles**
Individual	Before class, read and prepare individual PR&PI for submission	C1, C2
Team discussion & consensus	In class discussion, starting from individual PR&PI to find consensus for team PR&PI within the given time. Draw up an action plan and assign learning issues to each member to prepare for peer teaching. May request team PR&PI be submitted or presented.	C1, C2, C3, C4
Overall class	In-class discussion of each team PR&PI, where students may be randomly called to provide team answers. Conduct discussion to promote a learning community among all students.	C1, C2, C3, C4, C5

Requiring learners to individually prepare and submit written problem identification constructively aligns the learning activities and assessment to the outcomes. In addition, the preparation allows teams to have productive discussions to find consensus in class. These small team discussions, in turn, give confidence for learners to volunteer their view during the overall class problem restatement and identification. In addition, these discussions are important in developing thinking skills required in starting and planning to solve the problem, as well as inculcating a sense of community and cooperation among the whole class. Assessment of individual problem restatement and identification also provide feedback and evidence for the instructor on the achievement level of students so that appropriate scaffolding can be given if the need arise.

B. Phase - 2: Peer Teaching, Synthesis, and Solution Formulation

In phase 2, the outcome is to have learners develop the skill to learn new material and apply them to formulate the solution. Learners have to evaluate

different approaches to solve the problem and justify the choices made. Table 2 summarizes the TLA and the corresponding CL principles. Referring to Table 3 and Fig. 2, at the beginning of phase 2, learners individually prepare peer teaching notes in the form of explanations of what is understood, ideas or concepts that needs to be verified and questions on hazy points on the learning issues that have been assigned by their teams

Table 3 Phase - 2 Activities Mapped to CL Principles

	Teaching and Learning Activities (TLA)	**Cooperative Learning Principles**
Peer T&L	Individually prepare peer T&L notes, and conduct team peer T&L out of class. Submit individual peer T&L notes during class and have overall class peer T&L coordinated by a group. May give tutorials, quizzes or mini lectures.	C1, C2, C3, C4
Synthesis and application	Synthesize knowledge and information together as a team and use them to come up with possible solutions. Conduct progress checks for problems with a duration of more than 2 weeks.	C1, C2, C3, C4
Consensus on final solution	Reach a consensus on a solution that is deemed to be the best to all team members. Submit one report per team.	C1, C2, C3, C4

. A copy of the individual peer teaching notes must be handed in to align the activity with assessment. Other than promoting accountability, students learn to construct new knowledge by extracting important concepts and information, explaining what they understand, and inquiring about what they do not fully understand to develop abilities to learn through questioning.

Peer teaching is essential in developing skills to learn in students, especially on technically challenging material, where they would easily give up if they were to study alone. Students explain what they understand to teach team members while learning together, and discuss the questions or unclear concepts before coming to class for the overall class peer teaching and learning session.

The overall class peer teaching discussion is a 2-hour session monitored by the facilitator where each student understands that they need to be prepared to participate in the discussion as part of the learning community to gain the most and maximize their learning. Each team is expected to come to class

with a list of questions or ideas on concepts that they want to verify with other teams. A quiz on important learning issues may be given as formative assessment to enable students to gauge their understanding, and indicate to the facilitator if additional scaffolding, like tutorials or mini lectures, should be given.

During the rest of phase 2, all collated information and knowledge is shared and critically reviewed, before the relevant ones can be synthesized and applied to solve the problem. This step can be iterative, where students need to re-evaluate the analysis of the problem, pursue further learning, reporting and peer teaching. Usually, at this point students actively participate in e-learning forums designated for the problem - asking questions, giving opinions and views, discussing the concepts in order to solve the problem. The electronic forum is monitored by the facilitator and if necessary, will join in the discussion to probe, motivate and bring students to the right path whenever they are off-track. For problems lasting more than 2 weeks, a simple progress report or progress check on each team is recommended midway through the duration of the problem. The aim is to provide feedback to ensure that students do not stray too far from what is required, and prevent last minute work.

C. Phase - 3: Generalization, Closure and Internalization

In phase 3, the outcome is to have learners evaluate the final solution from each team, and internalize and generalize the concepts and skills learned. Referring to Table 3 and Fig. 2, the teams submit the final product, whether it is a report, presentation or other deliverables. If there is insufficient time for all teams to present, presentation of solutions from one or two teams would be sufficient to start the ball rolling to discuss solutions obtained. In this case, the assessment of the final solution will depend on the report or other deliverables handed in, rather than the presentation, which serves as a discussion session on the possible solutions found by the different teams. The facilitator should probe students during the discussions to determine acceptable solutions, and justify their choice of the best solution for the problem.

During the closure, the facilitator comments on the possible solutions, as well as identifies the best solution. Mistakes or misconceptions in important concepts, and difficulties or good practices in process skills or teamworking may also be analysed and reviewed. Connections between concepts and applications in other areas are discussed. This is necessary to widen the views and generalize the knowledge transfer for other types of applications, thus strengthening students' understanding. It is also important to tie up loose ends to avoid feelings of dissatisfaction among students. To support the development of students' team working skills and improve their learning process, a team-based post-mortem on the process that they went through and the team performance must be conducted in class. Confidential peer

rating and written feedback from each team member to his/her teammates, (example: what is good and what needs to be improved) is also given during a class session.

Reflection may be assigned individually or team-based. Initially, prompting questions are provided as scaffolding for students to do a good reflection. In submitting individual reflections and the team feedback, students are guided to internalize what they have learned and develop meta-cognitive skills. Meta-cognitive skills are essential for life-long learning and for students to understand themselves as a learner, and as part of a community. By the end of the semester, most students learn to internalize not just knowledge, but also the process that they went through to develop their skills. In addition, as part of continuously improving themselves, they were also able to identify aspects that need improvements.

Table 4 Phase - 2 Activities Mapped to CL Principles

	Teaching and Learning Activities (TLA)	**Cooperative Learning Principles**
Presentation, reflection, team peer rating and feedback	Teams present the final solution in class. Conduct individual reflection, rate team members and provide written feedback on good actions to keep up and things to improve on. In-class discussion on overall team performance and strategies for improvements.	C1, C2, C3, C4, C5
Closure	Summarizes and generalizes important concepts covered in problems. May compare different approaches and solutions to suggest the best solution for the problem.	C1, C2, C3, C4

This can be seen in Table 4, which shows part of the end of semester meta-reflection written by a third-year student.

Table 5: Course Assessment Division

Course Assessment	**Marks**
1. Two written tests	15%
2. Three problems Problem restatement & identification Peer teaching notes Final report Written reflection	25%
3. Final examination Final problem (10%) Final written examination (40%)	50%

4. Others Tutorials and quizzes e-learning and class participation	10%
Total	100%

Assessment for the course can be seen in Table 5. The final examination consists of a final problem and a written examination. The final written examination is 40%. Questions given in the written examination shall match the cognitive taxonomy level of the outcomes as well as the teaching and learning activities that students had undergone in the course. The assessment of problems was mostly individual, except for the final report, which is a team effort. Mark received by each student from the final report is multiplied with an autorating factor calculated based on the peer rating for the individual students at the end of each problem. Details for calculating the autorating factor can be seen in the illustrative example given below.

A teaching assistant (TA) converts each verbal rating to a numerical equivalent, with "Excellent" = 100, "Very Good" = 87.5, and so on in 12.5-point decrements down to "No Show" = 0. The TA then entered the ratings on a spreadsheet and computed a weighting factor for each student as the student's individual average rating divided by the team average. The student's final homework grade was determined as the product of the weighting factor and the team average homework grade. An illustrative calculation is given in Table 6.

Row 1 of Table 5 shows that John (Student 1) received ratings of "Very Good" (= 87.5) from himself and Angela, "Excellent" from Betty, and "Satisfactory" from Dave (horizontal entries for John). The entries in the "Vote 1" column indicate that John gave ratings of "Very Good" to himself, Betty, and Angela and "Ordinary" (= 62.5) to Dave.

Table 6 Illustrative Peer Rating Analysis

Team Grade	80							
Name of the Student	Vote 1	Vote 2	Vote 3	Vote 4	Indiv. Avg.	Tm. Avg.	Weigt. Fctr.	Ind. HW grade
John	87.5	100	75	87.5	87.5	82.8	1.06	85
Betty	87.5	100	87.5	87.5	90.6	82.8	1.09	88
Dave	62.5	75	50	75	65.6	82.8	0.79	63
Angela	87.5	87.5	87.5	87.5	87.5	82.8	1.06	85

IV Scaffolding using e-learning

Scaffolding using e-learning, through a Learning Management Systems (LMS), can be very powerful to enhance and aid the implementation of CPBL. In e-learning, scaffolding in the form of electronic forums can be used as a platform for problem discussion and motivation, as well as for assessing the level of students' understanding to decide the type of support needed for learning. This feature provides a channel of communication among students and lecturers that is not bounded by the class time and physical presence. An electronic forum is very useful to boost up students' engagement and immersion in solving CPBL problems. In fact, it is an innovative approach to cultivate a learning community among students as they can continuously discuss learning issues, exchange ideas and validate understanding related to the problems. Facilitation through electronic forums can be done by probing students' discussion with thought-provoking questions that can promote critical thinking and deep learning/understanding. At the same time, students learn the skills of learning through questioning. Electronic forums also allow class facilitators to monitor students' learning process and ensure that they are on the right track. In addition, students' discussion in the electronic forum is a form of feedback for class facilitators for gauging students' understanding for better in-class facilitation.

Electronic forums can also be beneficial as a platform to provide peer support and motivation. Students, especially those from the same learning team, are accountable to motivate their team members to solve challenging problems and maximize each other's learning. Discussion forums centred on appropriate themes for the week, such as learning issues related to the problem, working and learning in teams, team performance, challenges in learning and understanding, and managing conflict, can be very useful to draw their interest.

An important advantage of using electronic forums is that this virtual support allows the participation of experts and former students who have graduated to be roped in, no matter where they are. Topics may range from supporting understanding of the content, giving context on how the material learned is used in industry, providing information or data for solving the problem, or simply motivating students to properly undergo CPBL so that they may develop essential skills needed when they work in industry.

Former students who work in industry can have a strong impact in motivating current students. Their participation in motivating current students by sharing experiences and tips on how to do well and gain the most in CPBL is valuable and enlightening. This approach provides an opportunity for students to see the necessity of undergoing CPBL to develop important skills from those who have entered the workplace. A common topic for discussion is the impression, reaction and reflection of undergoing CPBL class, and the way CPBL trains students to suit and fit themselves in the actual working environment.

Having professionals from industry as expert resources for a certain problem is scaffolding not only in how the content is used in industry, but also in developing students' technical communication skills, and the skill to gain information and learn through questioning. In addition, this increases students' motivation to work on the problem. If it is difficult to find professionals to volunteer as experts, then a virtual expert can be created on e-learning, where the students can post questions and hold discussions with the "expert" virtually. But in actual fact, class facilitators are behind the person answering all students' queries and doubts.

However, scaffolding using e-learning is not that easy to do as students are not automatically interested to take part in the e-learning activities. Therefore, it may be necessary to allocate a small portion of course marks for e-learning participation.

V Other Form of CPBL Implementations

The problem-based learning is a traditional instructional approach in science, mathematics, engineering, and technology. The problem based cooperative learning strategy presents the fundamentals and then presents the applications that make use of the fundamentals to solve problems.

Virtually all modern research-based approaches

Task: Solve the problem

Individual: Examine Answer and note the strategy

Cooperative: One set of answers from the group, strive for agreement, make sure that everyone is able to explain the strategy used to solve each problem.

Expected Criteria for success: Everyone must be able to explain the strategy used to solve each problem.

Evaluation: Best answer within the available resources or constraints.

Individual accountability: One member from any group may be randomly chosen to explain (a) the answer and (b) how to solve each problem.

Expected Behaviours: Active participating, checking, encouraging, and elaborating by all members

Inter-group cooperation: Whenever it is helpful, check procedures, answers, and strategies with another group.

Groups formulate and solve problems. Each group will place its formulation and solution on an overhead transparency or paper.

Randomly selected students will present their group's model and solution

Discussion of formulation and solution. All members of the class will be expected to discuss and question all models.

Each group will prepare and submit a project report, and process its effectiveness as a group.

Reference

1. Khairiyah Mohd. Yusof, Syed Ahmad Helmi Syed Hassan, Mohammad Zamry Jamaludin, Nor Farida Harun, Cooperative Problem-based Learning (CPBL): Framework for Integrating Cooperative Learning and Problem-based Learning, Procedia - Social and Behavioral Sciences, Volume 56, 2012, Pages 223-232, ISSN 1877-0428, https://doi.org/10.1016/j.sbspro.2012.09.649.

(https://www.sciencedirect.com/science/article/pii/S1877042812041110)

CHAPTER 3 PROBLEM BASED LEARNING

I. Preamble: In order to produce quality graduates, since the BMSIT&M has been accredited by NBA, henceforth it adapts the NBA program outcomes to reflect in its program. BMSIT&M graduates shall have sound disciplinary and professional knowledge, high self-esteem and effective skills in communication, team working, problem solving and life-long learning. To achieve the desired outcomes of expertise in content knowledge, positive attitudes and abilities in generic skills, student centred teaching and learning techniques, especially Problem-based Learning (PBL), are highly encouraged.

PBL originated and gained wide acceptance in medical education. However, in the last decade, there has been a growing movement throughout the world to adopt PBL in other fields, including engineering. Many implementations are reported in North and South America, Europe and Australia.

The PBL approach sought to embed small groups of students in the role of a professional and present them with a messy, unstructured, real-world problem, based within the context of the profession, to solve. Students are then guided by cognitive coaches through the problem-solving process and develop high levels of generic skills and attributes, along with the content specific knowledge and skills that they require. PBL practitioners often claim that their learners are more motivated and independent in their learning.

II. Implementation

The PBL is normally implemented in small groups of students up to ten students with a dedicated tutor. The PBL can also be implemented in medium to large classes (20 to more than 100 students) with small groups consisting of 3-5 students. In this case, instead of having a dedicated tutor facilitating a group at all times during the tutorial, one or more floating facilitators or dedicated student or peer tutors may be utilized during class time. They were asked to fill in a personal information form that consists of their cumulative grade point average (CGPA), the grades obtained for the courses that were the prerequisite of this course, and what they aim to get out of the class. PBL was described, and the advantages were explained. Rules and policies of the class, especially those designed to ensure that each student contributes to the group were discussed in class. The students were also given motivation on team work. By the end of the first week, the students were divided into groups. Students were assigned to various groups according to a mixed ethnic background and genders. Each group consists of three to five students. Students with high CGPAs were also mixed with students with low CGPAs. As far as possible, there were at least two good students with CGPA above 8.0 (out of 10 maximum), and at least two female students in a group. To develop a sense of belonging, the students were encouraged to choose a name for their groups.

From the second week onwards, students were asked to work in their respective groups. Quizzes and assignments were performed in groups. There were in-class assignments, as well as out-of-class assignments. Students were reminded to contribute and at least try to work out a rough approach to the problem for the out-of-class assignments before the formal group discussion in class. Students were suggested to go through the recommended text books for the course. Each group was advised to have at least a copy of all texts. The students were also encouraged to find other resources for the subject. This was purposely done to encourage students to be resourceful and share the knowledge gained among their group members.

PBL was implemented from the 8th to the 11th week of the semester with a dedicated facilitator along with the floating facilitator for large students' strength. The case-study is broken down into three parts. The case study may be modified from a text that was not used in class. The first part was due at the end of two weeks (end of week 9), the second after one week (end of week 10) and the third after one week (end of week 11). Students shall not have any lectures on the material covered in the case study. Since most of them have never heard of PBL, they were briefed on what PBL is, the advantages and how to approach the problem. The case study was first given to the groups in a two-hour class. They have to understand the process as well as identify the problem and learning issues. About mid-way through the class, the first of two triggers for the first part of the case study were given. Students were given two days to complete the triggers and present the answers in a one-hour class. The triggers contain key words or concepts that would help the groups identify learning objectives and try to solve the problem. During the presentation, it may be clear that the students have managed to decipher the problem and are well on the way to solving it. All students shall participate in the presentation, willingly offer answers even to questions that require deep thinking. The second trigger/assignment was given at the end of the class. The groups shall submit the first part of the case study. The result of the case study is orally presented by students and discussed in class. The second and subsequently the third part of the case studies was given.

III Outcomes, Results and Discussion

Students were given a questionnaire to fill in at the end of the third part of the case study. Questions are listed in the first column, and the percentage of students giving positive and negative responses are tabulated in the respective columns. Those who gave both positive and negative responses, or those who were undecided, are grouped under the "Undecided" columns.

Questions	**Positive**	**Negative**	**Undecided**
What do you feel about PBL?			
Learned more in PBL compared to traditional lecture?			
Recommend PBL in other subjects?			
Attend another course using PBL?			

Problem-solving ability increased?			
Self-learning and motivation increased?			
Interaction and team-work skills increased?			
Self-confidence increased?			

A week after completing the case study, students were assessed in internal tests. Question in the test was on the topics covered in the case study. The performance of the students in the test is compared prior and post the PBL session.

IV Other Forms of PBL Implementation

The students (generally working in groups) carry out the following steps:

- Attempt to write clear problem definition statement
- Hypothesis ways to obtain a solution
- Identify (a) what they know, (b) What they need to know (both information and methods), and (c) What they need to do. These lists are regularly updated as the students proceed through the solution processes.
- Prioritize learning needs, set learning goals and objectives and allocate resources and (if teams are used) responsibilities.
- Carry Out the necessary research and analysis and generate possible solutions (first seeing if the problem can be solved with currently known information), examine their 'fit', choose the most appropriate one and defend their choice.
- Reflect critically on the new knowledge, the solution of the problem and how effective the solution process is.
- The faculty serves as a resource in all stages of this process, but does not provide formal instruction until the students (possibly with some guidance) have generated a need for it in the context of the problem.
- Any teaching method may be used to provide the instruction, ranging from lecturing to full-scale cooperative learning. Relative to students taught conventionally, students taught using PBL will acquire greater mastery of problem solving, interpersonal, and life-long learning skills and are more likely to adapt a deep approach in learning.

Problem based learning is very suitable for engineering because it helps students develop skills and confidence for formulating problems they've never seen before. This is an important skill since few professional engineers are paid to formulate and solve problems.

Implementation Steps (Example only):

Step I: Presentation and analysis of the problem:

The first step of the methodology is the introduction of a specific problem presented by the tutor (teacher or professor) and analysed by groups of students. The proposed projects are presented and elaborated on to the students, obviously. The projects are having the same size from a different domain and have been allocated to the group randomly.

Step II: Proposal of hypothesis:

After the presentation and problem analysis, the students, assisted by the tutor, discuss and raise possible causes of the problem and potential solutions for it. These hypotheses were related, for instance, identification of potential users, types of applications, domain, and others.

Step III: Problem-solving attempts with knowledge available:

After the hypothesis is clearly defined, students tried to provide answers intuitively and predict possible results for the solution of the problem based on their previous knowledge. These answers were, in general, related to the requirements identification obtained in Step II.

Step IV: Identification of learning standpoints:

In this step, the professor already had the opportunity to present all the concepts of the course that had been covered by the students so far or which they had previous knowledge about. These concepts were in general related to the requirements elicitation, requirements analysis using UML, use case diagram, activity diagrams, and others.

Step V: Workgroup planning:

In this step, students planned the group work based on the problem to be solved and on the new knowledge acquired. In this software development, the following activities were carried out: requirements elicitation, analysis, design, implementation, and testing.

Step VI: Deployment of knowledge about the problem:

The students apply the knowledge acquired during problem-solving as many times as required in order to achieve the deliverables at the end of every phase

Step VII: Production of documents:

The final step of this problem-solving cycle is related to the production of a document, as in Table 7, describing all the proposed solutions for the problem, which will be presented to the tutor and all the other groups.

Step VIII: Process assessment:

In this step, the professor of the course carried out the formal presentation where each student in the group has to present their work, and assessments are based on the group work.

Table 7 Phases and Deliverables

Phases	Artifacts
Requirements Elicitation	List of requirements
Analysis	Activity diagrams Sequence diagrams Collaboration diagrams Sequence diagrams (Design perspective)
Design	Collaborations diagrams (Design perspective) Class diagram Package diagram Component diagram
Implementation	Deployment diagram Prototype
Testing	Software test plan Software test report

Record of Assessment of Student's Skills
Course Name:
Student Name:
USN:
Course Code:

Skill Area	Task/ Interview Question	Unsatisfactory	Satisfactory	Good	Exemplary	Score/ Grade	COs	POs	PEOs
		1 (0 -25%)	2 (26-50%)	3 (51-75%)	4 (76-100%)				
					Average Score				

Record of Assessment of Student's Skills in a Course
Course Name:
Course Code:

Sl. No.	Student Name and USN	Skill Area	Task/ Interview Question	Unsatisfactory	Satisfactory	Good	Exemplary	Score / Grade	COs	POs	PEOs
				1 (0 -25%)	2 (26-50%)	3 (51-75%)	4 (76-100%)				
1.											

							Average Score				
N											
							Average Score				

Reference

1.https://citl.illinois.edu/citl-101/teaching-learning/resources/teaching-strategies/problem-based-learning-(pbl)

CHAPTER 4. COOPERATIVE LEARNING

Preamble: Cooperative learning is effective teamwork for engineering classrooms. Cooperative is working together to accomplish shared goals. Within cooperative activities individuals seek the outcomes that are beneficial to themselves and beneficial to all other group members. Cooperative learning is the instructional use of small groups so that the students work together to maximize their own, and each other's learning. Carefully structured cooperative learning involves students working in teams to accomplish a common goal, under conditions that include the following **essential elements**:

i. **Positive interdependence**: Team members are obliged to rely on one another to achieve the goal. If any team member fails to do his/her part, everyone suffers consequences.
ii. **Individual and group accountability and responsibility**: All students in a group are held accountable for doing their share of the work and for mastery of all of the material to be learned.
iii. **Face-to-face interaction**: Although some of the group work may be parcelled out and done individually, some must be done interactively, with group members providing one another with feedback, challenging, reasoning, and conclusions, and perhaps most importantly, teaching and encouraging one another.
iv. **Appropriate use of collaborative skills**: Students are encouraged and helped to develop and practice trust building, leadership, decision making, communication, and conflict management skills.
v. **Regular self-assessment of group functioning**: Team members set group goals, periodically assess what they are doing well as a team and what they need to work on, and identify changes they will make to function more effectively in the future.

These five essential elements must be present for small group learning to be truly cooperative.

Relative to students taught traditionally i.e with faculty centred lectures, individual assignments, and competitive grading **cooperatively taught students** tend to exhibit higher academic achievement, greater persistence through graduation, better high-level reasoning, and critical thinking skills, deeper understanding of learned material, lower levels of anxiety and stress, more positive and supportive relation with peers, more positive attitudes toward subject areas, and higher self-esteem.

Implementation

Forming teams: Teams in the cooperative learning classroom are best formed by the faculty member. Self-selected teams are usually composed of groups of students who all have similar skills and therefore may be lacking the requisite skills to complete particular tasks or assignments. Such teams are often

composed of individuals with similar academic achievement, while a range of academic achievement would better ensure that all teams will acquire the knowledge and skills needed for success in the course. Finally, self-selected teams are almost always composed of students of the same ethnic group or of the same national origin, when it would benefit students to learn to work with a diverse range of colleagues.

Group size: Three to four students per group (maximum four for the entire class)

Group presentation: After each chapter of the syllabus, a group was selected to prepare for a five-to-ten minutes' presentation. Each group will have two to three chances to present different chapters during the entire semester. The presentation was a summary of the chapter just taught and every presenter was individually assessed by all other groups. The grading rubrics were based on four considerations:

- **Completeness**: does the presentation cover the major topics of the chapter?
- **Understandability**: is the presentation easy to follow along?
- **Helpfulness:** is the presentation good enough to help form a general picture of the chapter?
- **Participation:** does every team member actively participate in the presentation?

In the presentation, everyone in the class was free to ask questions, and the presenting group was responsible for further clarifying ambiguities. After the review, the whole class was quizzed on the chapter.

Presenters	Completeness (5 Points)	Understandability (5 Points)	Helpfulness (5 Points)	Participation (5 Points)

Group work to study specific Topic

The second group activity is done by dividing the whole class into two big groups and each group shall take two weeks to learn one instrument. A group report was required and the following tasks should be completed:

• Learn the instruction manuals of the instrument provided by the vendor;

• Develop a simplified instruction manual for proper use of the instrument (the students are encouraged to record the operation steps by video camera);

• Compile a trouble-shooting manual for instrument maintenance;

• Use the instrument to finish tolerance measuring assignments.

Group environment helped the students to quickly grasp the essence of the instruments. Meanwhile, the report, manuals, and video clips enriched the knowledge base of this course by providing a good training resource for the current and future students.

Cross-training between Groups

The third group activity was cross-training between groups. After a team was finished with the study of one instrument (say, coordinate measure machine), it exchanged the training materials (video clips, instruction, and trouble-shooting manuals) with the other group (which studied optical comparators). Then, two groups spent another week to cross-train each other. The cross-training result was tested by the instructor at the end. Some machine parts and their engineering drawings were given, and the students were asked to measure the tolerances. Two students were demonstrating in front of the class during the cross-training test.

Group Research

The fourth group activity for the course was group research. In this activity, the students studied product prototypes. They did research from various aspects, including product functionality, quality requirements, machining, and assembly process. After that, the students put forward the specifications for product quality improvement. When it was first made, there was no GD&T specification. Group research gave the students an opportunity to fully apply their subject knowledge into real manufacturing practices.

Evaluation of the Class

After cooperative learning was introduced, the time allocation for an average student in a course obviously changes. As illustrated by Table 1 the proportion of group activities (55%) is considerably more than that (20%) before cooperative learning was used.

Activities		Time Allocation	Traditional Time Allocation
Individual based	Lecture		
	Reading and homework		
	Quizzes and exams		
Group based	Laboratory		
	Presentation		
	Cross-training		
	Group Research		

Cooperative learning effectively motivates the students to get involved in the learning process. The student's feedback template is as shown below:

Feedback Form on Cooperative Learning

Performance Criteria	Unsatisfactory	Marginal	Satisfactory	Exemplary	Score
Individual					
Team Work					

Advantages and disadvantages of Cooperative Learning

Advantages

- Helps foster mutual responsibility
- Supported by research as an effective technique
- Students learn to be patient, less critical, and more compassionate

Disadvantages

- Some students don't work well this way
- Loners find it hard to share answers
- Aggressive students try to take over
- Bright students tend to act superior

Reference

1.https://www.researchgate.net/publication/321698800_Cooperative_Learning_Approach_in_Engineering_Education

2. D. Zhang, L. Cuthbert, S. Ketteridge and Y. Ying, "Evaluating the effectiveness of a Cooperative Learning approach in engineering education in China," 2013 IEEE Frontiers in Education Conference (FIE), 2013, pp. 1496-1502, doi: 10.1109/FIE.2013.6685086.

CHAPTER 5. JIGSAW CLASSROOM COOPERATIVE LEARNING

Preamble: The jigsaw classroom is a cooperative learning technique for increasing positive educational outcomes. Just like each piece of a jigsaw puzzle, each student's part is essential for the completion and full understanding of the final product. If each student's part is essential, then each student is essential; and that is precisely what makes this strategy so effective.

This is how it works. Suppose the students in an engineering class are divided into small groups of three to five students each, and assigned a task. - for instance, learning how the motor car works. In one jigsaw group, one student would be responsible for researching the design. Another, assigned to prepare the list of components/parts necessary to build the car. A third, assigned to assemble the parts. A fourth, to figure out how the engine works and the fifth assigned to start the engine and drive the car.

Eventually each student will come back to his/her jigsaw group and will try to present a well-organized report to the group. The situation is specifically structured so that only access any member has to the other four assignments is by listening closely to the report of the person reciting.

The benefit of the jigsaw classroom cooperating learning is first and foremost, it is a remarkably efficient way to learn the material. But even more important, the jigsaw process encourages listening, engagement, and empathy by giving each member of the group an essential part to play in the academic activity. Group members must work together as a team to accomplish a common goal; each person depends on all the others. No student can succeed completely unless everyone works well together as a team. This "cooperation by design" facilitates interaction among all students in the class leading them to value each other as contributors to the common task. Moreover, the students in jigsaw classes were absent less often than were other students, and they showed greater academic improvement "poorer students in the jigsaw classroom scored significantly higher on objective exams then comparable students in traditional classes, while the good students continued to do as well as the good students in traditional classes.

Jigsaw in 10 easy steps

The jigsaw classroom is very simple to use. As a faculty, just follow these steps to implement this teaching method in your classroom.

- Divide students into a four or five-person jigsaw group. The group should be diverse in terms of gender, ethnicity, race and ability.
- Appoint one student from each group as a leader. Initially, this person should be the most mature student in the group.
- Divide the day's lesson into four or five segments. For example, if you want engineering students to learn about how a motor car works, you might divide it into standalone segments on: (1) researching the design,

(2) preparing the list of components/parts necessary to build the car, (3) assembling the parts, (4) finding how the engine works, (5) starting the engine and driving the car.

- Assign each student to learn one segment, making sure students have direct access only to their own segment.
- Give students time to read over their segment at least twice and become familiar with it. There is no need for them to memorize it.
- Form temporary 'expert groups' by having one student from each jigsaw group join other students assigned to the same segment. Give students in these expert groups time to discuss the main points of their segment and to rehearse the presentations they will make to their jigsaw group.
- Bring the students back into their jigsaw group.
- Ask each student to present his or her segment to the group. Encourage others in the group to ask questions for clarifications.
- Float from group to group, observing the process. If any group is having trouble (example, a member is dominated or disruptive), make an appropriate intervention. Eventually, it's best for the group leader to handle this task. Leaders can be trained by whispering an instruction on how to intervene, until the leader gets the hang of it.
- At the end of the session, give a quiz on the material so that the students quickly come to realize that these sessions are not just fun and games, but really count.

Tips on implementation

Compared with traditional teaching methods, the jigsaw classroom has several advantages:

- Most faculty find Jigsaw easy to learn
- Most faculty enjoy working with it.
- It can be used with other teaching strategies
- It works even if only used for an hour per day.
- It is free for the taking.

It would be misleading to suggest that the Jigsaw sessions always goes smoothly. It does have some drawbacks:

- A dominant student will talk too much or try to control the group.
- Some students were poor readers or slow thinkers and had trouble creating a good report for their group.
- Some students are so gifted that they get bored working with slower students.
- Students may never have experienced cooperative learning before.
- Jigsaw technique may not work with older students who have been trying to compete with one another.

All of these disadvantages/problems are real but not so fatal that they can't be resolved with experience over time.

Jigsaw Example

Jigsaw is one of the cooperative learning techniques. The purpose of this technique is to increase the students' sense of responsibility for their own learning and also learn from other members of their group. They were asked to study the material that will be their responsibility, because they must also teach that material to other members of their group instead of himself. Jigsaw technique is a simulated setting of scientists of the scientific community. Using this technique, students will be able to understand any phenomenon requiring research activity. In Jigsaw learning, the dependence among students is very high. Basically, each student will be a member of two groups, namely

• The group home

The home group was formed by members of the heterogeneous. In this home group, they will share the task of the studied topic. After all members of the home group have obtained each task, they would leave the home group to form an expert group.

• The expert group.

The expert group is a group formed from members of the group who have the same task as the studied topic (based on their agreement in the home group). After studying the topic in their expert group, they will be back to their home groups and teach each topic that is their responsibility to the rest of the group in turn.

Implementation

Students are divided into groups of 5–6 members. The theme that is going to be taught is also divided into equal parts. Each part is then assigned to each student in all the groups to be analysed. Finally, students must present their parts to their team members. At the end, an individual quiz is taken. This approach improves test performance and teamwork among class members because students are dependent upon each other. Improves learning

References

M. A. Kousa, "Jigsaw cooperative learning in engineering classrooms," 2015 IEEE Global Engineering Education Conference (EDUCON), 2015, pp. 58-62, doi: 10.1109/EDUCON.2015.7095951.

CHAPTER 6

ROLE-PLAY

I. Preamble: Students adopt a character to make a performance related to a determined situation. Then, participants switch characters so all of them have the opportunity to assume all the roles. The understanding of concepts and theories is improved

Role playing is mostly used in organizations that try to analyse a problem pertaining to the organization, and this is also used in management institutions. But the similar kind of practice can be tried in other specializations too like science and engineering. Science and engineering courses have practical but in support of those practical's, if students are given a scenario and other options to solve a particular issue, then the students are exposed to decision making in a given environment.

For example, in teaching personality development skills, the role of interviewee can be explained by role playing technique. Interviewer & interviewee can be dividing students and asking them to assume the role of interviewer. Here the real question pertaining to the interview is made by the student and this is a more practical approach to teaching where theory is supplemented by proper practical knowledge. Similar techniques can be applied in management, engineering and science courses.

II. How to teach using Role-play

The course coordinator needs to decide the context for the exercise and the role(s) that the students will play. If the students are taking human roles, the context is generally a specific problem such as global warming or dealing with an active volcano. Lessons need to be carefully explained and supervised in order to involve the students and to enable them to learn as much as possible from the experience. However, a well-done scenario never runs the same way twice, teaches people things they might not ordinarily have learned, and tends to be fun for all involved.

Role-playing exercises teach skills that are often assumed to be learned outside of the classroom (and sometimes aren't), and how to use those skills to complement scientific knowledge. These exercises require the students to use imagination, background knowledge appropriate to the character being role-played, and communications skills.

A. Individual Role-Playing Exercises:

The student's research and writes about or presents the issue being studied in a format appropriate to the character they've been assigned: a letter to the editor, or a report to the board of a corporation. The challenge for these exercises is for the student to "get into character", to accept and work in the role that they've been assigned, especially if their character is very different from them.

Students can write a paper or give a presentation from the perspective of another person or even from an object within the process being studied. This exercise can be a simple brainstorming exercise or a full-blown research project. The process is similar to those of other research projects, but the writer needs to know not only about the subject, but also the character from whose perspective the project is being done and the audience for whom it is theoretically being done. This could be a stand-alone project or it could be part of the preparation for an interactive exercise.

i. Typical Individual Role-Playing Exercises

Stories: much more fun than a typical research paper, especially when they deal with such topics as the Calvin cycle

Letters: simply learning the format is a valuable experience

Problem statement: includes a summary of the problem, and a plan of action for dealing with it. These are often appropriate substitutes for term papers, especially in environmental science class.

Political position papers: should combine social, economic, and scientific research

Speeches: can later be followed with a debate

Report on findings: usually scientific, but often focused on a political or economic objective

B. Interactive Role-Playing Exercise

Most interactive role-playing scenarios currently available are debates and collaborative problem-solving exercises. These have many features in common and tend to grade into one another. Productive debate requires the participants to build a consensus by a certain deadline (perhaps the ultimate challenge in problem-solving), and arguments can build within originally collaborative projects, often as a natural and often healthy part of the process. More unusual exercises include scripted interactive demonstrations and introductory projects in which groups of students work out a character's perspective on a topic and then present it in character.

Example: The students could be citizens of a town on a river that is receiving so much pollution from the town that neighbours downstream have requested that the town rein themselves in before they are forced to involve a higher authority. Some could role-play farmers whose crops need fertilizer. Others could represent the union of workers from a factory that disposes of waste in the river or people from downstream who no longer have safe drinking water or from the government. The instructor could provide the students with backgrounds for their characters, maps, details on what kinds and quantities of pollutants the river is carrying (and where they came from), and a budget for remediation projects. The students could do research on the consequences

of the sorts of pollution at issue and on remediation and restrictions. They can then try to work out which methods are feasible, and simulate the kinds of compromises that communities and industries in the real world must make to keep the environment liveable.

For most exercises (not the scripted ones), there is no "correct" outcome; these scenarios are open-ended. The obvious education goals are dealt with when students research their roles and the problem under discussion. The subtle goals are for students to learn not just their characters' but other characters' perspectives in order to work with them and/or to persuade them to some end. After the exercise, instructors can show, with examples, that modern environmental policy and resource economics were and are shaped by the processes that the students have spontaneously simulated.

i. Familiar forms of Interactive Role-Playing

Many students are already experienced role-players because of their extracurricular activities. There are two thriving hobbies based on interactive role-playing, one of which is straightforwardly educational and the other of which has educational potential. Both are recognizable examples for students when trying to explain role-playing to them.

Model UN: is one of the most ubiquitous (and highly organized) instances of educational role-playing. The students prepare to serve as delegates from a variety of countries, then get together to simulate a UN meeting. Many students have experience with Model UN from middle and high school. This may actually be an appropriate format for some lessons, as the UN often deals with environmental and resource issues. The strict rules for debate and the size of the actual General Assembly make this an attractive interactive role-playing debate for a large class.

Role-Playing Games: such as Dungeons and Dragons, are a form of entertainment. The relationship between role-playing games and interactive educational role-playing exercises is similar to that between fantasy adventure novels and geoscience textbooks. The design and execution of a gaming adventure and of an educational role-playing exercise have many elements in common. However, random events and outcomes (determined by die rolls or cards) are often important to role-playing games, whereas educational role-playing exercises are focused more on how and why than on what is happening. As with books, the variation within each genre is sometimes greater than the differences between them.

C. Why use Role-playing

The problem with teaching pure, undiluted information is that afterwards, the students, if they paid attention, will be left asking "What is it for? What does it mean?" Role-playing enables them to start answering these questions and to start expanding them: Role-playing, like any good inquiry approach, transforms the content of education from information into experience.

i. Motivating Students

- The creative aspect of the exercise will make it seem more like play than like work.
- The pressure to solve a problem or to resolve a conflict for their character can motivate a student far more than the sort of pressure that they usually face preparing for an exam, and it is far more typical of the pressure that will be on them in real life.
- Role-playing exercises are particularly useful in courses for non-majors to emphasize the intersection between science and daily life. Popular geoscience role-playing scenarios generally deal with hazards and environmental issues that combine natural and social sciences.

ii. Augmenting Traditional Curricula

- The primary purpose of role-playing exercises is to get students to look at the material they are learning in a new light. The course coordinator is persuading them to alter their mental maps of the world instead of just filling them.
- Role-playing exercises show the world as a complex place with complicated problems that can only rarely be solved by a simple answer that the student has previously memorized.
- Additionally, the students learn that skills they learn separately (such as quantitative and communications skills) are often used together in order to accomplish many real-world tasks.
- Adding a sympathetic, generally human element to science is often encouraging to students with science and math anxiety. Lessons can use role-playing to emphasize the value of feelings and of creativity as well as of knowledge.
- Exercises emphasizing the importance of people and their viewpoints are important preparation for students who will go on in many professions, including business, academia, and politics.

iii. Real World Skills

- Students need to understand the needs and perspectives of the people around them to get through life, and to understand themselves.
- Role-playing exercises can be used to develop skills important inside and outside of science: the kind of skills needed to make learned information useful in the real world. Many of these are very difficult to teach using more traditional methods of instruction: self-awareness, problem solving, communication, initiative, teamwork.
- If an assignment includes research or problem solving, students are more likely to retain knowledge that they have constructed themselves more than that simply handed to them in lecture

III. Implementation

A. Define objectives

The details of what you need to do depend entirely on why you want to include role-playing exercises in your course.

- What topics do you want the exercise to cover?
- How much time do you and your class have to work on it?
- What do you expect of your students: research, reports, presentations?
- Do you want the students role-playing separately or together?
- Do you want to include a challenge or conflict element?

B. Choose Context & Roles

In order to prepare for the exercise:

- Decide on a problem related to the chosen topic(s) of study and a setting for the characters. It is a good idea to make the setting realistic, but not necessarily real. Consider choosing and adapting material that other instructors have prepared.
    - For problems and settings with lots of detail, have a look at examples in the Starting Point Case Study Module. The module itself contains more information about using cases to teach.
- If the characters(s) used in the exercise are people, define his or her goals and what happens if the character does not achieve them.
- You should work out each characters' background information on the problem or, better yet, directions on how to collect it through research. If possible, prepare maps and data for your students to interpret as part of their background information rather than the conclusions upon which they would ordinarily base their decisions (especially if the characters are scientists).

C. Introducing the Exercise

Engage the students in the scenario by describing the setting and the problem.

- Provide them with the information you have already prepared about their character(s): the goals and background information. It needs to be clear to the student how committed a character is to his/her goals and why.
- Determine how many of your students have done role-playing before and explain how it will work for this exercise.
- Outline your expectations of them as you would for any assignment and stress what you expect them to learn in this lesson.
- If there is an inquiry element, suggest a general strategy for research/problem solving.

D. Student Preparation/Research

Even if there is no advanced research assigned, students will need a few moments to look over their characters and get into their roles for the exercise. There may also be additional questions:

- Why are they doing this in character? Why did you decide to make this a role-playing exercise?

- Students may have reservations about the character that they have been assigned or about their motives. It is good for the course coordinator to find out about these before the actual role-play. It can be very difficult for a student to begin researching an issue from a perspective very different from their own because even apparently objective data tends to be reinterpreted as support for pre-existing world-views.

    - With regards to environmental issues, many environmental groups have well-written, carefully researched, and nicely-engineered websites that will provide arguments as well as information for a student assigned a character to whom protecting the environment is very important.

    - Similar websites representing the very common viewpoint of the worker, property owner, or industrialist whose future may be in conflict with environmental interests are hard to find. One site, Debate Central, has constructed arguments for characters promoting property rights and wary of government intervention. Their topic coverage is still limited, however. A poorer alternative is to send students to the websites of companies involved in an issue to read their PR material.

    - Often, the best resource for understanding people is other people. Model UN encourages participants to call the embassy of the country they are to represent for advice. The same can be done with the PR divisions of mining firms and unions, environmental and taxpayer protection groups, etc.

- If there is an inquiry component (i.e. student-led research), the students may need help coming up with a research plan and finding resources.

IV. Assessment

Generally, grades are given for written projects associated with the role-play, but presentations and even involvement in interactive exercises can be graded. Special considerations for grading in role-playing exercises include:

- Playing in-character
    - Working to further the character's goals
    - Making statements that reflect the character's perspective.
- In an interactive exercise, being constructive and courteous

- For many assignments, being able to step back and look at the character's situation and statements from the student's own perspective or from another character's perspective.

Reference

http://dx.doi.org/10.3926/jotse.13

CHAPTER 7

MIND MAP

Mind maps were developed as a way of helping students make notes that used only key words and images, but mind maps can be used by teachers to explain concepts in an innovative way. Mind Maps are also very quick to review, as it is easy to refresh information in your mind just by glancing once. The key notion behind mind mapping is that we learn and remember more effectively by using the full range of visual and sensory tools at our disposal. Pictures, music, color, even touch and smell play a part in our learning armoury which will help to recollect information for a long time. This would bring a very high impact on the minds of the students about a concept.

7.1 Preamble: Mind map is used as an effective tool for teaching-learning in the classroom. With the growing demand of shifting from teacher-centric to learner -centric classroom, mind map is looked at as an active learning module to tap lateral thinking of students. It helps them to record notes in a non-linear way and promotes out-of-the-box thinking. Hence, mind maps are a popular tool to structure and visualize information. It is an activist learning method for capturing ideas on a horizontal surface. It is a graphical way to represent large information into a useful knowledge base and also helps in connecting the knowledge base with real time scenario. This facilitates the students to build better and new ideas. This section aims at bringing out the learning experiences of students using mind map in recalling technical concepts in the course Materials and Metallurgy. A questionnaire was administered to find out the various learning experiences of third year Mechanical students of this course. Findings showed that there was a significant positive difference in student's academic achievement and attitude towards learning the subject through mind mapping.

7.2 Introduction: Education is the process of developing the capacities and potentials of an individual so as to prepare that individual to be successful in a specific society or culture. The world is becoming more and more competitive such that the quality of performance has become the key factor for personal progress. Parents desire that their children climb the ladder of performance to as high a level as possible. This desire for a high level of achievement puts a lot of pressure on students, teachers, and schools and in general education system itself. School achievement may be affected by various factors like intelligence, study habits, and attitudes of people towards school, different aspects of their personality, socio-economic status etc. The desire of success is divided from individual’s concept of himself and in terms of the meaning of

various incentives as they spell success and failure in the eyes of others thus a child who sees himself as top ranking as scholars may set as his goal the attainment of the highest grade in the class. Mind mapping is a diagram used to visual form of note taking that offers an overview of a topic and its complex information, allowing students to comprehend, create new ideas and build connections. Through the use of colors, images and words, mind mapping encourages students to begin with a central idea and expand outward to more in-depth sub-topics. Mind maps can be drawn by hand, either as "rough notes" during a lecture or meeting, for example, or as higher quality pictures when more time is available. An example of a rough mind map is illustrated.

7.3 Methodology

This section focuses on illustration of the case study of using mind map as a technique to educate 'Materials and Metallurgy' to third year engineering undergraduates in an Engineering Institution. Transmission of knowledge present in the information by teachers does not guarantee an effective understanding of the student in a large class room which has been a greatest

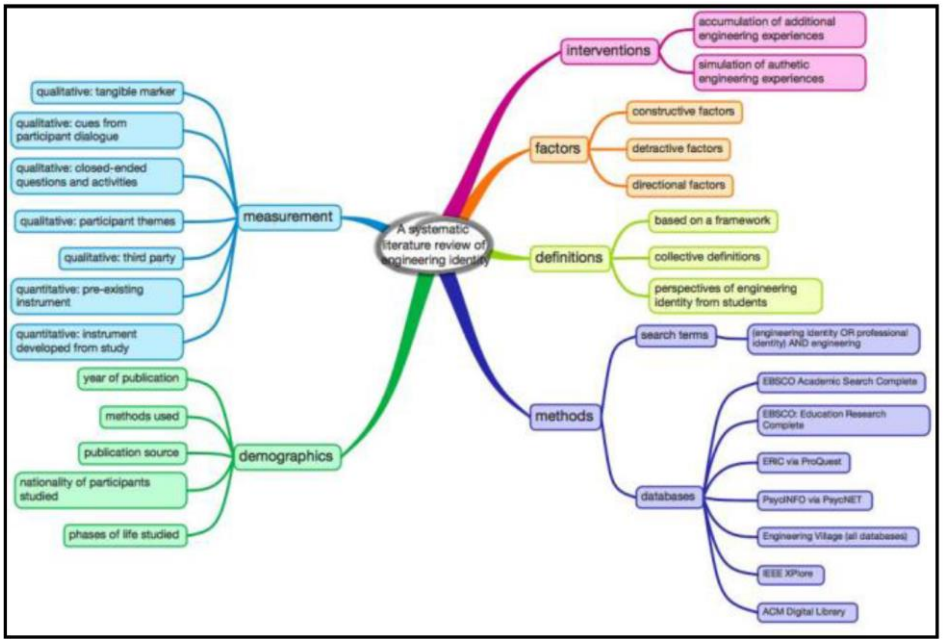


Fig. 7.1 Mind Map

challenge. Conventional teaching methods involve problem solving on boards as normal chalk and talk method it works only for a small group of students. In order to address the large class room visual techniques must be used as 65% of students are visual learners.

Conceptual mapping as implemented in this study has two major purposes. One is to help students gain and maintain an understanding of the overall conceptual structure of the course and, even more broadly, to see how and where the ideas in this course relate to other aspects of the engineering curriculum. The point is to help students avoid the sort of tunnel vision that can occur as students work on specific course tasks but never develop a

meaningful conception of what the course is about. A second, more focused map is used to help students organize their thinking and understanding of specific technical concepts. This study reports on how the maps were developed, used, and received by both students and the instructor in an engineering course. The techniques used to develop the
maps highlight collaboration between the engineering instructor and a cognitive scientist. We also solicited student feedback during the course and made adjustments in the map if these seemed warranted. The instructor referred frequently to the map, modeled its use in his own problem solving and thinking about the course ideas.

Concept analysis: In this, students have to analyze the concepts dealt in the class and build a mind map based on their understanding of the topics covered in the class individually in every hour of the class on daily bases. Group formation: In this the students in a group of four have discussions on the individual mind maps, gather all the information from different mind maps exchange views and the group has to come up with a master mind map comprising of the viewpoints of every individual in a team. A questionnaire survey was conducted to administer the effect of introducing mind map as a part of teaching learning. The entire class of 69 students was considered for this study. The questionnaire was conducted using 5 Likert scale. Question 1 reflects on the improvement on the memory in recalling, and in response 87% students agreed that relates to whether the students will use this learning technique in future for interactive learning. The questions are as follows:
1. Mind mapping is an effective tool to recall the technical concepts.
2. Mind mapping helps me to remember and recollect information better than note-making.
3. The images, symbols and keywords, found in mind maps, helped me dynamically relate with concepts.
4. There is clear connectivity and categorization of topics when I mind map.
5. Mind map helped me to collaborate with peers in the process of active learning.
6. Mind map enabled me to think on a specific concept in a wide perspective.
7. There was an increase in the confidence level, when I presented ideas on paper, learnt from mind mapping.
8. Mind map stimulates visual thinking.
9. In future 'mind mapping' can be integrated in all classes as a part of teaching and learning.
10. Mind map helped me to revise the course at the time of examination/test

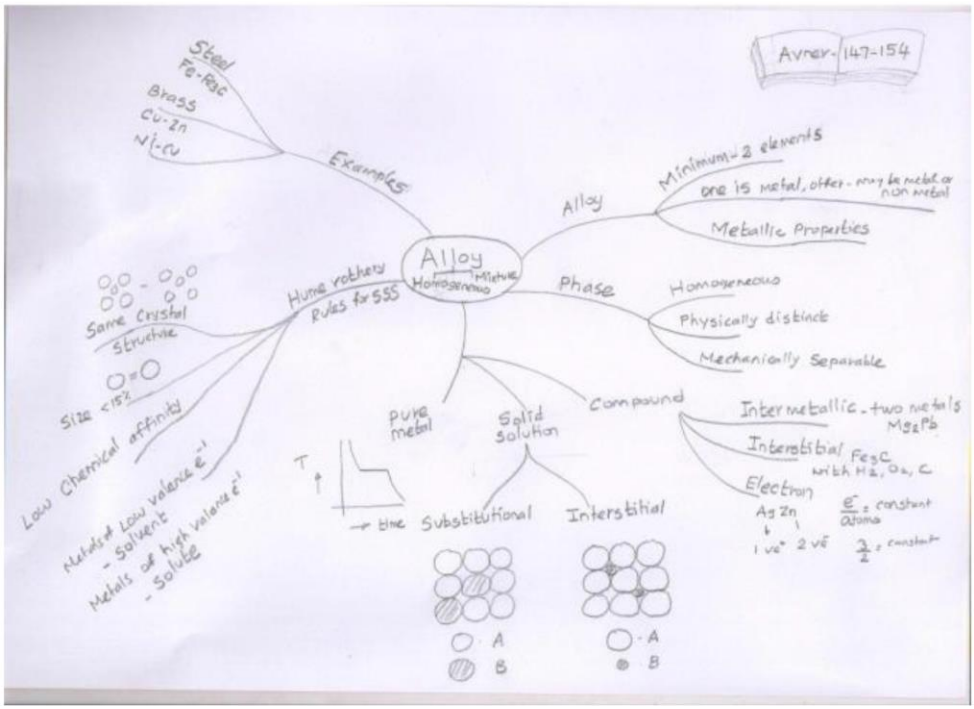


Fig. 7.2 Mind Map on Alloys

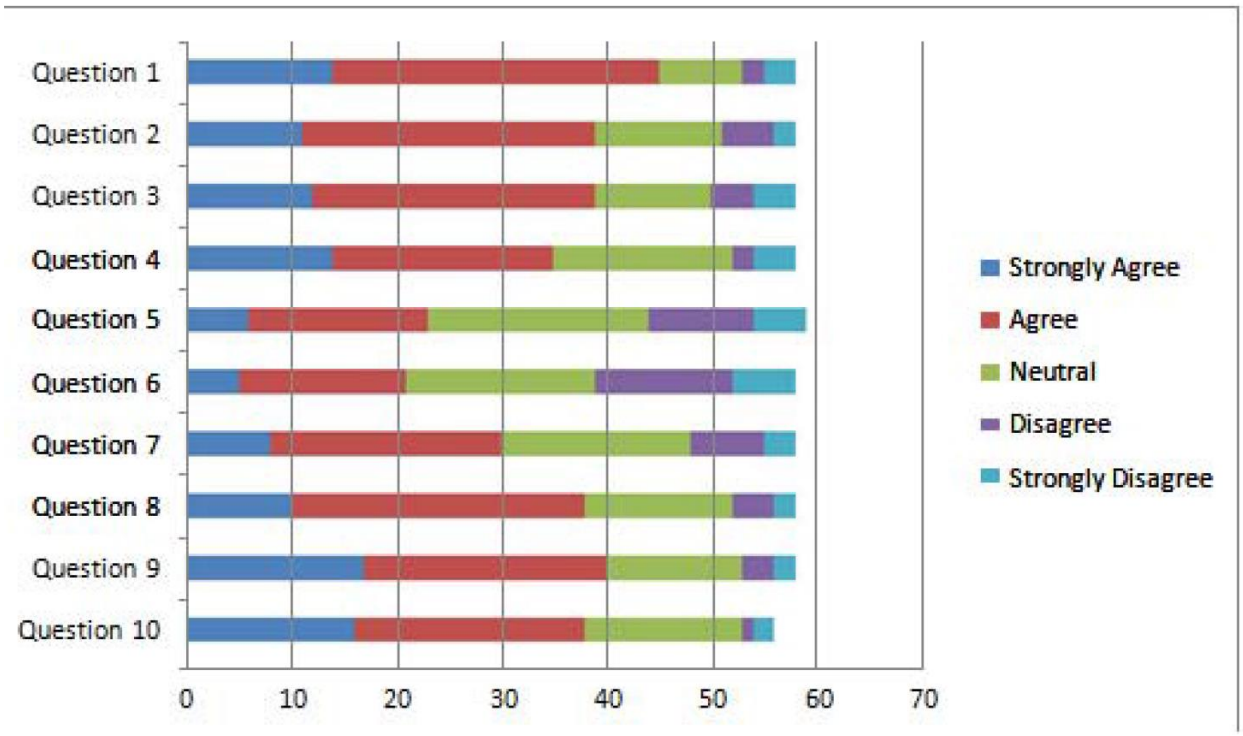


Fig. 7.3 Survey on using Mind map in the Classroom

7.4 Analysis and Interpretation

It was observed that the students were very responsive to the use of mind map in the class. Many students find writing difficult, and they find getting started the most difficult part of writing. Mind mapping reduces the difficulty by

giving students an organizing strategy to get them started. In mind mapping, ideas are freely associated and written out without pressure, thereby reducing tension and resistance often associated with writing. Although, it is one type of outlining methods, the product of the prewriting activity using mind mapping is notably different from the one using other type of outlining. Unlike conventional outlining, the product of prewriting activity using mind mapping does not follow a rigid fixed linear. In outlining, ideas must be arranged sequentially which is contradictory with the natural way of how brain works, because brain works in a nonlinear way. The elements of a given mind map are arranged intuitively according to the importance of the concepts, and are classified into groupings, branches, or areas, with the goal of representing semantic or other connections between portions of information. Mind mapping also aids recall of existing memories. Mind mapping may be used effectively with students beyond primary grades and in any class that requires writing. It is obviously appropriate for language classes. It is applicable for large groups. Teaching students how to use mind mapping takes about 10 minutes of demonstration time.

7.5 Conclusion

This section presents an effective learning technique in large classroom for the course Materials and Metallurgy and in this study it is observed that the students who used interactive learning technique that is, mind mapping found it easier to learn and visualize the concepts. As this is a collaborative learning technique the students were motivated to learn the course. Students who were not good in mathematics found it easy after using this technique as they could analyze the connectivity between different concepts. The most prominent positive outcome of the experiment is that over 90% of the students have clearly indicated that this has given them a very good opportunity to evaluate, work on and improve their ability for interactive learning. This interactive learning approach adopted has great impact in significantly improving the overall teaching learning process, encouraging the faculty and the students to extend the same to the relevant courses in the curricula program.

CHAPTER 8

ACTIVE REVIEW SESSION BASED LEARNING

For each exam, students are given a practice test with a set of problems a week in advance. They are encouraged to work on the practice test individually first and then in groups to discuss the answers. During the review session, the students are asked questions about the problems in the practice test and they are given the choice to decide which problems they want the professor to concentrate on.

CHAPTER 9

ACTIVE PRESENTATION BASED LEARNING

Students are asked to do projects and then to submit reports and give presentations. Each member of the group is required to give part of the presentation and during the presentation, the students are given the chance to have an open discussion and answer questions about their projects.

CHAPTER 10

FISH BOWL BASED LEARNING

Preamble: In a Fishbowl discussion, students seated inside the "fishbowl" actively participate in a discussion by asking questions and sharing their opinions, while students standing outside listen carefully to the ideas presented. Students take turns in these roles, so that they practice being both contributors and listeners in a group discussion. This strategy is especially useful when you want to make sure all students participate in a discussion, when you want to help students reflect on what a good discussion looks like, and when you need a structure for discussing controversial or difficult topics. A Fishbowl discussion makes for an excellent pre-writing activity, often unearthing questions or ideas that students can explore more deeply in an independent assignment.

Procedure

a) Select a Topic

Almost any topic is suitable for a Fishbowl discussion. The most effective prompts (questions or texts) do not have one right answer or interpretation, but rather allow for multiple perspectives and opinions. The Fishbowl strategy is excellent for discussing dilemmas, for example.

b) Set Up the Room

A Fishbowl discussion requires a circle of chairs ("the fishbowl") and enough room around the circle for the remaining students to observe what is happening in the "fishbowl." Sometimes teachers place enough chairs for half of the students in the class to sit in the fishbowl, while other times teachers limit the chairs further. Typically, six to 12 chairs allows for a range of perspectives while still giving each student an opportunity to speak. The observing students often stand around the fishbowl.

c) Prepare for the Discussion

Like many structured conversations, Fishbowl discussions are most effective when students have had a few minutes to prepare ideas and questions in advance.

d) Discuss Norms and Rules

There are many ways to structure a Fishbowl discussion. Sometimes teachers have half the class sit in the fishbowl for ten to 15 minutes before announcing "Switch," at which point the listeners enter the fishbowl and the speakers

become the audience. Another common Fishbowl discussion format is the "tap" system, where students on the outside of the fishbowl gently tap a student on the inside, indicating that they should switch roles. See the variations section below for more ideas about how to structure this activity.

Regardless of the particular rules you establish, make sure they are explained to students beforehand. You also want to provide instructions for the students in the audience. What should they be listening for? Should they be taking notes? Before beginning the Fishbowl activity, you may wish to review guidelines for having a respectful conversation. Sometimes teachers ask audience members to pay attention to how these norms are followed by recording specific aspects of the discussion process, such as the number of interruptions, examples of respectful or disrespectful language being used, or speaking times (who is speaking the most or the least).

e) Debrief

After the discussion, you can ask students to reflect on how they think the discussion went and what they learned from it. Students can also evaluate their performance as listeners and as participants. They could also provide suggestions for how to improve the quality of discussion in the future. These reflections can be in writing, or they can be structured as a small- or large-group conversation.

Variations

A Fishbowl for Opposing Positions: This is a type of group discussion that can be utilized when there are two distinct positions or arguments. Each group has an opportunity to discuss the issue while the other group observes. The goal of this technique is for one group to gain insight about the other perspective by having this opportunity to listen and formulate questions. After both sides have shared and listened, students are often given the opportunity to discuss their questions and ideas with students who are representing the other side of the argument.

A Fishbowl for Multiple Perspectives: This format allows students to look at a question or a text from various perspectives. First, assign perspectives to groups of students. These perspectives could represent the viewpoints of different historical figures, characters in a novel, social category (e.g., young, old, male, female, working-class labourer, industrialist, peasant, noble, soldier, priest), or political/philosophical points of view. Each group discusses the same question, event, or text, representing the assigned perspective. The goal of this technique is for students to consider how perspective shapes meaning-making. After all groups have shared, students can be given the opportunity to discuss their ideas and questions with peers from other groups.

CHAPTER 11

THINK-PAIR-SHARE

Preamble: Think-pair-share (TPS) is a collaborative learning strategy where students work together to solve a problem or answer a question about an assigned reading. This strategy requires students to (1) think individually about a topic or answer to a question; and (2) share ideas with classmates. Discussing with a partner maximizes participation, focuses attention and engages students in comprehending the reading material.

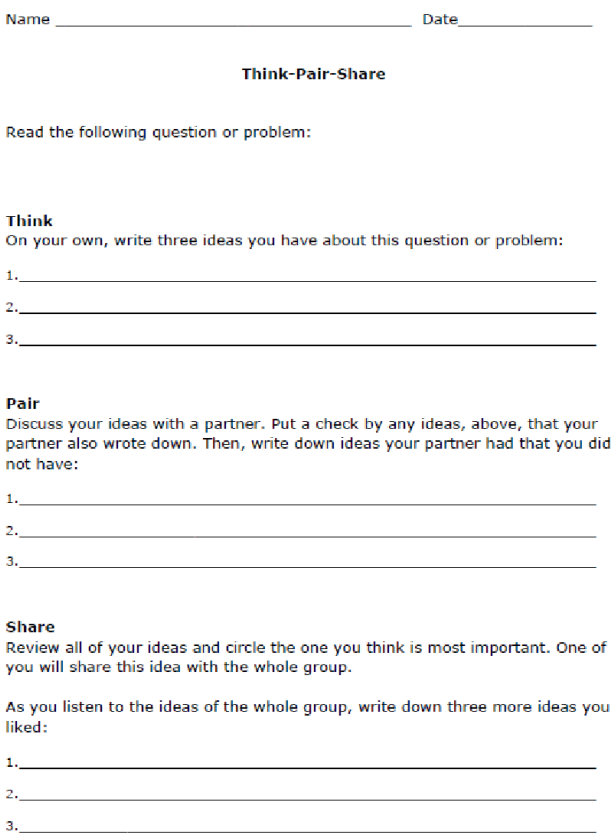
Alternatively, students are given a problem and are asked to analyze it individually (Think). Then, they compare their results with those of their nearest neighbour (Pair). Finally, the pairs present their conclusions to the whole class (Share). This enables the professor to determine students' understanding of a topic and to clarify misconceptions. Classes are more interactive and dynamic, enhancing involvement. Also, this promotes student reflection about concepts and problems

Why use think-pair-share?

- It helps students to think individually about a topic or answer to a question.
- It teaches students to share ideas with classmates and builds oral communication skills.
- It helps focus attention and engage students in comprehending the reading material.

How to use think-pair-share?

- Decide upon the text to be read and develop the set of questions or prompts that target key content concepts.
- Describe the purpose of the strategy and provide guidelines for discussions.
- Model the procedure to ensure that students understand how to use the strategy.
- Monitor and support students as they work through the following:



Name _____ Date_____

Think-Pair-Share

Read the following question or problem:

Think
On your own, write three ideas you have about this question or problem:

1._____
2._____
3._____

Pair
Discuss your ideas with a partner. Put a check by any ideas, above, that your partner also wrote down. Then, write down ideas your partner had that you did not have:

1._____
2._____
3._____

Share
Review all of your ideas and circle the one you think is most important. One of you will share this idea with the whole group.

As you listen to the ideas of the whole group, write down three more ideas you liked:

1._____
2._____
3._____

T: (Think) Teachers begin by asking a specific question about the text. Students "think" about what they know or have learned about the topic.

P: (Pair) Each student should be paired with another student or a small group.

S: (Share) Students share their thinking with their partner. Teachers expand the "share" into a whole-class discussion.

CHAPTER 12

STORY BASED LEARNING

(a) Real Life Stories

Course coordinators who do research have the advantage of drawing from that for their lectures and usually do that. the difference in using PBL or case study (CS) is that these examples are not used to illustrate the theory being taught, but rather as a tool to remember or apply the theory and can be presented when students have yet to gain knowledge of the theory being taught. Adding story elements to research problems, simplifying them, if needed is a simple and effective way to create a problem for PBL or case for CS.

Industry cases – if a problem already has a solution, but is still new, it can also be used as a case or a problem story, especially aiming at lower levels of Bloom's taxonomy. Students, analysing real life problems are not always able to present solutions by their own yet, but analysing lesser known solutions and presenting arguments for and against the method used is a good learning exercise.

News stories – to show that even the most fundamental theories have applications in real life, a sense of recentness is useful. Using news stories and adapting them to PBL and CS is a way to achieve that. Student engagement is increased by adding an emotional component and in recent news stories that is already present. Lecturers must keep in mind that these stories must be adapted to suit the learning outcomes, and the lower the year of the students, the more adaptation is needed.

Research papers - Analysing research papers can also be turned into a PBL activity and is already successfully used by CS practitioners. Not only does this show the students the real life of the problem, but can also be used as a tool to teach some scientific methodologies at the same time. With proper preparation and guidance, even students from first or second year can use research papers as cases, but they will need stricter guidance from the tutor during the process.

(b) Made up Stories

A more descriptive exercise – this is the most commonly encountered example in the author's experience and is very easy to use incorrectly. These types of exercises are used in schools as well as universities, and in many cases, adding characters to the exercise even more complicates the already hard to grasp concept. Simply adding a character with a name will not create an emotional context and might have an adverse reaction from the students. If the description of the exercise is not elaborate enough, it does not give the benefits of PBL or a case.

A typical practical situation – a lot of the subjects have such types of exercises. For example, beginners often encounter problems where the solution is using an amplifier; chemistry students have to find what kind of liquid is in the container and so on. Though these types of stories can become repetitive, the familiarity is reassuring for some students, especially at the start of the course. These types of stories strongly benefit from adding details of recent events or unexpected settings.

A complex story – the complexity of such stories come from not giving away the solution directly, or guiding the students in several directions at once. These are difficult to create, but both students and lecturers benefit the most from using them. Most research papers can be considered complex stories.

CHAPTER 13

MINUTE PAPER WRITING

Introduction

Students are asked to write a one-minute note (about the previous lecture, the homework or the material in general) to the instructor on a piece of paper. This provides a fast way for the teacher to have quick feedback on students' understanding of what was covered previously.

At the end of a class, course coordinators can ask students to write for a minute or two on one of the following kinds of questions: “What is the most significant thing you’ve learned today?” “What points are still not clear?” or “What question is uppermost in your mind at the end of today’s class?” Responses can help instructors evaluate how well students are learning the material. Student responses to the second and third questions also can help instructors select and structure topics for the next class meeting. Large numbers of such short papers can be read quickly, and a review of unclear concepts can take place at the next class meeting.

Alternatively

The professor asks a question related to the course, and students must write an answer in no more than 2 min. Responses are read anonymously, and feedback is given to participants. This permits tracking student progress regarding the understanding of the course materials

CHAPTER 14

JUST IN TIME TEACHING

Definition: Just-in-Time Teaching focuses on improving student learning through the use of brief web-based questions (JiTT exercises) delivered before a class meeting. Students' responses to JiTT exercises are reviewed by the instructor a few hours before class and are used to develop classroom activities addressing learning gaps revealed in the JiTT responses. JiTT exercises allow instructors to quickly gather information about student understanding of course concepts immediately prior to a class meeting and tailor activities to meet students' actual learning needs.

Preamble: Just in Time Teaching as a means to engage them in the designed activities; it was manifested by investing time to extend knowledge and promoting participation by reducing the affective filter. Students are asked to respond to one or two short questions posed by the course coordinator the day before a subject is to be taught. They submit their responses via e-mail or to a website. These responses give the course coordinator a good idea of what the students do and do not understand about the concepts to be considered. The course coordinator can then adjust the amount of time spent

on explaining the concepts, working through problems, or providing examples that will help the students learn and understand the concepts.

Implementation: The JiTT strategy includes a pre-class activity developed through a web-based exercise. There are different types of activities and they depend on the specific topic of study. The two most integral forms of JiTT exercises are warm-ups (designed to introduce new concepts and stimulate class discussion) and puzzles (designed to integrate various concepts and to assess student learning following their working with material). The purpose of the activities is to activate students' previous knowledge. Students should complete the proposed activities before class, in a learning management system (LMS), or as in the case of this study, through a web 2.0 tool. The teacher receives the answers to the activities just in time to address specific misconceptions, gaps in learning, and students' concerns about content. Micro group up to 10 is applicable to this approach.

Impact: Learners could publish their activities previous to class such as videos and paragraphs; as it was only one wall for all the participants, students were able to verify the publications from their peers on this web 2.0 tool. The teacher could observe all the students' answers towards the suggested activities and prepare the classes based on the answers posted on the website.

A Sample Example

JiTT - Fighting Recession: 2009

Context

This JiTT exercise asks students to apply and synthesize a number of macroeconomic concepts in a single context-rich problem that appears, at first glance, to be relatively large and unstructured. The underlying question is: How big did the fiscal stimulus package need to be to return the economy to full employment from a deep recession (depression)?

Learning Goals:

By the end of this JiTT exercise, students will be able to:

Apply multiple macroeconomic concepts to solve an unstructured problem.

Apply macroeconomic concepts to analyze political questions.

Analyze the linkage between macroeconomic policy actions and their impact on the economy.

Determine whether a given macroeconomic policy action is likely to solve the macroeconomic problem.

Teaching Notes

Background Information

By January, 2009 the U.S. economy had been in a recession for over a year (the NBER dating committee determined in early December, 2008 that the recession began in December, 2007). Even in January, 2009 the recession was viewed as one of the most severe in U.S. history, precipitated by large-scale failures in the banking/finance system that led to restricted credit, widespread loss of jobs, and a precipitous decline in consumer spending and housing purchases, which increased in volume during the latter part of 2008.

The basic ideas presented in the underlying essay are part of the standard course content in macroeconomics courses at the undergraduate level, both at the principles and intermediate level. The JiTT exercise can be structured in a variety of ways, depending on the level of the course it is being used in. General examples are suggested below:

Principles-level course - In a principles-level course the instructor might summarize some of the information provided in the essay (estimates of potential GDP, actual GDP, multipliers, fiscal policy recommendations) and ask students to determine whether the recommended fiscal stimulus would be enough to close the recessionary gap and to explain the reasoning behind their answers. An additional question could ask students to list issues that might cause the ultimate fiscal stimulus package passed by Congress to be larger or smaller than that put forward by Barack Obama or that would cause the recommended package to over/under-shoot the mark. Some items mentioned in the essay: differences in effects of tax cuts and direct spending on output, concerns about resulting deficits, lack of ready-to-go investment projects, political caution.

Intermediate-level course - Students could be asked to obtain data on potential GDP and actual GDP and calculate the recessionary gap or alternatively, find Congressional Budget Office analyses with current values and future predictions of these measures. Students could then use more sophisticated multipliers drawn from their textbook reading to estimate the amount of fiscal stimulus that would be needed (perhaps what percentage would need to be in direct spending increases and what percentage in tax cuts) and determine whether the recommended stimulus package is large enough to close the recessionary gap.

When to use in the course - This exercise would most likely be used after students had covered the basic ideas of actual and potential GDP, recessionary gaps, fiscal policy, and multipliers. Typically, this is toward the end of a standard macroeconomics course at either the introductory or intermediate levels.

Warm Up Question:

In early January, 2009 President-elect Barack Obama put forward a $775 billion stimulus plan intended to bring the U.S. economy out of a deep recession. According to economist Paul Krugman, about 60% of the Obama

stimulus plan consisted of public spending on goods and services, the rest consisted of tax cuts. The nonpartisan Congressional Budget Office estimated that economic output would "average 6.8% below its potential" during 2009 and 2010. The CBO estimates of potential GDP (nominal) for 2009 and 2010 were approximately $15,280 and $15,655 (in billions of dollars). According to economists, a dollar of public spending raises GDP by around $1.50.

1. Was Barack Obama's stimulus plan too large, too small, or just about right to bring the U.S. economy out of recession? Explain the economic reasoning behind your answer.

2. After completing this exercise, what questions do you still have about this topic?

Variations for different level courses

Principles-level: provide estimates of actual and potential real GDP for 2009 and 2010 based on CBO analysis, along with public spending multiplier.

Intermediate-level: have students obtain GDP data and public spending/tax cut multipliers themselves.

Selected Student Responses:

The student responses selected for viewing in class (along with a brief explanation of why that response was selected) from a principles-level course are shown below. A broader set of responses can be viewed using the link below.

Student responses selected for showing in class:

I don't understand these issues even though I do understand the question and I do try to follow the economic debate in the press. Based on an interview with Paul Krugman I heard recently, the stimulus package is not big enough to close the recessionary gap.

This will put the economy in the hole so much that it wouldn't have any effect on the economy. This whole stimulus package is a bad idea.

Only 60% of the $775 billion stimulus package will increase GDP. Thus GDP will increase by $697.5 billion. Given that the forecast recessionary/contractionary gap is $900 billion, the stimulus package will/will not close the recessionary/contractionary gap.

We know that the change in GDP is the autonomous change in expenditure x the expenditure multiplier. We have to figure out how much Obama's stimulus package will change autonomous expenditures. The question says that 60% of the package is covering "public spending on goods and services." 60% of 775 is $465 and this would lead to a change in GDP of $697.50. This wouldn't be enough to close the gap. What impact will the change in taxes

have? We don't know, therefore we don't really know if the plan will be big enough.

The Class that Follows:

In-Class Cooperative Learning Exercise

In groups, have students complete a cooperative learning exercise to break down this question into its component parts:

- Determine the recessionary gap.
- Use the provided multiplier to determine the output effects of the planned changes in government (public) spending.
- Estimate how much overall spending would be increased by the planned tax cuts.
- Determine the resulting overall estimated change in output due to the combined effects of the planned changes in government spending and planned tax cuts.
- Determine whether the estimated change in output will close the recessionary gap.

Alternatively, you could ask students to list the steps necessary to come up with the answer to the JiTT exercise. The steps should look something like those listed above.

At the conclusion of the cooperative learning exercise - Have students report out and comment on differences, if any, in responses. If responses are similar (stimulus package too small), continue with extension 1, followed by a similar reporting out.

Extension 1: Have students determine how large the stimulus package would need to be to close the recessionary gap (this might involve differences in composition of the stimulus package between spending increases and tax cuts).

Extension 2: Compare different stimulus packages developed in extension 1 and their effect on future economic growth (e.g. effects on deficits, composition of spending on government "consumption" (health care?) vs. government "investment" (e.g. bridges, education).

CHAPTER 15

BUCKET OF FUN

Preamble: In this assessment, various electronic components are written on a piece of paper and put into a cup. One component is drawn for each student and immediately, the student demonstrates/performs simple application in front of the other students. If they are stumped, course coordinator may ask questions. Online students can demonstrate the applications using any electronic packages.

An alternative could be scenario-based questions that require students to explain how they would handle the scenario (what questions they would ask, what tests they would perform, etc.).

This assessment can be used across disciplines, for example, a mathematics course coordinator could provide problems and ask the students to solve them in front of other students, chemistry faculty members could provide problems, ideas, and terms, ECE/CSE teachers could ask various generations of microprocessors/computers/evolution of ICs transistor, mechanical teacher can ask evolution of gears and its applicability in various vehicles.

CHAPTER 16

THREE MINUTE MESSAGE (3MM)

As a closing technique for class, students create a 3MM to synthesize the material and explain it to their partner. 3MM are posted online and students vote for the most effective message. The top five are shown during the next class, and students complete a reflective assignment that answers these questions: How does the explanation help us understand the topic in a broader societal way? How does this material relate to you and society in a relevant way?

CHAPTER 17

PROBLEM SOLVING VIDEOS

Introduction: Given a set of scientific principles and mathematical and computational tools, how do students go about answering a question, creating a design, and trouble-shooting an issue? Students record and watch themselves teaching a lesson and evaluate their own performance using a detailed rubric (provided in advance). Students set goals, based on the rubric results, to improve their own teaching skills. Being able to articulate and verbally explain a problem's solution is an effective learning exercise, as well as an effective assessment technique.

CHAPTER 18

SYSTEMS LEVEL DRAWINGS

Throughout the semester, students sketch out drawings for several systems and include factors that are important for controlling the behaviour of the system. A tutorial, rubric, and examples are provided to describe the drawings and how they are used. Through video feedback, particularly great examples are shared along with an explanation of why they were chosen.

CHAPTER 19

ANNOTATED TIMELINE

Students engage in the process of planning, researching, and choosing important items to include in a timeline. Submissions can be a Word doc, slide, short video, or hand drawn picture.

Students include at least 10 annotated items and additional non-annotated items. Content can include a mix of key individuals, political events, conflicts, ideas, movements, etc., or they can focus on a theme or a category. Students are expected to answer the who, what, where, why, and how in their annotation of the item but also the "so what?" question that justifies its presence on their timeline. Students write one paragraph per item.

CHAPTER 20

CONCEPT MAPPING

Concept maps are visual representations of information. They can take the form of charts, graphic organizers, tables, flowcharts, Venn Diagrams, timelines, or T-charts. Concept maps are especially useful for students who learn better visually, although they can benefit any type of learner. Concept mapping serves several purposes: Helps students brainstorm and generate new ideas. Encourages students to discover new concepts and the propositions that connect them. Allows students to more clearly communicate ideas, thoughts and information.

CHAPTER 21

ACTIVE REVIEW SESSIONS

Definition: Active review sessions help students prioritize the knowledge and develop the thinking skills will be required of them on the exam.

Preamble: By incorporating active and cooperative learning approaches during a review session, students are able to recognize critical concepts and better prepare for physiological problem solving.

Implementation: Begin the session using a "think/write, pair, share" (TPS) activity by asking each student to write down the five most important facts, theories, or concepts from the current section of the course. After a few minutes' students pair up with three other students and compare their answers.

Take a quick tally by listing topics on the overhead and noting the frequency in which they were cited by students. Then add in concepts that students might have omitted. Finally, rearrange the topics for students in order of

importance, and we discuss why these are critical topics to focus on for the upcoming exam.

Hand each group a transparency and ask them to generate two or three multiple-choice questions from the list of generated topics. The purpose is for them to take critical content areas and think about how the content might be used in an exam question. Each group then brings their questions to the overhead, and we collectively answer them. Micro group up to 10

Impact Analysis: By engaging students and making them responsible for summarizing, integrating, or synthesizing the information, students make visible to themselves and the teacher the depth of their knowledge. The review sessions help faculty in identifying content areas that needed attention, something that end of the semester course evaluations do not.

CHAPTER 22

PRODUCT BASED LEARNING

Definition: With product based learning, students create a product or service, using the knowledge gained in class to serve others.

Preamble: Product-based learning can promote positive attitudes, social interaction, and intentional learning in students while motivating them to achieve the intended learning objectives. Engage the students in applying what they have learned to a tangible product.

Implementation:

1. For example, students in political communication course learn how to use voter surveys and demographic analysis to understand voters' interests and how they will react to a candidate or public cause.

2. Demonstrate the process through the design and development of an educational software application. Micro group up to 10

Impact: Focus on product-based learning is how the students discovered what the client wanted and how their solution met the client's needs.

CHAPTER 23

HANDS ON TECHNOLOGY

Definition: Hands-on Learning is the process of learning by doing.

Preamble: Hands-on learning is more effective in helping students grasp what they're taught

Implementation:

1. Through laboratory experiments

2. Design and coding activities.

Impact: Allows Learning from Real Experiences.

CHAPTER 24

STUDENTS PRESENTATION ON LITERATURE

Definition: Presenting Literature Review in the Introduction and Discussion Sections

Preamble: Studying literature is like looking at the mirror of life where man's experiences, his innermost feelings and thoughts are reflected. Through literature, we learn the culture of people across time and space. We understand not only the past life of a nation but also its present.

Implementation: Project seminar / Technical Seminar/ Course Introduction Micro group up to 10.

Impact: Enhancing critical thinking. Fluency in writing through increased reading activity. Increasing confidence and ability to speak publicly.

CHAPTER 25

DISCUSSION BASED LEARNING

Definition: Discussion based Learning is a valuable pedagogical technique that can improve long-term knowledge retention when compared to the traditional lecture-based learning.

Preamble: Most people only recall 10% of information learned within just 72 hours in passive learning environments. Discussion-based learning can help to improve this retention rate up to 70%.

Implementation: Group Size: Mirco (1~10) The goal of a discussion is to get students to practice thinking about the course material. Role of the instructor is a facilitator. Instructor designs and facilitates the discussion rather than convey information.

Impact:

a. Increases students' interests and engagement

b. Provides Instructor with Feedback

c. Promotes Preparation

d. Develops Students' Speaking Skills

e. Controls the Classroom Environment

CHAPTER 26

SIMULATION BASED LEARNING

Simulation-based learning offers a wide range of opportunities to practice complex skills in higher education and to implement different types of scaffolding to facilitate effective learning. Simulation is a technique for practice and learning that can be applied to many different disciplines and trainees. It is a technique (not a technology) to replace and amplify real experiences with guided ones, often "immersive" in nature, that evoke or replicate substantial aspects of the real world in a fully interactive fashion. Simulation-based learning can be the way to develop engineering professionals' knowledge, skills, and attitudes, whilst protecting students from unnecessary risks. Simulation-based learning can be a platform which provides a valuable tool in learning to mitigate ethical tensions and resolve practical dilemmas. Simulation-based training techniques, tools, and strategies can be applied in designing structured learning experiences, as well as be used as a measurement tool linked to targeted teamwork competencies and learning objectives. It has been widely applied in fields such aviation and the military. Simulation-based education refers to the use of simulation software, tools, and serious games to enrich the teaching and learning processes. Advances in both computer hardware and software allow for employing innovative methodologies that make use of simulation-based education tools to enhance the learning experience. Moreover, thanks to the globalization of e-learning practices, these educational experiences can be made available to students from different geographical regions and universities, which promotes the development of international and inter-university cooperation in education.

Students in sciences, technology, engineering, and mathematics (STEM) have to deal with complex models of real-life systems. Regardless of whether these models refer to infrastructure systems, telecommunication networks, computer systems, or supply chains, STEM students need to receive specialized training to make informed decisions that affect complex systems with thousands of variables and interactions among there. Moreover, real-life systems are usually subject to uncertainty and dynamism, some of which are generated by the human component of the system. These aspects cannot be easily included in traditional analytical models, and typically require the use of simulation-based methodologies in coordination with other techniques, such as heuristic-based optimization and machine learning methods. As pointed out in the literature the use of simulation software, tools, and games facilitates the practical understanding of these complex systems and allows students to enhance their learning experience via the development of hands-on activities properly designed by their instructors.

Benefits of Simulation based Learning

Simulation based learning in an automatic control course allows students to gather hands-on experience and skills in different realistic scenarios. In the area of operations management and finance, simulation based learning facilitates the acquisition of quantitative-analysis skills among students without a strong mathematical background. Regarding e-learning, the additional challenges associated with teaching modelling and simulation to online students. They also provide some recommendations to overcome these challenges.

Case Studies

This section presents various case studies where serious games and simulation software have been implemented in different educational contexts. More precisely, the case of the University of Cantabria (Spain) is based on a traditional on-campus learning approach; the case of Universidade Aberta (Portugal) follows a pure online approach; while the case of the Universitat Autonoma de Barcelona (Spain) presents a blended approach. In addition, a fourth case regarding Trinity College Dublin (Ireland) has been included as well. It highlights some gender-related aspects to be considered when designing and implementing serious games and simulation software. Due to the present gender imbalance in the number of students in STEM studies, this last case is of special interest.

A case study at the Universidad de Cantabria (Spain)

The Universidad de Cantabria (www.unican.es) is a medium-sized university in Spain, with 12,000 registered students in graduate and undergraduate programs, mostly face-to-face taught. Electronic Engineering and Electrical Engineering are two different degrees, however, some first-year subjects are jointly taught, such as introductory programming courses. In this context, during the academic year 2006/2007, 37 students of Electronic Engineering and 48 of Electrical Engineering used a serious game to learn C-language programming during the first year of the grade. The gender distribution was 80% male and 20% female. The used software, developed by Universitat Politecnica de Valencia (www.upv.es), can be adapted to the learning of different contents. The game features a story plot where a submarine must accomplish a certain rescue mission. Questions about C-language programming are asked within the game, and the student must answer correctly for the submarine to keep advancing. In the first stage, the right answers are offered as feedback, so that the student can learn, or review previously learned contents. In the second stage, the student must answer further questions, however, the correct answers are not shown. In the third stage, there is an assessment within the game. The game was to be used as training for a test where the students should answer similar questions. However, the use of the game itself was not compulsory. The gaming had to

be done by the student in an autonomous way, outside the classroom, using their own resources or the university's resources available for students. The instructor could be contacted on demand for any query.

Free direct feedback given by game players was positive but scarce, limited to only a small number of students. The use of this game was discontinued after one academic year, as no noticeable learning results were observed, as well as no general attitude of interest towards it. The lack of interest was likely related to the fact that the activity was not considered in the assessment of the course. The instructor's view is that gaming activity should be tutored inside the classroom in order to have any impact on learning. Alternatively, it should be integrated with an online learning environment such as Moodle, so that the course coordinator can track the students' activity and progress. We also believe the poor results might be assigned to the game mechanics itself, as it is not actually related to the contents being taught, but merely a container for questions and answers that could be used for any topic.

A case study at the Universidade Aberta (Portugal)

The Universidade Aberta (UAb, http://portal.uab.pt) is a pure on-line Portuguese university offering university degrees over the Internet to more than 8,000 students located in different continents. An adapted version of the well-known Moodle (https://moodle.org) platform for e-Learning is used in most of their courses. This case study analyses the Advanced Optimization course in the Doctoral degree in Applied Mathematics and Modelling, during the time period from academic year 2015/2016 to 2018/2019 (4 academic years, one-course edition per year). All of the 5 to 8 students who take this module every year exhibit a strong background in Mathematics, although not all the students show a good background in programming and/or simulation concepts. Approximately 60% of them are male and 40% are female. Given that it is an online course, the students come from different Portuguese-speaking countries, such as Portugal, Brazil, Angola, etc. These students show a high degree of cultural heterogeneity and, of course, they live in different time zones, which explains why an asynchronous learning model is required.

In this course, students have to deal with complex decision-making problems that arise in real-life logistics, transportation, production, telecommunication, and financial systems. Most of these problems are large-scale and they include stochastic as well as dynamic components, which represent additional challenges for managers. During the course, students have to analyses different heuristic-based algorithms –implemented in programming languages, such as Java– that can effectively solve these problems in reasonable computing times. Simulation techniques are usually

integrated inside the heuristic algorithm in order to deal with the real-life uncertainty that characterizes some of these systems (Juan et al. 2015). Also, visual representations of the solutions generated by the algorithms are provided in order to obtain insights on how the different system components e.g., distribution routes in a multi-depot environment– interact among them. According to the different information sources used, that is, students' scores, students' opinions in the online forums about their learning process, and instructors' view of the learning process, it can be concluded that the use of simulation techniques and the visual representation of the solutions generated by the optimization algorithms were key factors to enrich and extend the existing theoretical background of the students so that they could link mathematical formulations and concepts to real-life applications in different fields. Although students in the course enjoy the possibility of learning new solving approaches that can effectively support managers during complex decision-making processes, they also acknowledge the methodological challenges associated with the design and code implementation of such algorithms, which usually require interdisciplinary skills in different areas, i.e., optimization concepts, advanced programming skills, and a good understanding of the specific application field (logistics, telecommunication, finance, etc.) as well as of the manager's utility function.

A case study at the Universitat Autonoma de Barcelona (Spain)

With over 30,000 registered students in more than 250 degrees (including both undergraduate and graduate programs), the Universitat Autonoma de Barcelona (UAB, http://www.uab.cat) is one of the largest and most prestigious universities in the area of Barcelona, Spain. Traditionally, UAB courses have been taught in a face-to-face modality. However, at present, the UAB also offers some degree programs which follow a blended learning paradigm via the support of online collaborative tools, such as Cisco WebEx (https://www.webex.com). Using this tool, students from any part of the world can follow the classes on-line and share their comments and questions with other students who are physically located inside the class where the instructor is lecturing.

One of these degrees is the UAB MSc in Aeronautical Management, which includes a course on theoretical and applied simulation. This case study analyses this master course, during the time period from the academic year 2013/2014 to 2018/2019 (6 academic years, one-course edition per year). The number of students per year ranges from 20 to 40, from which 65-70% of the students follow the course in a face-to-face format, while the remaining 30-35% follow the course online from South America. These students come with very different backgrounds, ranging from Aeronautical Management to Industrial Engineering or even Business Administration. About 70% of the students are male, while the remaining 30% are female. This course contains a lab in which students are requested to use simulation software, such as Simio (https://www.simio.com) and Cast (https://airport-consultants.com)

to model and analyses different scenarios in the context of airport and airlines management. For example, students can model a simple baggage handling system and monitoring how its performance evolves over time under different configurations. By varying the components of the baggage handling system and the available resources, students can obtain insight on how the process work and make informed decisions about the right number of resources (assistants, vehicles, etc.) to be assigned during the check-in and transportation stages. Similar analysis can be performed on the security-control point, the boarding process, the aircraft turn-around process; the aircraft evacuation process, etc.

The possibility of using modern simulation software to build their own models of the real-life systems allow students to promote their creativity and modelling skills, as well as their understanding of how these systems work and how they can be improved (in terms of some key performance indicators) by choosing the right set up, as confirmed by students' scores, students' opinions in the online forums about their learning process, and instructors' view of the learning process during several years of interaction with the described simulation tools and concepts. Moreover, the fact that modern software benefits from the object-oriented paradigm also facilitates the development of complex simulation models by simply using drag-and-drop actions on an extensive library of objects.

A case study at Trinity College Dublin (Ireland)

Traditionally, the number of female students interested in Engineering degrees is low. In the case of Ireland, women constituted only about 12% of the new entrants to engineering courses in the academic year 2017-2018. With the aim of attracting their interest in the STEM careers, in the last years, Trinity College Dublin, (www.tcd.ie) has held 6-weeks summer schools for groups of 10-15 female students of around 16 years old. Trinity College Dublin, with 17,000 undergraduate and postgraduate students, is ranked within the top 100 world universities in the 2017/2018 QS World University Ranking across all indicators. Within this context, the Department of Mechanical and Manufacturing Engineering developed and put into practice a tailor-made serious game for three years (2014-2017). The game is designed for the player to make a series of decisions required to manufacture hairdryers, e.g., the quantity to be manufactured, the selection of components considering aspects such as materials and suppliers, business strategies, etc. The main goal of the game is to show students specific job roles to enable them to envisage the type of work they might perform as engineers. The students' feedback collected by questionnaires showed that the most enjoyable diary activity in the summer school was the game, and in most of the cases, they continued playing at home. Nevertheless, further information about the capacity of the game to engage students in engineering careers has not been tracked.

When they designed the serious game, the mechanisms of cooperation and competition put in place were thoroughly considered given the different attitudes between male and female players, that is, women usually feel more comfortable cooperating than competing. In addition, students in pure competitive games do not benefit from the experiences and ideas of other colleagues. Nevertheless, competition is directly linked with the extrinsic motivation caused by a reward, as mentioned in "Introduction" section. An interesting element of the hairdryer manufacture game, which might have been the cause of its success in terms of popularity, is a newspaper where related pieces of news are released in a humorous tone. In addition, students can also release their own communications. This design component presents three advantages, i.e., to highlight the achievements of some players, which is related to the extrinsic motivation, to create the feeling of community, and to have fun, which both are related to the intrinsic motivation. In a second stage of the game, a more challenging version, requiring the application of engineering decisions is expected to be developed and used in the degree courses. The main goal is to avoid the loss of interest of students in the first years of Engineering, given the large content of foundation knowledge, without a straightforward application. Nevertheless, the development of the software is subjected to temporal and economic limitations, given that this type of activity is not seen as a priority, and there are not quantifiable indicators supporting their utility.

Discussion

Despite applied to different fields, target students and countries, the insights gained with each case seem to be consistent with the rest of the cases. In fact, recent literature addressing other case studies present well-aligned conclusions. For instance, like the cases of the Universidade Aberta and the Universitat Autonoma de Barcelona, Milosz and Milosz (2018) portray a case study in which simulation games are employed to train engineers in logistics-related concepts. Areas such as logistics, transport, and smart cities offer a clear environment where SE practices can be extremely useful in the training of new generations of decision-makers who do not necessarily have to certify a strong engineering background. Luna et al. (2018) tested the impact of integrating various learning strategies (i.e., simulation, serious games, case studies, and multimedia cases) in the curriculum of a Business Engineering course at the Universidad del Pacifico (Peru). Here, the use of simulation and serious games is guided by the instructors. They conclude that simulation games facilitate the development of students' analytical thinking, as discussed in the case study of the Universitat Autonoma de Barcelona.

In the field of marine ecology, Ameerbakhsh et al. (2019) used SE games to compare a student-centred (active) training approach with a teacher-led (passive) approach. The idea was to interact with a simulation game modelling a biomass production system. Then, by properly setting this model, the goal was to increase the sustainability of the marine environment. The study concluded that the participation of an expert instructor could significantly enrich the experience of the students with the simulation model and guide them better during their learning process. These results reinforce the idea that the instructor's support and guidance add value to the simulation-supported training process, as observed in the case study of the Universidad de Cantabria. Also, this conclusion is supported by Luna et al. (2018), who emphasises the fact that serious games need to provide goal-focused challenges for the users, and that the users should receive informative feedback from both the game and the instructor.

Many works mention the enjoyable learning experience and how the students feel more motivated when simulation and serious games are incorporated in their academic curricula, as highlighted in the case of Trinity College Dublin. Nevertheless, the adequate engagement of the students with these tools might require the recognition of the effort and time invested when students are assessed. In addition, they also contribute to reducing the gap between theory and practice, which in some STEM areas might be quite noticeable. This feature underpins the work of Reis and Kenett (2017), who present a set of storyboards to illustrate the potential of simulation in higher education when training students in a number of statistical methods.

Conclusions and future work

In areas such as engineering, science, technology, mathematics, and management, new generations of employees will require to deal with increasingly complex systems in their daily activities. Among many others, some examples of these systems are telecommunication networks, distributed computer systems, supply chains, civil infrastructure networks, transportation systems, etc. These systems are not only characterized by their large scale and the number of interactions among their components, but also by their levels of uncertainty and dynamism. Hence, it becomes necessary to train students accordingly and provide them with the analytical skills that they will need when designing, implementing, and using these systems. Simulation education software, tools, and games constitute an excellent methodological option to support instructors during the training process since simulation allows for realistic models that students can employ during their learning activities.

Among the many benefits provided by simulation education resources, their easy integration within blended and online courses is a remarkable fact that promotes their expansion and popularity among universities and training centres worldwide. In effect, simulation-based labs can be used by students located in different countries, universities, and degrees. This in turn facilities the development of interdisciplinary skills, teamwork abilities, and multi-cultural learning processes. Hence, we can think about simulation education as not only a popular educational resource, but as one that will still increase its presence in modern degrees' curricula.

The following research lines are aimed to be explored in the future; (i) an analysis of how simulation education tools are currently being used in blended and online education; and (ii) a discussion on how simulation education can also contribute to enhancing the learning and teaching experience in interdisciplinary master courses, where students show different backgrounds and skills.

Reference

https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-020-0181-y

CHAPTER 27

GAME BASED LEARING

Preamble: Games can be instantiated for learning as they involve mental and physical stimulation and develop practical skills - they force the player to decide, to choose, to define priorities, to solve problems, etc. Games can be social environments, sometimes even involving large distributed communities. They imply self-learning abilities (players are often required to seek out information to master the game itself), allow transfer of learning from other realities and are inherently experiential with the engagement of multiple senses. Gaming and simulation environments are excellent learning tools because they can replicate real contexts or even provide training situations that occur in very specific circumstances. Serious Games are specifically designed to change behaviours and impart knowledge and are widely used in training situations.

Game-Based Learning supports all forms of formal or informal learning which are supported by digital (or not) simulations, games, modelling, virtual and augmented reality, new interaction devices, toys and playthings. It is a multidisciplinary approach to research, theory, application, practice and validation in any level and any area of education. As such it covers areas like cognition, psychology, technology enhanced education, evaluation and assessment, multimedia and information technology.

For today's generation of young adults and their children computer and videogames are second nature to most. They identify with and embrace this medium.

Through games, learning is not confined to the acquisition of a specific tool but becomes rather a construction of a mental competency that might be useful in another context. The important thing is not what we think but how we think. Games require decision taking and force the player to decide, to choose, to set priorities. Games encourage people to gain important skills such as negotiation, planning and strategic thinking. Therefore, game players "learn to take right decisions: evaluate data, analyze situations, to revise the long-term objectives and then decide". Games can be good learning tools for certain students and teachers (in training contexts) as they are extremely effective for increasing student motivation and a powerful tool for the teacher in teaching-learning process.

Why Game based Learning

Games can be used to 1) reinforce concepts learned in class, 2) to create greater engagement with course material, and 3) to provide multiple methods of approaching course material. Games produce effective learning experiences, particularly, video games make the students ideal for education. Some of these include:

- **Interaction**-video games require a player to take part in order to play the game, unlike many learning experiences which allow the learner to take an inactive role
- **Risk taking**-video games provide a low risk environment in which to try different approaches to problem solving; if one approach does not work the player can simply try another
- **Agency-players** have an ownership in the outcomes and course of the game
- **Well-ordered problems**-video games present problems in a way such that the difficulty level of what the player must solve starts at an easy level and becomes progressively more challenging
- **Situated meanings**-all knowledge and experience in a video game is connected to the context in which the player finds him or herself
- **Systems thinking**-players of a video game receive information and undergo challenges that are always mindful of the context of the whole game; all the learning is connected to the entirety of the system; there are no parts that exist in isolation
- **Performance before competence**-players of a video game are taught skills that they use at a low level and practice over and over again until they achieve mastery at these skills

Implementation

Game-based learning uses games, whether virtual or physical, and game-like simulations/role playing to create learning experiences that can engage students and effectively teach classroom content. Game-based learning can take multiple forms depending on the needs of the classroom. These may include such formats as:

- Board games
- Card games
- Word games
- Video games
- Simulations
- Role-playing games
- Puzzles

We can break down video games further into adventure games, puzzle games, role-playing games, strategy games, sports games, and first-person shooter games. There are also numerous ways to classify board or card games into further meaningful subdivisions. Board games can be race games, conquest games, turn-based strategy, abstract strategy, and many others. Card games include matching games, trick-taking games, and so on. This list is by no means exhaustive, as different types of games are invented all the time. Some games, such as the card game Fluxx, even play with the conventions of games themselves; in these games the rules and goals of play change with nearly every player turn.

Game-based learning can be implemented at a range of levels, from simple game-like icebreakers that shake up the classroom environment to full-fledged classes being taught through a video game

The specific type of game used will depend on several factors, including:

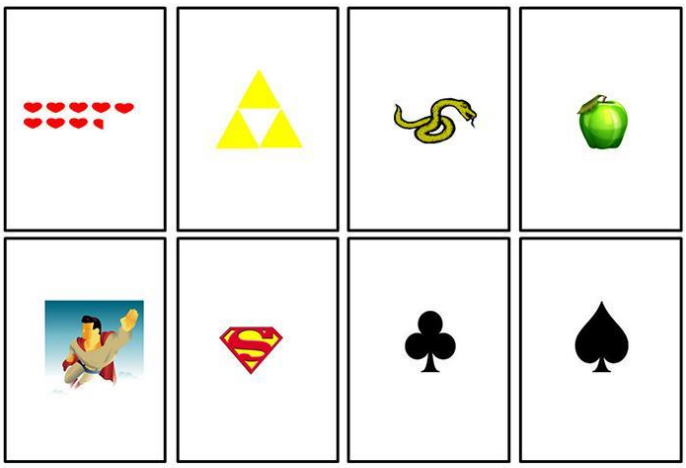
- Educational purposes
- Amount of time allotted and its place in the course
- Size and type of class
- Resources (budget, staffing, technology)

Some suggestions for linking the educational intent of the game to its genre:

- Card games—memorization, pattern recognition, drill
- Jeopardy-style games—quick responses, factual recall
- Arcade-style games—hand-eye coordination, visual processing
- Adventure games—problem solving

Example 1: Symbol Matching

A game-like exercise can be used as an icebreaker. First step is dividing the students up into groups and giving each group a set of 32 cards with different symbols on each one.



For this exercise, students are not given much guidance on what to do with the cards and they are simply told to impose an organizational scheme on the set in any way they choose. The cards can be matched up so that there are 16 pairs of cards that can be matched thematically (logos for Twitter and Flickr), symbolically (club and spade), and physically (left half of box matches with right half of box). Few groups of students match the cards up in exactly the way the pairs were set up. Some groups will match the cards into mixed groups of two, three, or four cards. One group created a story that utilized the content of every single card. Many of the symbols were intentionally chosen to have several meanings, and the importance of the exercise is to compare what the different groups propose. The ways in which people impose their own subjective meanings (the groups' organizational schemes) onto the same set of objective facts (the cards) can then be discussed from the example of the exercise.

Example 2: Hobbes Games

One example of the classroom uses of games to enhance student understanding of material is the Hobbes Game. In order to give students a feel for questions of ethics-Hobbes' concepts of the "state of nature" and "the war of all against all"-the students are pitted against one another with the object of securing a grade for the assignment. The game takes place in three stages:

Caucus

During the Caucus stage, the rules of the game and the procedure for playing are explained, any questions that the students have are answered, and the students are encouraged to talk over what a good strategy for getting the best outcome might be. Students are also encouraged to make any moral arguments they might make based on previous classroom discussions of ethics, including Kant and utilitarianism. Students typically talk together in small groups at this stage, and it requires a bit of effort to get them to address

the class with their ideas, but eventually a short discussion can be coaxed out of them.

Initial Grade Award

During the Initial Grade Award, students are paired up by using the playing cards distributed at the beginning of class. Each student is also given an index card. The cards are folded in half, and students are instructed to write their names on the outside of the card and once they have been paired up, they are asked to write either an A or a B on the inside of the card. They are not to allow any other student to know what grade they are writing. Then the instructor collects the cards from each pair of students and writes their names and grade on the board.

- If both players request an A, both will receive a 1.5
- If both players request a B, both will receive a 2.5
- If one player requests an A and the other requests a B the player who requested an A receives a 4.0. The player who requested a B receives a 0.0

Once all players have their names and scores on the board, the next stage begins.

Grade Readjustment

During this stage, any student is allowed to challenge any other student for their points. A challenger simply names the person they wish to challenge, and then assistance with the challenge is solicited. Any number of students can choose to assist either side of the challenge. A black Go stone is placed in a cup for every individual on the challenger side, and a white stone is placed in the cup for every individual on the challenged side. A student is then asked to draw a stone to designate the winning side. The losing side loses all of its points, which are then redistributed among every person on the winning side. Any fractions of a point beyond tenths, or above 4.0 are simply gone. Therefore, the longer the students challenge each other in order to better their own situation, the more overall points disappear from the system. Most students realize this is happening at least part way through the process and sometimes an equilibrium is reached. Of course, some students are still unsatisfied with their ending position and wish to continue challenging in order to get a better outcome.

At the end of the class, students are informed that those who are unsatisfied with the grade they "earned" through playing the game can improve it to a 4.0 by writing a short reflection paper on the game. Since almost all students do not achieve a 4.0 through the process of the game, Mr. Rice receives a large number of papers.

Finally, a portion of the next class period is used to discuss the lessons learned and reflections the students may have about the game. The course coordinator also asks about ways in which the game might be improved, made easier to understand, or more dynamic.

Example 3: Virtual Worlds Scavenger Hunt

To motivate students and encourage exploration, a simple scavenger hunt game in a set of virtual worlds for a class of first year may be introduced. The objective of the game was to introduce students to virtual reality. The online company Active Worlds allowed guests free access to dozens of virtual worlds. To play the game required some preparation on the part of the instructor, which involved visiting a number of worlds and looking for interesting things for the students to find. A list was created and points were assigned to the various items based on the perceived difficulty of finding them among all the various virtual worlds available to guest users. The students were placed into groups and asked to take screenshots of the items they found and place them in a collaborative Google Drive presentation. Here is an example of some of the items students were asked to find:

- Pictures of five different avatars in five different worlds (50 pts)
- List of possible dance moves (2 pts per dance)
- Picture of two signs in two different languages (neither one English) (25 pts +10 pts for each additional language)
- Picture of a cat (10 pts)
- Picture of a character from Sesame Street (50 pts)
- Picture of a non-human avatar (10 pts)
- Picture of an object that you have made, with your name on it (100 pts)
- Picture of a world from high up in the air (10 pts)
- Picture of two people talking with talk bubbles above heads (10 pts)
- Picture of sign saying "Welcome to Mars" (15 pts)
- Picture of fireworks (45 pts)
- Picture of yourself in 25 different worlds (150 pts)
- Picture of disco floor complete with disco ball (50 pts)
- Picture of your avatar in a vehicle (5 pts per different vehicle)
- Picture of your avatar in your own custom-made costume (50 pts)

Example 4: Virtual Library Orientation/Scavenger Hunt

With 100-200 students per semester needing instruction on how to use the instruction materials, it was impractical to attempt to fill this instructional need with face-to-face classes. So an online tour and scavenger hunt video game was devised to provide this instruction. The game involves a virtual tour of the physical spaces of the instruction material with 16 hidden "hotspots" with instructional content that must be found while looking through 360-degree panoramic pictures of the Library. Once all 16 puzzle pieces are found within the confines of the game, students are given the call number to a physical item that can be found in the IMC and asked to locate it to find its

bar code. The barcode is then used to provide access to a quiz that students take on the content of the game in order to prove that they have passed the orientation. Students are given the first two weeks of classes in which to accomplish this task and may do so at any time.

This game is very successful for a number of reasons. First, the quiz results show that students were at least as well educated about the offerings of the instruction materials as they would have been after receiving a traditional presentation. Second, no class time (or instructor time) is taken up as the students complete the objectives of the game. Third, the game not only provides educational content about the resources and services of the Library, but players can also see and navigate the physical spaces of the Library within the confines of the application. Fourth, the students are then asked to use what they have learned to retrieve a real item from the physical Library. Finally, the students enjoy the format of the virtual tour/scavenger hunt, as shown by comments left in a formative survey at the end of the experience.

This game and its content is also open source and available for other educators to use in any way they wish. The game files and instructions for adapting it for other uses can be found at http://guides.library.appstate.edu/games.

Example 5: Jeopardy Game Review

For the first few semesters of the class, students were generally reticent to ask many questions at this time, so the open review period was replaced with a Jeopardy style game with representative concepts and content that may appear on the final.

Students were given class participation credit for garnering points within the game and were encouraged to use their notes in class to assist recall. A simple JavaScript program to display the game board and keep track of student points was created and used specifically for this purpose. The program is free to use and can be accessed at http://guides.library.appstate.edu/games.

Ethics	Movie/Book People	Philosophy of Mind	Latin	Art	Fallacies
100	100	100	100	100	100
200	200	200	Scott	200	200
300	300	Joe	300	300	300
400	400	400	400	400	400
500	500	500	500	500	500

Scores

Scott 200
Joe 300

Fig. Online Jeopardy Board Game

Instructions within the file explain how to change the categories to suit the educational need. Students seem to be more enthusiastic and proactive about reviewing the material in class while searching for answers to the questions posed during Jeopardy.

Other Examples of Games

- Little Big Planet, Shaun White Skateboarding, Guardian of Light, and Uncharted 2 to teach concepts in an introductory physics class (Mohanty & Cantu, 2011).
- Jenga used to teach about oppression in an undergraduate social work class (Lichtenwalter & Baker, 2010).
- Using role-playing exercises in history classes (Beidatsch & Broomhall, 2010).
- Using a board game as a peer mentoring tool to enhance student success in a nursing program (Sulpizi, Price, Yetto & Burris, 2014).

CHAPTER 28

PROJECT BASED LEARNING

Preamble: Project Based Learning is a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge.

PBL Implementation

1. Needs to know: The teachers start an investigation with an introductory activity such as video, discussion, guest speaker, field trip while starting a project.

2. Driving question: A question which gives students a sense of purpose and challenge may be asked for a purpose.

3. Student voice and choose: The voice and preference of the student have a value to make project feel meaningful to students. Students can decide which products they will create, Students could even choose a project's topic and driving question.

4. 21st Century Skills: The project must support 21st century skills such as cooperation, communication, critical thinking and the use of technology.

5. Inquiry and Innovation: Students find project work more meaningful if they conduct real inquiry. In real inquiry, students begin with their own questions, leads to a search for resources and the discovery of answers,

6. Feedback and Revision: Formalizing a process for feedback and revision during a project makes learning meaningful. Apart from the direct feedbacks, the teachers may coach students in using rubrics or other criteria.

7. A Publicly Presented Product: Projects are more meaningful when students present their work to a real audience. The schools must provide support for presentation of projects.

CHAPTER 29

SMALL GROUP TEACHING METHOD

Group size, usually 3 to 5 participants and focus on active learning and communication between members of the group, define small group teaching. These sessions can occur in classroom, a conference room, an administrative office, workshop or even a laboratory. All that's needed is a room large enough for everyone to be to be able to sit and make eye contact. Tutorials, seminars, workshops, and lab classes are the traditional modes of small group instruction. Small groups can be effective in accomplishing many tasks:

- Introduction of new material/concepts (Basic science and/or engineering)
- Review of material
- Application of material
- Situation based formats for review, introduction, integration, or application or material
- Student centred discussions (e.g. tutorials, seminars, workshops, and lab classes)
- Team projects

Small group teaching offers students an opportunity to discuss and refine their understanding of complex issues, to engage in problem solving, apply their knowledge to new situations, and to reflect on their attitude and feelings. This method also provides an opportunity for the integration of domains, such

as professionalism, humanism, communication skills, and self-directed learning into the formal curriculum of engineering education. Finally, small group teaching allows for much closer contact with faculty than the traditional lecture approach.

Categories of small group teaching methods

The main categories of small group teaching methods include:

- Focussed discussions
- Problem based learning
- Student-led seminars, and
- Role-play

The Role of the faculty in small group teaching

In a small group teaching, the faculty member should view himself as a facilitator rather than as an instructor. The effective facilitator will accomplish the following task:

- Prepare, or assign preparation of material to be used
- Negotiate and check agreement on small group learning objectives and ground rules
- Facilitate small group activities and discussion
- Provide focus as needed
- Check that learning objects are attained and tasks are completed
- Troubleshoot problems in group dynamics
- Monitor the flow of the session and attend to time management
- Assess and give feedback on student performance

Advantages and disadvantages of small group teaching

Advantages

- Allows for participation of everyone
- Students are often more comfortable in small groups
- Group can reach consensus
- Easier to pool ideas and experiences
- Effective after a presentation, film, or experience that needs to be analysed
- Allows everyone to participate in an active process

Disadvantages

- Groups may get side tracked
- A few students can dominate
- Some students may not participate
- Need careful thought as to purpose of group.

CHAPTER 30

INQUIRY BASED LEARNING

This is a learning process based on inquiry or asking questions. Through asking challenging questions learners get intrinsically motivated to start delving deeper to find answers for these questions and in doing so they explore new avenues of knowledge and insight.

CHAPTER 31

DISCOVERY LEARNING

Discovery learning involves allowing learners maximum freedom within a resource-rich environment to discover answers to disadvantages. It requires learners to build upon background knowledge and utilize resources available in the environment to increase their knowledge base. Discovery learning is usually juxtaposed with instructor-centred approaches, as learners are not told all the information; instead, they must discover knowledge for themselves.

Advantages

- Learners generate knowledge for themselves rather than being told what is right and wrong.
- By discovering the facts, learners will have a firmer comprehension of the reasoning behind why something is real.

Disadvantages

- Too much learner freedom may distract learners from their goals.
- This can be a time-consuming technique as learners uncover information and learn at their own pace. It can, therefore, be challenging to implement in school districts that are packed with curriculum outcomes that must be met.

Implementation

- The course coordinator places the appropriate resources in the classroom to allow learners to discover knowledge and skills.
- The course coordinator transparently presents the lesson objectives to the learners (e.g., “What is heavier—sand or water?”).
- Learners are given minimal guidance but sent to the learning stations to try to answer the prompt themselves.
- The course coordinator provides minimal guidance, recognizing that making mistakes and trying the wrong thing is also a part of the discovery experience.
- Learners get together at the end of the class to discuss what they discovered.

CHAPTER 32

AUTHENTIC LEARNING

Introduction: As teachers, we are constantly searching for articles, books, or advice on how to make learning 'stick' with our students. In our classrooms, we want engaged learners who retain what they have learned and apply it in their lives for years to come. But how do we actually make this happen?

What can we do to ensure our students are getting the most out of every moment during school? There is definitely one surefire way to do this and it goes by the name of Authentic Learning. Not certain what that actually means? This section will cover what Authentic Learning actually is and how to use it in your classroom to create meaningful learning experiences for students.

Definition: In education, authentic learning is an instructional approach that allows students to explore, discuss, and meaningfully construct concepts and relationships in contexts that involve real-world problems and projects that are relevant to the learner.

Authentic Learning "is real life learning. It is a style of learning that encourages students to create tangible, useful products to be shared with their world."

Not only are we teachers bringing in real world context to our classrooms, but our students are taking real world issues and problems and working to solve them and developing solutions applicable to the world or community around them. This is the future of learning. Students will become adults in a world more complex than our own and will have to solve real world problems creatively and collaboratively.

Aspects of Authentic Learning

Now that you have an idea of the definition of Authentic Learning, let's dive into the aspects that make Authentic Learning what it is.

Learning as an Active Process

This means that students are not just sitting at their desks listening to lecture after lecture. This is not teacher directed learning. It is student-led learning where your class is up and moving and exploring the world around them. This could look like something as simple as taking a community walk, field trip or even virtually connecting with other students or relevant special interest groups.

Self-Directed Inquiry

If you are familiar with the Inquiry Cycle or Inquiry Based Learning, this will come naturally to your classroom. If not, this just means that the learning going on in your classroom is led by your students' questions and curiosities.

The questions they have will guide your lessons to exploring and researching the answers and promote independent inquiry in your students.

Problem Solving

Problem solving in this case refers to the real-world problems your students may be facing or witnessing in their communities or beyond. If you are familiar with the PYP this is where your student-led 'Action' comes into play. Social activism and justice can take the center stage in your classroom.

It may require higher level thinking from your students to go beyond themselves and see larger problems in their communities, however, students of any age are capable of accomplishing this. It is just necessary to give them the tools beforehand.

You can help guide your students by taking field trips to local charities or reading books about global problems. Here you can start to come up with actual solutions your students can create and promote to the community.

Reflection in Real World Contexts

Really focus on real world issues that garner an emotional connection with your students. Authentic Learning is about making learning meaningful and what better way to do so than to focus on your students and things that directly impact them or ignite passion in them? Find books, films, or pictures of children facing challenges or have students share problems they may know about or have faced themselves. Once students become emotionally invested in their learning that's when the learning sticks and continues to grow as they do.

Implementation of Authentic Learning

At this point you may be asking yourself "how do I apply this to my classroom? How do I make learning meaningful and authentic?" It all may seem a bit overwhelming and complicated, but it is a lot simpler than you may think.

Get to Know Your Students

Ask yourself these questions:

Where do my students come from?

What is the family dynamic/socioeconomic status/culture?

What does each student enjoy doing? Reading? Making? Watching? Eating? What beliefs do my students have?

The answers to these questions can be found by talking to your students. Observe them during play. Ask them these questions! Once you have the answers, it is easy to start bringing in material or lessons that make a connection with your students.

Get to Know Your Families

It's just as important to get to know the families of your students, as it is to know your students. Find out the answers to these questions:

Who makes up the family unit?

Where do they come from?

What do they do?

What do they enjoy doing together?

Get to Know Your Community

Really find out where your students are coming from especially if you are not from the area or are new to the area. Ask these questions:

What are the demographics?

What is your community known for or proud of?

What are some issues or problems facing your community in general?

Go through and experience your community as if you were one of your students. See it from their perspective.

Get to Know Your College and Yourself

Really take time to reflect on your personal beliefs about learning, about your community or about your students. Take note of what you believe is important and what your teaching philosophy is. Really ask yourself these questions:

What might be some outdated thoughts or practices on learning do I or my Institutions have?

What learning programs are already in place?

How can I change or work with them to make learning more meaningful?

What learning programs already support Authentic Learning?

What might be holding me back from implementing Authentic Learning in my classroom?

Getting to know ourselves as teachers and as people will help us to better connect with our students and make their learning more meaningful.

Our aim for this method of teaching is for teachers everywhere, in every type of institution, to begin to understand what Authentic Learning is and how to really connect with your classroom to make their experiences and learning truly meaningful to them. Once a child connects to learning on a personal level and can see how it relates to their world, the possibilities for growth are endless. It if you found something that speaks to you here and that you feel inspired to bring Authentic Learning into your own classrooms.