Instructional Note

Scaffolding systemic and creative thinking: A hybrid learning sciences-decision support approach

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ABSTRACT

Studies on critical thinking have often focused on the provision of guiding questions. However, in the inculcation of systemic and creative thinking, scaffolding has to extend beyond the provision of guiding questions. This paper aims to help students to think systemically and creatively by learning from examples and generating their own ideas without mechanically substituting from the examples learnt; guiding them to elaborate on their ideas meaningfully; and guiding them to consider other alternatives while maintaining associations between these alternatives (parts) to the goal (whole). Concepts from the learning and decision sciences are applied. Findings from a study on 123greetings.com indicate positive generation, elaboration, evaluation, reflection and association of concepts culminating in systemic and creative decision-making.

Keywords: Systems thinking, creative reasoning, decision-making, scaffolds
Introduction

Most students studying finance enter the working world without sufficient familiarity with the environment that they will be engaged with. This environment includes the challenges of dealing with imperfect information, complex tasks, and linking abstract theory to actual situations. Although much research has been done on this issue in other disciplines, limited research has been done in the finance area. Responding to this deficit, this research explores the applicability of authentic learning to finance education. Through scrutiny of, and reflection on, the project set for assessment in a finance subject, the importance and relevance of authentic learning is demonstrated.

Inculcating critical and creative thinking has become a top priority in school and university curricula around the world. For example, in the United States, the Partnership for Twenty First Century Skills (Greenhill, 2009) has specified critical and creative thinking, communication and collaboration skills and the ability to think across disciplines as desirable graduate attributes.

Examples of notable approaches towards the inculcation of critical thinking skills are those by Carrol (2007), Dunn (2007) and French and Tracy (2010). Carrol (2007) has used team-based role-play and assessment to teach students how to think critically in order to resolve conflict among teams, to understand more effectively how accounting information is used and to realize the consequences/impact of decisions made. On the other hand, Dunn (2007) has used the review of media reports to help students critically analyze how media influences viewers, the tourism industry and tourists. French and Tracy (2010) however, have asked students to interpret a problem specific to organizational theory and to develop their own arguments based on five sources of information, with the aid of a list of guiding questions. Subsequently, they summarize what they have learnt as well as the skills that they have developed. This self-reflection summary then contributes towards the students' graduate capabilities portfolio, which is accessible to the university and to future employers via Internet.

This study extends from the inculcation of critical thinking skills to the inculcation of systemic and creative thinking. We shall first consider lessons from the learning sciences, which form the foundational concepts to this paper; followed by key concepts from the decision sciences, implementation guidelines, findings and conclusion.

Foundational concepts from the learning sciences

Kolodner's (1993) characterization of creativity draws out the essence of creativity: creativity involves more than mechanistic, analogical substitution of elements. It is an incremental knowledge and skill refinement process, which requires goal-directed reflection and backtracking. Reflection and backtracking are central to inculcating creative thinking as they encourage the consideration of alternatives and consequently elaboration and evaluation of these alternatives in relation to the learning or task goal.

To scaffold goal-based contextual thinking, goal-based scenarios or GBS (Schank, Fano, Bell & Jona, 1993) is referred. GBS uses mission context. The mission context consists of themes that can be adapted into different cover stories with variations in situations, roles and challenges. These cover stories consequently, result in interrelated smaller missions structured from easy to difficult situations, roles and challenges.
Now that the learning goals have been clearly identified, case-based reasoning or CBR (Kolodner, Cox & González-Calero, 2005) is referred to help students to learn from examples. CBR encapsulates each set of problem-outcome-solution-success/failure and corresponding reasons as a case. Each case is indexed by situations in which the case can be used and retrieved based on the learner’s current goal. As such, it is projected that the more specific and cohesive the cases (prior problems-solutions) are, the better the quality of emergent solutions. Similarly, the more accurate the learner’s interpretations of the design/problem requirements, the more optimal the solution should be. CBR’s value is best seen when students are guided to access and assess information from multiple perspectives, creating cognitive flexibility or CF (Spiro, Coulsen, Feltovich & Anderson, 1988).

Once the goals and foundational knowledge have been acquired, the focus shifts to facilitating iterative and incremental reflection, search for alternatives and evaluations of these alternatives. Reflection is important because dialogic inquiry within positive social environments is more likely to result in the development of schematic associations and refinement (Couger, 1996; Csikszentmihalyi, 1996). These associations and refinements in turn, are deemed by Minsky (1975) and Rumerhart (1980) as foundational to constructivist knowledge building. This is because peers and experts will question and guide students to derive meaning through what may appear to be a maze of unrelated information.

However, the accuracy of the developed schema depends on the degree that the schematic representations are related to the schematic whole. Hence, Schneiderman (2000) suggests that students need to first realize that any dialogic inquiry should lead to the identification of systems and subsystems. Subsequently, they should reason critically to compare and contrast information, make decisions, and solve problems, principally by evaluating the parts in relation to the whole. Skyttner (2001) adds that systemic thinking does not merely associate parts to whole but also forces students to evaluate from three aspects: part, whole and the guiding principle for associating both, i.e. function or goal.

Hence, key contributing factors to creative thinking are:

a) *an open and encouraging playground*: positive social environment where original ideas/artifacts are sought, imagination, exploration of alternatives and elaboration of ideas are encouraged, in relation to the goal;

b) *framing and reframing of goals*: goal-based learning and case-based reasoning which then drives (and is triggered by) c);

c) *dialogic inquiry and systems thinking*: determination of systems and subsystems, interrelating between parts and whole, and the evaluation of parts and whole in relation to function and goal;

Having identified the key factors contributing to creative thinking based on lessons from the learning sciences, let us now glean insights from the decision sciences.

**Key concepts from decision support science**

Decision support is usually supported by a knowledge base. However, the methodology that taps into this knowledge base is even more crucial. Among the many problem-solving methodologies, Theory of Inventive Problem Solving (TRIZ) provides principles for making choices. Principles are needed because there is no problem-solving process or technique, which is applicable to all types of problems (Hicks, 2004). Furthermore, where problem-solving often focuses on correcting what went wrong (debugging), principles provide a means for questioning the “why” behind designs. Hence, with principles, the root problem can be addressed, and not just the symptoms. In other words, the methodology can structure the problem-solving
process, but it is the principles which will direct exploration and scaffold adaptation to different contexts.

The founders of TRIZ, Altshuller and Shapiro (1956), notice from their study of about 40,000 patents, that patentees use similar problem-solution patterns. Subsequently they generalize and transform these patterns into 40 principles. TRIZ methodology begins with the specific problem, then abstractize it to determine the general problem similar to the specific problem. Next, the solution to this general problem is referred to derive an adopted/adapted/created specific solution, which is suitable to the specific problem. Fundamental to this adoption/adaptation/creation process is working around constraints brought about by contradictions. Working around constraints/contradictions often means making tradeoffs between two possibly contradicting solutions. Resolving tradeoffs and making this tradeoff positively valuable can thus reveal novel solutions.

In this study, students are asked to learn from prior examples and thereafter generate alternatives through what-if analysis. Hence, students proceed from CBR to adoption/adaptation/creation. The process progresses from general problem to specific problem and then the specific solution is abstracted to a general solution to seek further alternative solutions. However, in TRIZ, the progression is from specific problem to general problem, then from general solution to specific solution. Thus, the proposed methodology and TRIZ are similar in terms of progression between general and specific. However they differ in terms of what is generalized and specialized and at which stage.

Furthermore, the strength of TRIZ mainly lies in its principles. This study however, allows a more exploratory process where students themselves determine the concept and subsequently diverge from there. TRIZ principles are not used in this study because this is the students’ first exposure to decision support and creative thinking/entrepreneurship. In addition, the focus was on helping students to use value proposition as the key concept for divergent thinking. Value proposition was also used in the later stages to evaluate proposed solutions in terms of feasibility and interestingness. In other words, value proposition was used to anchor the traversal from general to specific and vice versa while keeping a systems view of these traversal outcomes. Subsequent studies will utilize TRIZ principles to test its effectiveness in helping students in divergent and systems thinking along Hicks’ soft/principle-based approach.

**Learning objectives**

Insights from the learning and decision sciences will contribute towards the following learning objectives:

1) to learn from examples and to generate own ideas without mechanically substituting from the examples learnt;
2) to elaborate on ideas meaningfully;
3) to consider other alternatives while maintaining associations between these alternatives (parts) to the goal (whole).

Referring to the three contributing factors to creativity, the assignment creates an open and encouraging playground for exploration of ideas. What-if analysis is used within this open and encouraging playground, to help students to learn from examples and thereafter, to create their own adaptations or suggest new ideas. Drill-down analysis helps students to elaborate their ideas. Framing and reframing of goals guides students to associate between parts and parts and parts to the whole. Framing and reframing of goals comes about through an iterative deepening goal-based search, which looks for a feasible solution at every stage, given the constraints of the
environment at hand. First used by Lee (2009) to scaffold creativity, iterative deepening goal-based search is deemed suitable because it caters to dialogic inquiry and systems thinking.

**Implementation guidelines**

The students involved in this study are 20 groups of students taking the course TDS3281 Decision Support Systems. Each group consists of 4 students (students choose their own group members). The study is over a period of 3 months. Students have learnt that the motivation for decision support is the need to make informed responses to address dynamic business challenges. Strategies integral to decision support systems that they learnt in this course are those stipulated by Hicks (2004) and Turban, Aronson, Liang and Sharda (2005). These are: identifying the problem or opportunity, generating intelligence, designing, making choices and implementing. Identifying the problem or opportunity forms the mission structure (GBS), and the basis for designing is prior examples (CBR). What-if and drill-down analyses help when making choices.

Students take on the role of chief technological officer for a popular e-card website, i.e., 123greetings.com. Their goal (GBS) is to suggest strategies to increase revenue from the website. Scaffolds are as follows:

a) Generating intelligence:
   - **Scaffold:** Compare the technical features in 123greetings.com with 3 competitors (CBR).
   - **Activity 1:** Mark the features, which exist, as Strengths and those absent, Weaknesses.
   - **Activity 2:** Identify Opportunities and Threats from the above Strengths and Weaknesses comparison study to complete a SWOT analysis.
   - The instructor provides feedback on whether the comparison criteria and comparisons among competitors are accurate.

b) Designing:
   - **Scaffold:** Traversal between different levels of abstractions to:
     - raise the students’ reasoning abstraction from technical features to identifying the value that each new opportunity is adding to the business (which contributes to the goal of increasing revenue of the website);
     - help students generate alternatives at a higher level of abstraction (value level) and not just at the features level
   - **Activity 1:** Students identify the value behind each opportunity suggested. For example, the value behind connecting 123greetings.com to Facebook is social networking.
   - **Activity 2:** Suggest alternatives and solutions from the opportunities that they have identified (what-if analysis). Visualize the alternatives and solutions using a concept map relating each opportunity with how these contribute to the overall goal.
   - **Activity 3:** Evaluate alternatives in terms of feasibility (likelihood to overcome constraints) and interestingness (how much users will be attracted to the new feature) on a scale of 1 to 5. Rank the opportunities by averaging feasibility and interestingness score for each opportunity. Then, identify the top three ranked opportunities.

b) Making choices:
   - **Activity 1:** Identify and elaborate possible constraints to the implementation of the top three ranked opportunities.
   - **Activity 2:** Determine whether it is possible to overcome constraints identified earlier by carrying out a drill-down analysis.
   - **Activity 3:** Based on the drill-down analysis outcome, re-evaluate the ranking of opportunities.
   - **Activity 4:** The instructor provides feedback on the coherence of the what-if analysis and drill-down analysis outcomes.
Assessment criteria guide

Creative reasoning is evaluated based on five criteria consistent with the above-mentioned learning objectives: the number of new opportunities generated (non-mechanistic substitution), justification for the proposal (elaboration), degree of coherence between what-if analysis and drill-down analysis associations and degree of logical outcomes in the students’ conclusion (systems thinking).

Findings and discussions

The following subsections show examples of findings for the better performing (category A) versus the lesser performing (category B) group. Better performing students are those who are able to think of three or more than three number of new opportunities.

Designing opportunities/proposals

Table 1a and Table 1b show the number of examples adopted and the number of new opportunities generated for category A and category B groups respectively.

Table 1a.  
_number of adopted examples and new opportunities generated for category A groups_  

<table>
<thead>
<tr>
<th></th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
<th>G7</th>
<th>G8</th>
<th>G9</th>
<th>G10</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of concepts generated</td>
<td>0, 3</td>
<td>1, 3</td>
<td>1, 5</td>
<td>2, 3</td>
<td>2, 3</td>
<td>3, 3</td>
<td>3, 3</td>
<td>3, 4</td>
<td>4, 3</td>
<td></td>
</tr>
</tbody>
</table>

Table 1b.  
_number of reused examples and new opportunities generated for category B groups_  

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</tr>
</thead>
<tbody>
<tr>
<td>No. of concepts generated</td>
<td>1, 1</td>
<td>1, 2</td>
<td>1, 2</td>
<td>1, 2</td>
<td>2, 1</td>
<td>2, 1</td>
<td>2, 2</td>
<td>3, 2</td>
<td>3, 2</td>
<td></td>
</tr>
</tbody>
</table>

The groups with the highest adopted examples-to-new opportunities ratio for category A are G1, G2 and G3. On the other hand, for category B, the group with the highest adopted-new opportunities ratio is G12. Besides these 4 groups, 6 other groups generated more number of new opportunities than number of adopted opportunities.

Interviews with all groups of students indicated that they seldom used other websites to generate their own ideas. However, they found that marking the presence of a technical feature as strength and the absence of a technical feature as a weakness to be useful as a means for comparative analysis. Most importantly, learning from examples in this way made sense to them.

Comparison between those groups, which generated higher number of new opportunities compared to adopted opportunities versus groups, which adopted higher number of existing opportunities compared to new opportunities and possible reasons are presented in the subsequent section.

Traversing between different levels of abstraction

Table 2 shows the number of adopted examples-to-new opportunities and corresponding concepts/values for the four groups with high adopted examples-to-new opportunities ratio.
Table 2.
Adopted examples-to-new opportunities-concepts/values for G1, G2, G3 and G12

<table>
<thead>
<tr>
<th>Adopted opportunities</th>
<th>New opportunities</th>
<th>Concepts/values</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>- internationalize appeal &lt;br&gt;- integrate with social networking sites, &lt;br&gt;- integrate with video sharing sites</td>
<td>- diversify internationally &lt;br&gt;- promote socialization &lt;br&gt;- promote socialization</td>
</tr>
<tr>
<td>G2</td>
<td>Free newsletter subscription to remind users about the website offers or updates &lt;br&gt;(concept: constant virtual presence in users’ daily lives) &lt;br&gt;- send real paper cards once the virtual card has been chosen and enable payment via credit card or PayPal &lt;br&gt;- sell real flowers as a service by itself or to complement the real paper cards mentioned earlier &lt;br&gt;- popular tags</td>
<td>- make full use of possible complementary services – one-stop portal &lt;br&gt;- make full use of possible complementary services – one-stop portal &lt;br&gt;- highlight what others like, &lt;br&gt;- saves browsing time</td>
</tr>
<tr>
<td>G3</td>
<td>- create a multi-cultural website &lt;br&gt;(concept: cross-cultural appeal to cater to all culture, religion &amp; language) &lt;br&gt;- create user accounts to predict what users will like &lt;br&gt;- add chat or forums to communicate with the web administrator &lt;br&gt;- cards can be in graphic, animation, video or audio form &lt;br&gt;- connect to social networks e.g. Facebook, MySpace, Hi5 &lt;br&gt;- add simple and interesting games and reward the user with e-points to buy e-cards to attract the users to keep coming back</td>
<td>- understand the users’ preferences better &lt;br&gt;- communicate directly – speed up improvement &lt;br&gt;- cards don’t always have to be graphic – different media can be more expressive &lt;br&gt;- increase traffic through existing popular means &lt;br&gt;- reward gamers so that they feel proud for winning the points</td>
</tr>
<tr>
<td>G12</td>
<td>Customers can customize the message &lt;br&gt;- allow customers to design their own cards &lt;br&gt;- can be accessed by other devices &amp; social networking sites</td>
<td>- customize cards with own pictures, video, sound &lt;br&gt;- increase traffic</td>
</tr>
</tbody>
</table>

From Table 2, it becomes apparent that all groups with high adopted examples-to-new opportunities ratios were able to identify the underlying concept/value that the new opportunity can offer to 123greetings.com. Next, we look at groups which have number of new opportunities lesser than number of adopted opportunities, i.e. G10, G12, G15, G16, G17, G19 and G20 (Table 3).
Table 3.
Adopted-new opportunities-concepts/values for G10, G12, G15, G16, G17, G19, G20

<table>
<thead>
<tr>
<th>Adopted opportunities</th>
<th>New opportunities</th>
<th>Value propositions</th>
</tr>
</thead>
<tbody>
<tr>
<td>G10 - advertising, online shopping links  - Website security  - photo galleries (concepts: earn money; security; convenience and trends; sharing photos and ownership)</td>
<td>- sharing cards with social networking sites  - mobile e-card  - game e-card</td>
<td>- promote the website and disseminate the website’s name  - convenience &amp; flexibility  - unique, interesting &amp; attractive</td>
</tr>
<tr>
<td>G11 - make use of festivals to promote website  - customize messages (concepts: not specified)</td>
<td>- option to self-design or use ready-made</td>
<td>- by allowing import or storage of e-mail contacts, related festivals &amp; important dates</td>
</tr>
<tr>
<td>G15 - use chatrooms to create user profile  - enable membership to retain loyalty (concepts: not specified)</td>
<td>- use social networking sites to send e-cards</td>
<td>- gave examples of types of chatrooms</td>
</tr>
<tr>
<td>G16 - change design &amp; layout periodically (concept: prevent boredom)</td>
<td>- enable self-design</td>
<td>- could not specify</td>
</tr>
<tr>
<td>G17 - downloadable ringtones  - MMS (concepts: more expressive)</td>
<td>- mobile e-cards</td>
<td>- more expressive</td>
</tr>
<tr>
<td>G19 - tighten network security about viruses and spam (concepts: not specified)</td>
<td>- add organizer to the website  - self-design</td>
<td>- reminders – more convenient  - personal touch – humor</td>
</tr>
<tr>
<td>G20 - additional servers to increase speed  - offer high quality animated e-cards for sale  - expand search features (concepts: fast loading and response speed, additional profit, quick finder by classifying based on category and occasion)</td>
<td>- add customization tools e.g. add own voice, own photo, own layout, own color  - mobile e-card</td>
<td>- make the site interactive, attractive and useful  - access from mobile devices e.g. iPhone, Blackberry etc.</td>
</tr>
</tbody>
</table>

Findings in Table 3 indicate that G11, G15, G16, G17 and G20 were able to successfully elaborate from the proposed opportunity but were not accurate or were not able to identify the value that their proposed new opportunity would provide to 123greetings.com. Furthermore, some of the new opportunities that were proposed tended to be similar to that of other groups’.

Hence, there appears to be a link between the ability to traverse up a level of abstraction (from new features to be proposed to the value underlying these proposed new features) and the ability to propose original new opportunities. In order to guide students to consider other alternatives, what-if analysis is carried out. Findings are presented in the next section.

**What-if analysis and ranking of opportunities**

Example of what-if analysis by a group, which generated high new opportunities (G1)

G1 students were able to identify the concepts/value propositions underlying their initial proposed new opportunities. For example,

**Opportunity: Reach more people internationally**

**Concept/value: Diversification through localization (Translating the service into different languages, and hosting some of the service in areas with highest interest) and International advertising online (by using services like AdWords provided by Google the advertising potential for web sites and regions would be maximized).**
After what-if analysis, they added 2 other new opportunities: personalized cards and printable cards. After evaluating each of the 5 opportunities based on feasibility and interestingness and averaging the combined scores, they decided that the top three opportunities that they would venture into are: integration with social networks, integration with video sharing sites and personalized cards. Reasons for their ranking were:

*We cannot pursue improvement internationally at the moment due to lack of capital and staff. Although, the most important opportunity from the business point of view, it would not be very interesting to explore since it would involve mainly administration. Printable cards should not be explored in this time period because they involve entering another field: publishing. Once again, that would involve a lot of paperwork and administration as well as other legal procedures in order to make sure that no intellectual property rights are being violated.*

For the sake of contrast it is important to mention the contradictions which students identified as not viable enough to consider tradeoff. Firstly, promotion of brand internationally: this would require at least 3 full time persons traveling extensively. The persons would need to be experienced and would need to know what they are doing. This would also require setting up things like a trademark and registering with various authorities in the region: authorities that may not always be lenient. Secondly, printable cards: first a printer and all the necessary equipment would be needed, then the person who would set all the equipment up, another person who would operate it, and another who would maintain it, in addition to contact with vendors for both the hardware and the materials used.

*Examples of what-if by groups with lower number of new opportunities*

G10 managed to extend their proposed new opportunities to include Webcam greetings, personalize a party and links to related special services and links to online shopping portals. Compared with what was proposed initially, students backtracked to their goal, i.e., to generate more revenue. Hence, the root problem was how to attract users to choose another service that is related to the event that he/she wants to send a card for. The next question was what types of services would be attractive. This provided the basis for elaboration.

As illustrated in Fig. 1, they categorized the special services links into online consultation agent, online traveling agent and event planning agent. Subsequently, they elaborated on the types of services these agents should provide. Next, they evaluated their proposals based on feasibility and interestingness on a scale of 1 to 5 with 1 being least feasible/interesting and 5 most feasible/interesting. Consequently, they ranked photo gallery, online shopping and related special services links and update website with better network security as their top three new opportunities. Hence, what-if analysis did help the students to design, elaborate and concretize their ideas.
However, as for groups, which were not able to identify the underlying concepts/value that an opportunity offers to 123greetings.com, most of them came up with enhancements to their initial proposals after what-if analysis. For example, G15 suggested adding a web-cam to the chat rooms so that it would be real-time chat. G16 proposed inviting famous artists to contribute their designs to the website. On the other hand, G17 identified first the different types of industries and the types of e-cards that would most likely be relevant to them, and subsequently, MMS capabilities that can be improved in terms of performance and reliability. G19 proposed improvements such as, increasing the quality of resolution, and the network speed. G20 suggested using advertising on Facebook and creating a page in Facebook and support of different platforms in order to avoid excessive use of plug-ins due to the incorporation of various media into the portal.

From these findings, the possibility that there is a strong link between ability to identify concepts/values and number of original new opportunities is strengthened. Another finding came after interviews with the students. They realized the value of what-if analysis as it forced them to really look at what they had proposed and forced them to come up with better ideas in order to get better grades.

**Drill-down analysis**

The drill-down analysis helped students to gain insight into actual implementation issues such as financial and human resource constraints. Constraints/contradictions identified by G1 corresponding to opportunity proposed were lack of capital and lack of staff who are experienced in branding and intellectual property and willing to travel extensively (international branding), lack of expertise and possible violation of intellectual property (printable e-cards). After completing the drill-down analysis, they decided to retain their top three new opportunities, i.e., integration with social networking sites, integration with video sharing sites and personalized cards. The primary reason for choosing these three was that there is currently an up-trend in these three opportunities. Other reasons were:

- **Integration with social networking sites**: Interesting to make, only cost is time, can be maintained by current staff, social networking is very popular now
- **Integration with video sharing sites**: similar to that of social networking sites
- Personalized cards: It’s a challenge, would add a personal touch to the site and the cards, it’s not currently available everywhere

G10 students managed to successfully identify the constraints/contradictions for each of the top 3 opportunities mentioned above:

- big storage space and the cost incurred (photo gallery);
- attracting vendors to promote their online stores/shopping mall in 123greetings.com, creating a user-friendly user interface to help users navigate through the multiple online shopping links and cost (online shopping links);
- getting new ideas (related special services);
- getting developers due to budget constraints, contacting users who often use the website, hiring someone to follow other websites’ updates and updating web site security to prevent viruses and hackers as well as to secure customers’ privacy (update website).

After considering these constraints, this group of students decided to proceed with the opportunity ranked highest in terms of feasibility and interestingness but lowest in terms of the number of possible constraints, i.e. creating a photo gallery for users. They preferred to leave the other two opportunities to the next phases of development if there is available budget.

The above examples show that drill-down analysis successfully helped students from both category A and B groups to associate concepts more holistically, taking into consideration actual implementation issues and subsequently, possible re-evaluation of earlier decisions.

Conclusion

Minsky and Rumerhart’s schema theories are well established. However, not much is said about how to go about building schema holistically and about extending schema building to critical and creative thinking (two key desirable graduate attributes). This paper has presented strategies to inculcate systemic and creative thinking, as students propose alternatives, investigate, defend and revise their ideas in teams.

GBS formed the mission structure, CBR the basis for adaptation and a TRIZ-like process, the methodology. In CBR, SWOT analysis was used to identify strengths, weaknesses and new opportunities. In the TRIZ-like methodology, what-if and drill-down analyses were used. What-if analysis was successfully used to generate and elaborate on opportunities identified, as well as to evaluate these opportunities in terms of feasibility and interestingness. These activities have helped students to think more creatively by encouraging them to think of alternatives. Drill-down analysis was used to associate the outcome of the what-if analysis to their company’s current resources; thus identifying actual constraints/contradictions that are likely to occur during implementation. Findings show that these activities have successfully helped students to think more systemically and critically.
References:


