The study of teaching strategies to cultivate creative problem solving capability

Aiching Tseng
National Taiwan Normal University

Abstract
This study is related to some of the creative teaching strategies (such as problem-based, thematic, situated teaching, and goal-driven, etc. teaching strategy) to explore the elements (such as the styles of problem design, the discovery method of promising learners to explore the knowledge, and the solving problem method of learners to cooperate with others, etc.) Which cultivates student’s problem solving capabilities. To cultivate student’s problem solving capabilities, teachers should provide students with the opportunity to discover the knowledge and how to cooperate with others to solve problems. When they design the teaching strategies according to basic steps of problem solving and theories of problem solving processes including problems finding, causes analysis, assuming problem solving strategies, verifying problem solving strategies, and arrangement for concepts of problem solving.

Key words:
problem-based teaching, thematic teaching, situated teaching, and goal-driven teaching
Introduction

In the process of economic development of (Taiwan)R.O.C., Technical-Vocational Education (T.V.E.) plays an important role and cultivates lots of excellent practical professional human power. Totally, the main orientation of T.V.E. is to make students smoothly getting properly job. The big difference between T.V.E. and general education which takes more ratios on the basic academy is T.V.E. requires their students must reach the standard of the level of skills and expected to meet the needs of the enterprises. So, at the design of teaching activity, in addition to verbal modeling and rehearsal, it also needs more practice opportunities to compete with the trend of the enterprise. Scholars interest the issue recently. Since, in order to cultivate students with creative problem solving ability, what teaching strategy should be used by teachers during the class to adapt students’ characteristics except that the capability-based teaching orientation of vocational education which was used before.

In order to compete with the enterprises practical needs, except those students with skills can have occupation in the job market; the creative technicians are especially desired by the enterprises. It is said that the characteristics of creative technician are as followings: 1. Can master and develop the new tech in his/her fields. 2. Can pursue the real knowledge. 3. With the ability to solve the complex problem. 4. Have the attitude of better than others do in his/her own fields. 5. Can adapt his/her own direction through observation. 6. Can complete his/her work due time and make some evaluation. 7. Will notice the extended problems on others works. 8. Can understand the hint of the beginning problems. 9. Can always pursue the new directions. 10. Will use the newly methods to solve the problems. 11. Can pinpoint the problem and proceed the research individually. 12. Can cast him/her to some problems. 13. Filled with energy. 14. Specialize to use time. 15. Expected to have completely technical ability. 16. Can thoroughly do the research. 17. Always collects new information and resulted with properly conclusion. 18. Can develop assumption. 19. Can connect the past experiences with present work. 20. Can treat specials to general problem. 21. Active using theory. 22. With confidence and have his own insist on the professional conference. 23. Can excite colleagues to join the cooperation. 24. Can participate the professional group activity in his/her own fields. 25. Can accept others’ direction. 26. Won’t totally accept his/her boss’ advice. 27. Disrespect non-technician. 28. Requires for definite reason when the decision is changed. 29. Hope to get acknowledges effectively. 30. With the expected to be the director. (Kao-Chaio, 1993).

For cultivating the technician with creativity, capability-based teaching teachers should predict student’s learning goals and select properly teaching strategy according to students’ characteristics before designing the teaching activity. The goal for this teaching strategy to be reached should definitely express student’s ability level after learning. In the past, the goal and ability level was analyzed from the successful workers, in addition to, in the teaching items of T.V.E., such as ironmongery, auto-repair
industry etc., practical skills learning. The contribution of practical operation is pretty clear and so as to teaching evaluation.

For deeper realizing what related creative teaching strategies in the field of T.V.E., this paper tried from the directions of problem-based, thematic teaching, situated teaching and goal-driven to do the research of the elements of cultivating creative problem solving capability, such as problem scenario approach, discover approach to allow learners exploring and cooperative/collaborative styles for learners to solve the problem etc.. According to basic steps of problem solving and problem solving proceeding theory to explore if teachers design teaching strategy to cultivate students creative problem solving capability through problem finding, cause analysis, problem solving assumption, problem solving assumption verified to provide opportunity for students’ properly guide, knowledge exploring and problem solving cooperation/collaboration.

**Related creative teaching strategies**

- **Problem-based teaching strategy**

  Peterson & Treagust (1998) mentioned how to use problem-based teaching strategy to teach student-teachers teaching basic science. They develop three knowledge base components, such as science content knowledge, curriculum knowledge and knowledge of learner to design problem-based learning’s problem scenario and comprehension, transformation, instruction, evaluation, reflection and new comprehension six aspects as pedagogical reasoning model.

  Problem-based learning needs students to find related information with problem according to facts, concepts and principle which already known and to discuss them in group by case. Through discussion to clear problem’s inner and field and to take different information collected strategy. During the proceeding of discussion, what kinds of information are needed, can definitely solve the problem and promote over present knowledge. Since, in this kind of learning, students must prepare many different prior knowledge and problem-related background. There are proceeding steps as following:

  1. Find out the problem, make its terms and concepts cleared but not do a deep comprehension (the purpose is to understand students’ prior knowledge).
  2. Define the problem, verify if it’s a general problem for students.
  3. Find out the related literatures, proceed independent analysis and research individually.
  4. Describe systematic discovery instruction, return to step 3 to ponder the problem usually.
  5. Learning goal regulated.
  6. Collect more information from outside and combine new knowledge.
  7. Conclude new-acquired information, clarified knowledge field. Restarted from 1st step if there were any new problem generated during the proceeding.

  After all, problem-based learning concentrated on student-center and group discussion. Students' prior knowledge in the teaching processing engaged extremely important parts.
Thematic teaching strategy

Boyle & Trevitt (1997)’s through thematic teaching strategy plan to strong students learning quality. Research thought to integrate teaching and learning elements to develop learning skills of whole life education is important. Such as connection with students past experience, structured teaching proceeding and expectation, high related teaching materials which was related to students experience, practice in the real situation and as student-center. The research insists that teacher is not only an instructor, but also designer and facilitator of teaching environment. There are characteristics as following:

1. Learning’s goal and value must be discussed and communicated with students, for example, when and where will have learning needs.
2. It must be clearly communicated about what thematic teaching materials, information, and teaching strategy will be needed during the proceeding of teaching activity.
3. Select and develop planned learning activity to stimulate students’ interest and promote pursuing realized and developed high level learning outcome (such as critical thinking).
4. Select learning materials (thematic contents) with high related to students’ interest and real situated experience. So students can apply learned to real work situation after graduated from school
5. Through the interaction among students, active-experience, multi-information tunnel, self-director, and personal responsibility to encourage students learning.
6. Significant feedback (such as teachers to students, among students, and students to teachers) to form the methods of learning and learning needs and to respond it in the content of thematic designing.
7. Execute method of evaluation should help learning, appropriate reach the goal of thematic, and complete students intended learning types and levels.
8. Help students clearly understand the thematic’s education theory, purpose, and needs of evaluation. It is also included what should be reached about their learning achievement level and evaluation standard.

The origin of thematic teaching has been requested from democratic society. The main characteristic included multi. In order to let learners can include multi, learners should understand that they can connect with others in the real world because the share of experience and knowledge (Erickson, 1995). Thematic teaching strategy can also unite many kinds of related academic knowledge to make students bringing themselves into concluded teaching units. Across subject teaching, changed traditional teachers’ role and status and made students to think that learning is a sharing, meaningful, and student-centered teaching principle. It enforced at critical and creative thinking, students’ active participation, and course’s relationship, concept connection with others and no more segments (Cook & Dehart, 1996, Wood, 1997).

Situated Teaching Strategy

Vygotsky (1978) mentioned that according to his social concept of cognition. Knowledge is situated and some parts of it are belong to activity of application and the product of social and culture. So he intenses
that learning should exist and proceed in the real situated. There are some teaching methods as following:

1. anchoring situated learning

Brandsford et al. (1990) according to the aspect of problem scenario and some related concept had taken a series of developed program. In this program, teaching was anchoring in a general situation. There are a lot contents and enough for students to explore the concept, find the problem, and solve the problem..

2. Cognitive apprenticeship instruction

As anchoring situated learning, the teaching method of cognitive apprenticeship instruction tried to put learners into a problem-solving scenario. In the beginning, teachers will define the problems for students and demo there solving methods. Gradually, more and more responsibility of problem solving is transferred to learners. The model of master-apprentice exhibited that apprentice was immersed in the problem solving scenario from the beginning (Collins, Brown, & Newman, 1989). Apparently, the aim of cognitive apprenticeship instruction is an exploring learning method with modeling, teaching, rehearsal, and students speak out what he had learned and extended what he had learned.

Above all are learning methods of collaboration and problem solving. The role of teacher in this teaching strategy was coaching, guiding, advising, and facilitator, etc. Among them, the main task of facilitator was recording by the side and provides his/her direction when students needed to be helped. In the evaluation, the point is building personal file, the evaluation learning outcome, understand the path of cognition and if learning can be transferred (Choi & Hannafin, 1995).

Autonomous and experiential learning, cognitive apprenticeship, etc. situated teaching strategy intenses the importance of situated learning training and problem solving in daily life. Situated teaching strong requested that knowledge and skills learning were acquired from real life environment, in addition to new knowledge learning should build on the basis of old knowledge. It’s the kind of planned learning which under teacher’s supervision. For example, in the designing of computer aid teaching, interactive teaching method makes students are able to learn the choice and integration of knowledge. In the learning of language, first, introduce it with real thing and learning from daily life. Second, explain it with picture then student voice with language. At last, transfer it by abstract sign and describe with writings. Collins, Brown, & Newman (1989) revealed that learner follow instructor or professional long term learning in a real scenario. Besides deep observation, imitate master’s experience and behavior, and have the opportunity to experience the complete situation further to construct his/her own learning experience and develop new knowledge and skills. Obviously, situated learning require student to learn in the real scenario, through the active exploring and experience learning, share, and interactive participation are important to student.

- Goal-driven Teaching Strategy

Goal-driven teaching strategy is one of teaching strategies ask active and strategic learning proceeding for learners. Learner follow task goal clearly to identify learning goal and try according to goal, ability,
and opportunity in the environment, through a reasonable decision to pursue properly learning activity. Goal-driven teaching strategy, in the learning proceeding, through learning goal to lead learner’s learning behavior. It is also a teaching strategy, which arranged learning information and selected appropriate learning method, or produced properly learning opportunity so as to make students can proceed their learning and reach the task of learning. Except that, goal-driven teaching strategy must appropriately describe the following questions (table 1):

<table>
<thead>
<tr>
<th></th>
<th>Analysis of Goal-driven Teaching Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What’s the goal?</td>
<td>● The relationship between goal and antecedent learning &amp; logic include task, problem's answer, needs description, the concept of learning goal, learning strategy, and aims. Since, the meaning of goal-driven learning is decided by learning proceeding to the application of goal.</td>
</tr>
<tr>
<td>2. What is the kind of goal?</td>
<td>● According the task and environment within the scope of learning research to identify how's their relationship between different kinds of goals? And how to form different effect to each other?</td>
</tr>
<tr>
<td>3. How’s goal’s effect to learning?</td>
<td>● What triggers the goal and how to complete and affect learning is considered by the goal-driven teaching.</td>
</tr>
<tr>
<td>4. What’s the practical meaning for the goal-driven teaching strategy?</td>
<td>● The effect which is predicted by the model with the meaning of examining and confirming the goal-driven learning. ● With the meaning of practical applying materials and teaching environment design.</td>
</tr>
</tbody>
</table>

The goal-driven learning imply students actively to search the goal of learning. It tries to excite student's learning ambition from their learning goal. It is the module of learning proceeding from building a clear learning goal. Obviously, The teacher's role has transferred from early instructors to facilitator. They have to watch the student's learning behavior and take a necessary director in time. So, teachers are responsible to plan a learning activity and arrange the learning context in advance to provide student with enough learning opportunity. To use student's prerequisite ability to reach the predicted learning goal. The teacher's teaching activity changed from traditional active lecture to full understand their students, learning materials, learning proceeding, and learning context in advance. To use adaptive teaching style, design the learning proceed and activity, provide student for self-learning. The purpose is to let student taste the pleasure of success during the learning proceeding. The basic educational ideal of goal-driven learning is to recognize the value of self-learning and to maintain or excite their learning interest and desire. During the proceeding of student's activity, decide learning goal, and to reach the learning goal, through self-ideology and self-decision at no time to conquer the difficult of learning and acquire the satisfaction of self-success and complete the individual learning.
Related creative problem solving ability

According to the meaning of above teaching theories, it can be found that the whole wave of teaching strategy following the democracy thought wave aimed to the center of students' prerequisite knowledge. As scaffolding’s educational theory, to connect students' prerequisite to the new and old knowledge connection. Through the team discussion, the model of companions' learns to build new knowledge theory frame. The elements of cultivate students' problem-solving ability can almost be concluded as followings: a. The problem scenario approach. b. To allow learner to explore new knowledge discover approach. c. Learners as a cooperation/collaboration approach to solve their problem.

1. Problem Scenario Approach.

A1: Open: Problem appear can be adapted at any time.
B1: Confined: The problem is within the certain scope, it can not be tuned.
C1: Semi-confined: Under certain conditions, it can have some selection.

2. Discover approach.

A2: Goal Discovery: The purpose of problem solving is very clear, the prompt of procedure or method is as less as possible.
B2: Guided Discovery: The purpose of problem solving is also very clear, the pre-prompt of procedure or method is given.
C2: Semi-Guided Discovery: The purpose of problem solving is also very clear, the prompt of procedure or method is given when it is needed.

3. Cooperation/Collaboration approach

A3: Collaborative: To work separate but problem solving with cooperation.
B3: Cooperative: To work and problem solving together.
C3: Collaborative/Cooperative: both of all.

The different creative teaching strategies and possible selection of problem solving approach as arranged as following (Table 2).

<table>
<thead>
<tr>
<th>Problem-based Teaching</th>
<th>Problem Scenario Approach</th>
<th>Discover Approach</th>
<th>Cooperation/Collaboration Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thematic Teaching</td>
<td>A1 Open</td>
<td>A2 Goal Discovery</td>
<td>A3 Collaborative</td>
</tr>
<tr>
<td>Situated Teaching</td>
<td>C1 Semi-confined</td>
<td>C2 Semi-Guided Discovery</td>
<td>C3 Collaborative/Cooperative</td>
</tr>
<tr>
<td>Goal-driven Teaching</td>
<td>B1 Confined</td>
<td>B2 Guided Discovery</td>
<td>B3 Cooperative</td>
</tr>
</tbody>
</table>

Table 2: The analysis of different creative teaching strategies and possible selection of problem solving approach
From table 2, it can be found that goal-driven teaching is belong to B1 confined and can not be adapted. Problem-based teaching and thematic teaching are belong to A1 open, the problem appear can be tuned at any time. Situated teaching is belong to C1 semi-confined, under certain condition, it can be selected in the problem scenario approach to cultivate students' problem solving.

To allow learner to explore new knowledge discover approach, thematic teaching and goal-driven teaching are belong to B2: Guided Discovery: The purpose of problem solving is also very clear, the pre-prompt of procedure or method is given. The problem-based teaching is belong to A2: Goal Discovery: The purpose of problem solving is very clear, the prompt of procedure or method is as less as possible. The situated teaching is belong to C2: Semi-Guided Discovery: The purpose of problem solving is also very clear, the prompt of procedure or method is given when it is needed.

As learners use cooperative/collaborative approach to solve problem. The problem-based teaching belong to A3: Collaborative: To work separate but problem solving with cooperation. The goal-driven teaching belong to B3: Cooperative: To work and problem solving together. The thematic and situated teaching are belong to C3: Collaborative /Cooperative: both of all.

In addition, from the basic model of problem solving, It can find that the proceeding of problem solving includes: Find the problem, Cause analysis, possible policy to the problem, verify the policy, analysis, problem solving, new problem etc as following (figure 1).

From the teaching strategy to cultivate students' creative problem solving ability find that if it is needed to give prompt and guide more at the steps of finding the problem, cause analysis, possible policy to the problem, and to verify the policy. Then the creative problem solving teaching strategy has been used less. In converse, the more open for the steps of finding the problem, cause analysis, possible policy, and to verify the policy, then has more the creative problem solving teaching strategy. From table 3 can find that at the step of level 1, since finding the problem till verifying the policy needs teacher's prompt and guide, it is impossible to cultivate student's creative problem solving ability. In return, since finding the problem till verifying the policy are open at level 5, students can explore as much as they can, it is possible to

![Figure 1: The basic frame of problem solving proceeding](image-url)
cultivate student's creative problem solving ability.

Table 3: the relationship between different teaching strategy and student's creative problem solving ability

<table>
<thead>
<tr>
<th></th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem finding</td>
<td>Guided</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td>Cause analysis</td>
<td>Guided</td>
<td>Guided</td>
<td>Open</td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td>Possible policy to the problem</td>
<td>Guided</td>
<td>Guided</td>
<td>Guided</td>
<td>Open</td>
<td>Open</td>
</tr>
<tr>
<td>Verify the policy</td>
<td>Guided</td>
<td>Guided</td>
<td>Guided</td>
<td>Guided</td>
<td>Open</td>
</tr>
</tbody>
</table>

Although problem-based, thematic, situated, and goal-driven teaching strategies are related with the teaching strategy of creative problem solving ability. When to use the prompt, the guide, and the open approaches during teaching, and at the proceeding of problem solving (such as finding the problem, cause analysis, possible policy to the problem, and to verify the policy) to give students more opportunity to explore, the students' prerequisite knowledge and thinking ability should be concerned. This research suggests that the timing of the problem-based teaching applies when students have more prerequisite knowledge, higher thinking ability, and they don't need a guide. The effect of learning will be much better. The goal-driven teaching strategy should be used when students have middle or lower prerequisite knowledge and middle thinking ability. The guide and some prompts are needed. The situated teaching strategy applies upon the students with middle prerequisite knowledge and higher thinking ability, the guide is prepared but not need to be used. The thematic teaching strategy applies upon the students with lower prerequisite knowledge and middle thinking ability. The guide needs teacher's actively observation and provides prescription (table 4).

Table 4: The relationship between teaching strategy's applied and students' prerequisite knowledge and thinking ability

<table>
<thead>
<tr>
<th>Thinking ability</th>
<th>Lower</th>
<th>Middle</th>
<th>Higher</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Situated</td>
<td>Problem-based</td>
<td></td>
</tr>
<tr>
<td>Goal-driven</td>
<td></td>
<td>Goal-driven</td>
<td></td>
</tr>
<tr>
<td>Thematic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Students' prerequisite knowledge

Conclusion

It is needed to have prior knowledge to understand the problem and in advance to solve it (Jonassen, 1997). Among the problem solving teaching strategies, the methods of exploration have guided and goal oriented. When takes the guided orientation, even in short of prior knowledge can acquire prompts at any time. And if takes as the goal orientation, in short of prior knowledge, the students must explore by
themselves. It also proves that prior knowledge will affect the teaching result.
Thornburg(1992) thought that teaching design should be as student-centered. Teachers must provide students with systematic knowledge learning and the performance opportunity as learning by doing. The aim is to cultivate students' work ability in the future and the problem solving ability and to force the reservation, application, and acquisition of learned knowledge to reduce the distance between the theory and the practical. At last, hope that the cultivated person from schools just the man who is needed by the enterprises.

Reference


### About author:
Ai-Ching Tseng
National Taiwan Normal University
Email: aiching@ms32.hinet.net
Mailing address: 15, Alley 104, Lane 648, Ming-Hu Rd.
Hsin-Chu city, Taiwan, R.O.C.
Tel & Fax: 886-35203652