ACRONYM FOR “T. H. I. N. K.”

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Abstract
On February 11, 1998 ABC News presented a *Primetime Live* segment on the comparison of test scores of United States high school students with those of other countries. The results were embarrassing when U.S. students were compared with students in forty (40) other economically advanced countries. Overall, the U.S. students outperformed only seven (7) countries in the world! It turned out that our top students were only average in the analysis.

Surprisingly, factors such as class size, newer schools, more technologically advanced equipment, stricter discipline and slavish studying by the foreign students were not the reasons for their superior performance. The researchers from the *Primetime live* segment implied answer to improving the U. S. ranking did not involve less television viewing, more homework, better teachers, school uniforms and more passion on the part of students and teachers! Rather, the secret to exceptional student performance and learning in the United States will involve changes in what we teach and how we teach it! The conclusions from the *Primetime Live* segment stressed that we can learn from other countries in this regard.

This paper focuses on an innovative concept best represented by the key words of what and how we teach our students. It discusses a new problem analysis methodology developed to encourage another mode for student learning. The concept has been successfully applied to several Engineering Technology courses and received excellent reviews from the students who give witness to its effectiveness in helping them learn.

Traditionally, subjects are presented in terms of these are the rules, equations, procedures and methods for solving a problem. The underlying assumption implies that if students learn the applicable math and engineering expressions they now know the subject material. In reality nothing could be further from the truth for effective learning.

The “Turning Hunches Into New Knowledge” (“T.H.I.N.K.”) concept is unique in that it provides students with a comprehension of the concepts underlying the solution to a problem. It fits naturally into a class when new material must be presented. With "T.H.I.N.K.", the professor limits the initial formal lecture on the subject and then assigns the students a problem related to the new material. Students work in teams and begin to "T.H.I.N.K." about the unfamiliar problem and what is required to solve it. During this interactive and contemplative time students make a significant intellectual and emotional investment in obtaining a solution. Gradually solution ownership takes hold and becomes part of the student’s desires.
Students are then required to explain their analysis thought process during a general class discussion. Ultimately, comprehension of the underlying concepts of the rules, equations, procedures, and methods give students more confidence in and a better retention of the new material. These in turn serve as an excellent foundation for additional learning on the subject.

Introduction
Many faculty lament the high school educational experience of their students. They cite with each other concerns because students appear lacking in the areas of educational competence, intellectual curiosity, self discipline, acceptance of responsibility and overall maturity. For those teaching technical courses the frustration goes even deeper because students definitely do not possess a comprehensive problem solving methodology essential to engineering and science fields.

The predicament professors find themselves in necessitates they engage in “out-of-the-box” strategies for student learning to compensate for the educational deficiencies of their students. In an effort to address this situation a search was undertaken to determine which teaching method(s) would be most effective in assisting the students to learn new technical material.

During the search one of the authors viewed ABC News’ Primetime Live program and determined it addressed this exact subject. The segment compared the performance of United States high school students with those of other countries. The dismal results were amazing as noted in the abstract. A recent study by the Program for International Student Assessment arrived at the same conclusion. (1)

The authors then attempted to translate the findings highlighted in the Primetime Live program into a very practical and meaningful way for the Engineering Technology students at the University of Pittsburgh at Johnstown. The result of this effort required students to become actively engaged in real life learning by having them simulate problem solving methodologies they would incorporate after graduation when working in industry.

Initially the concept was employed only during classroom instruction but was later expanded to include homework assignments from material not yet covered in class. Students were asked to evaluate the “T.H.I.N.K.” concept from both the in class and out of class perspective. The results of this evaluation can be found later in this paper.

Concept Development
Initially, the challenge to develop the concept required that the students be familiar with it and then accept it as new learning model. The need for the rationale of student acceptance derived from the work of Dr. Spencer Johnson in his No. 1 Best Selling book entitled “Who Moved My Cheese?”. In that book he states, “Change that is imposed is change that will be opposed.” (2) Sensitive to this fact the authors choose not to simply “impose” the concept but rather seek student buy in by understanding the need for it as part of their learning experience. Determining how to obtain student buy in led to the conclusion of showing the Primetime Live video to each class during the first week of classes. ABC News was contacted and a copy of the actual video was purchased by the authors.
After deciding how to introduce the students to the video, the task became one of how to actually use it during class. Numerous specific examples of applying the concept were examined with their individual merits and demerits evaluated so those chosen could be included in the material. Since time is limited during class, discretion had to be used when the examples were selected for incorporation into the learning experience.

Since employing this concept was a work in progress, the instructors were always looking for ways to further enhance its effectiveness. About halfway through the semester the idea of furthering the utilization of the concept evolved after several discussions between the authors. It was decided that, in addition to the homework assignment for a specific day, the students were required to do the first homework problem of the next section dealing with material that had not been covered in class.

The thought behind this idea would attempt to ensure students came to class with some self-taught knowledge on the subject material. It was hoped that having invested mental energy in addressing uncovered material would result in students coming to class more prepared than they traditionally have been in the past.

**Concept Implementation**

During the first day of class the University requires several topics be discussed as to the conduct and grading of the class. Once completed the authors then extended the time to include discussion to the less than encouraging results of the United States students on the world-wide tests. The students are told they too are included, either directly or indirectly, in the results since they came from essentially the same high school educational experience as the students who took the international tests. Telling them this serves as a motivational technique since no one wants to think of themselves as second to others, especially to third world countries across the globe, who for a multitude of political and economic reasons cannot offer their students a high quality education!

The students then watch the Primetime Live segment which details the international examination results. No further comments are made on the video itself and it is then shown to the class. The video lasts about eleven minutes after which the students are asked to write down what one or two points stood out and amazed them. After they finish writing what impressed them, the authors go around the class having every student share what stood out to them. Consensus usually centers on several key points and these are further discussed. Also, students actually “see” themselves as part of this video because they connect with having come from the same United States high school learning experience portrayed in the program.

After this lively and interactive dialogue on what impressed them the students are motivated and determined to make sure their college learning experience does not mimic what and how they were taught in high school. The authors then ask the students if they want to be taught in a way which incorporates the best methods utilized in those countries which ranked highest on the international examinations. The response is nearly unanimous and this serves as the student buy-in so essential to the successful implementation of the T.H.I.N.K. concept. Incidentally, up until
now the word “T.H.I.N.K.” has not been explicitly discussed with the students. This comes in the next phase of introducing the students to the details of how they will be exposed to them with this new method of learning.

With the students choosing to be taught by a new method, the authors begin discussing how the “T.H.I.N.K.” concept will be implemented during class. With students making decisions and solving problems as an everyday occurrence, it was quite natural for them to be open to the new concept. First, students are told the “T.H.I.N.K.” concept involves being given a problem in general terms. Also, the problem is centered on material not yet covered in class. The students are then told they must “T.H.I.N.K.” about the problem individually for several minutes contemplating how they would attempt to solve it. Next, they discuss their idea with two other classmates trying to resolve any differences they may have with each other. The entire class then engages in a discussion on how the problem can be solved. The collective class wisdom produces a problem solving outline with no specific details or calculations. Once the outline is completed, the specific solution is produced on the board by the instructor following prompts from the class as they fill in details of how the solution can be obtained.

Second, the students are warned that while their current emotions and commitment are very high and positive, time will take its toll during the semester and they will yearn to be spoon fed similar to what happened in high school. They are told that, since they made the choice of utilizing “T.H.I.N.K.” there will be absolutely no returning to the traditional way of being taught. As a side note, it was necessary several times during the semester to remind the students of the choice they made regarding being taught this new way. They were asked to reflect on the Primetime Live program and encouraged to act as responsible and mature adults especially since their future livelihood and success in the engineering profession are directly related to how well they can solve problems.

Third, the students are given some very minor examples of how the concept will be implemented so they understand the model and how it will be used throughout the term. This step is critical since it begins to illustrate how they will encounter unfamiliar material and how the “T.H.I.N.K.” concept must be used to begin solving the problem facing them. An example used in Engineering Statics involves asking them to “T.H.I.N.K.” about what it would take for an object to be in and remain in equilibrium if an object was exposed to several forces. Discussion on what constitutes equilibrium and the arrangement of the forces to achieve equilibrium evolves to include elimination of rotation of the body.

After this example and the intellectual investment made by the students, the authors then discuss “teaching” versus “learning”. “Teaching”, for the sake of comparison, is defined as telling the students the conditions necessary for static equilibrium which the authors could have done in a few minutes without any student involvement at all. “Teaching” implies giving the students something they need to know like the conditions or formulae and then having them solve various problems using the information presented to them.

“Learning” on the other hand requires the students invest some personal intellectual energy to arrive at the same conclusion for the conditions necessary for static equilibrium. After having
spent time and energy, the students develop a curiosity about their observations and opinions which can only be satisfied by discussion with others, the class and the instructor. The goal of “T.H.I.N.K.” focuses on learning rather than teaching. The authors realize the difference between teaching and learning is only a matter of semantics but it is presented as this “black and white” comparison to help students understand their need to invest some intellectual capital if it is to be truly profitable to them. Another way of saying the same thing is that while it can be more time consuming, ideas that are reached through discovery may be more firmly grasped than those that are acquired through typical lecture or textbook. (4)

Finally, the students are told the “T.H.I.N.K.” methodology is a work in progress and they must offer feedback if it is to be successfully utilized during class. Since the authors also teach with “Student Learning Teams”, which was introduced to the students prior to any discussions on the Primetime Live video, the students are asked to come up with ways the “T.H.I.N.K.” concept can be used when they are studying together as a team doing the assigned homework.

Results
While soliciting informal feedback during the semester, a formal evaluation of the “T.H.I.N.K.” occurred at the end of the semester and will now be discussed. The actual evaluation form used is included as Appendix “A”. The questions in this evaluation were divided into three categories. The first was entitled “General Evaluation” since these questions focused on the overall concept of “T.H.I.N.K.”. The questions in this category are presented in Table 1 below. As noted in Appendix “A”, the scale for ranking ranged from “1” to “10” with the latter representing the most favorable evaluation of the question. The same ranking was used for Tables 2 and 3 also presented below. Sixty two students responded to the survey.

<table>
<thead>
<tr>
<th>General Evaluation Questions</th>
<th>Avg. Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>What was your impression of the “T.H.I.N.K.” concept based on the instructor’s presentation of it before you watched the NBC video?</td>
<td>6.29</td>
</tr>
<tr>
<td>What was your impression of the “T.H.I.N.K.” concept after you watched the NBC Dateline video?</td>
<td>7.83</td>
</tr>
<tr>
<td>Did you understand the need to employ the “T.H.I.N.K.” concept in Engineering Statics?</td>
<td>7.74</td>
</tr>
<tr>
<td>Overall, how well did the “T.H.I.N.K.” concept improve your ability to learn the material?</td>
<td>6.77</td>
</tr>
<tr>
<td>Do you feel utilizing the “T.H.I.N.K.” concept in your other classes would have helped you to better learn the material in those classes?</td>
<td>6.00</td>
</tr>
<tr>
<td>Overall, how would you rate the “T.H.I.N.K.” concept implemented during class?</td>
<td>6.90</td>
</tr>
</tbody>
</table>

Comparing the first and second questions in Table 1 clearly demonstrated the value of having the students watch the Primetime Live video. Closely tied to this result was the student’s definite understanding of the need to employ the “T.H.I.N.K.” concept in Engineering Statics where it received a ranking of 7.74. Question four in Table 1 shows the students felt the use of “T.H.I.N.K.” in the class helped improve their ability to learn the material.

The second category of the evaluation involved two questions dealing with using the “T.H.I.N.K.” concept in class. Those results are presented below in Table 2. In this category the students felt the “T.H.I.N.K.” situations presented in class were challenging. They also noted it
was somewhat difficult for them to “T.H.I.N.K.” about new subject areas during class. The authors believe that ongoing familiarity with the concept helped alleviated many of the students concerns in this regard.

Table 3 below summarized the “Uncovered Material Use”. It should be noted this part of the concept was a new addition to “T.H.I.N.K.” for Fall 05 semester. The students were given a standard homework assignment based on the material covered in class. They were also asked to work the first problem of next standard assignment which is called the “Uncovered Material Use”. The information to work this problem was to be covered in the following class. Consequently the students were attempting to work a problem for which they had no knowledge or idea on how to solve it. This fitted quite well with the concept of “T.H.I.N.K.” which required students to solve situations for which they were unfamiliar.

This requirement was not as well received by the students as indicated by the ratings they gave each question in Table 3. They did admit to this segment being challenging (7.32) and their overall rating of this exercise as 5.77. This part of the concept will be addressed in the current semester to make it more palatable and meaningful to the students.

Finally, Appendix “B” contains representative student comments about the “T.H.I.N.K.” concept. Overall the comments are favorable and encouraging. No negative comments per se were generated by the students which in itself is a positive statement on the concept.

Conclusions
This concept has been experimented with over the last several years with enough positive feedback received from the students and other faculty to warrant it being submitted for ASEE’s annual conference. The methods to employ the “T.H.I.N.K.” concept worked well considering
the novelty and apprehension by both the students and authors. The student appreciation for the attempt to truly make this learning experience more effective and meaningful served as further encouragement to continue refining the concept during future semesters. Since Engineering Statics is the first in a series of Engineering Technology courses taken by the students, it became much easier to implement the “T.H.I.N.K.” concept in the Engineering Dynamics and Engineering Economics classes the subsequent semester which, incidentally, were taught by the authors and taken by the same students they had in Engineering Statics last term.

Because of the high scores given by the students after they viewed the Primetime Live video, it is very highly recommended any one attempting to implement this concept purchase the video from ABC News.(5) The visual impact of the report left the students with a much more profound appreciation of the deficiencies in their high school learning experiences. This is not to negatively point fingers at the high school teachers since many of them are superb teachers who care tremendously about their students. The criticism lies in “what” they teach and “how” they teach and much of the pressure comes from the political requirements for students to perform well on standardized achievement tests.

A follow up abstract will be submitted next year evaluating the improvements made to the “T.H.I.N.K.” concept based on this year’s experience. Clearly getting students to “T.H.I.N.K.” out-of-the-box is necessary if our country in general and industry in specific are to remain at the cutting edge of innovation for the needs of tomorrow.

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Note: The authors have no affiliation with ABC News or Primetime Live.
APPENDIX A

T.H.I.N.K. ANALYSIS EVALUATION

Please circle your response to the following questions based on a scale of “1” to “10” with the explanation of the values indicated below each question.

1. What was your impression of the “T.H.I.N.K.” concept based on the instructor’s presentation of it before you watched the NBC video?
   1 didn’t like it 2 3 4 5 6 7 8 9 10 exciting and interesting

2. What was your impression of the “T.H.I.N.K.” concept after you watched the NBC Dateline video?
   1 not interested at all 2 3 4 5 6 7 8 9 10 Bring it on! I welcome the challenge.

3. How difficult was it for you to “T.H.I.N.K.” about new subject areas during class?
   1 very easy 2 3 4 5 6 7 8 9 10 very difficult

4. How challenging were the “T.H.I.N.K.” situations presented to you during class?
   1 minimum challenge 2 3 4 5 6 7 8 9 10 very challenging

5. Did you participate in doing the “1st” homework problem assigned for the upcoming uncovered material in the syllabus?
   1 No 2 3 4 5 6 7 8 9 10 yes, did vast majority of problems
   NOTE: If you answered “1” (no) to question No. 5, go to question No. 9.

6. How challenging was it doing the uncovered problem without any class instruction on the material?
   1 not challenging 2 3 4 5 6 7 8 9 10 very challenging

7. How beneficial was doing the one uncovered problem in helping you understand that material when it was covered in class?
   1 not beneficial 2 3 4 5 6 7 8 9 10 extremely beneficial

8. Even though it was an individual assignment, did your team discuss the uncovered problem prior to class?
   1 never 2 3 4 5 6 7 8 9 10 always

9. Did you understand the need to employ the “T.H.I.N.K.” concept in Engineering Statics?
   1 No-not at all 2 3 4 5 6 7 8 9 10 Definitely – saw the need for it

10. Overall, how well did the “T.H.I.N.K.” concept improve your ability to learn the material?
    1 Did not help 2 3 4 5 6 7 8 9 10 Definitely helped me

11. Do you feel utilizing the “T.H.I.N.K.” concept in your other classes would have helped you to better learn the material in those classes?
    1 No, not at all 2 3 4 5 6 7 8 9 10 most definitely

12. Overall, how would you rate the “T.H.I.N.K.” concept implemented during class?
    1 Waste of time 2 3 4 5 6 7 8 9 10 Outstanding, great help

13. Overall, how would you rate the “T.H.I.N.K.” concept used during the “1st” homework problem assigned for the upcoming uncovered material in the syllabus? (Do not answer if you did not participate.)
    1 Waste of time 2 3 4 5 6 7 8 9 10 Outstanding, great help

14. Please provide any written comments on the “T.H.I.N.K.” concept:

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APPENDIX B  REPRESENTATIVE STUDENT RESPONSES TO  QUESTION #14

- I believe it is a good idea and it shows that results of students' scores where higher. It teaches concepts to apply to problems not just straight line plug and chug.
- Like I said, it was hard for me to understand things at first being used to all the old methods. Once I grasped concepts, I understood it better. This process was very frustrating at times but beneficial.
- I enjoyed the fact that this class seemed to be much more interested in actually learning the material rather than just memorizing for a grade.
- Using the "THINK" concept really makes a person become involved in the class.
- I thought that the T.H.I.N.K. concept was a good idea except the homework on uncovered material. (Especially how it changed over the course of the semester.) It just took more time overall which in my opinion, was time needed for other classes. Overall though, I really enjoyed the class.
- If you were able to get the concept during the think time it was a great help. If you struggled at that time the entire concept seemed to remain difficult.
- I never heard about this type of teaching before this class. It did make the classes more challenging but I probably would have the same grade without it.
- I thought the "THINK" homework assignments were very difficult. It was hard, because the work load increased (regular problems + think homework). The think problems took a lot of time and were difficult to understand before class. After you get us started on the material they became much easier.
- Helped in some areas, but others were rather difficult. I didn't feel that the book explained as well as a teacher did.
- THINK helped even if I couldn’t get the problem on my own. It at least got me familiar with the problem, methods, and always made me want to know how to do it in class the next day.
- In theory, it’s a good concept. But sometimes I just didn’t understand what we were doing, so “THINKING” about the material didn’t help me at all.
- I think it is a great concept. It definitely makes the class after doing an uncovered material problem much easier to follow and understand. You are doing the hard part before class, so during class it is easier to pay attention and really grasp the concept being learned.
- It’s a great concept. My only suggestion would be to speed things up a little bit. Without the think method you’d be able to go over more problems in class, but probably not as effectively, finding a middle ground would be my advice.
- This concept works, it is extremely critical to think about a problem before attempting it. This concept is important in all aspects of a professional career, not just statistics. If I ever teach a class, I will insist on this concept.
- It is a very good method of learning, but sometimes it really made me stuck on things to the point where I couldn’t finish.
- It was a challenge at first since I was used to the traditional way where teachers give you the equation and show you how to use. But it’s better now since I know how to “THINK” on my own.
- Think concept was interesting, however not very applicable to statistics in my case. I learn best through examples and group interaction. The THINK concept put me on my own. Truly, would rather enjoy class with many teacher lead examples and discussions.
- THINK method caused me to spend most of my time on statistics and my other classes suffered.
- GREAT way to separate the Engineers and the soon to be business majors. Really helped me analyze problems to compile an answer. This is what engineering is!! Instead of working out an entire HW problem, maybe just answer specific questions about any of the problems the students might have. There shouldn’t be anyone who doesn’t know how to do anything for one specific problem.
- It was very helpful when it came to understanding the material.
- THINK would be good for elementary/middle school, but I think harder high school/college courses need to be explained to students before doing problems. Doing problems wrong will not help students except to mess them up later.
- This was hard to do on my own. The principal concepts need to be given in class before attempting a problem by yourself.
- Use the homework think problem as example when teaching the new material would let students see what they did wrong.

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