A Framework for Implementing Higher-Order Thinking Skills (Problem-Solving, Critical Thinking, Creative Thinking, and Decision-Making) in Engineering & Humanities

Omar J. Alkhatib
Department of Architectural Engineering
United Arab Emirates University
Al Ain, United Arab Emirates
omar.alkhatib@uaeu.ac.ae
ORCID: 0000-0003-0836-6149

***Abstract*—Learning skill is the ability to acquire basic knowledge and concepts across multiple dimensions (e.g., affective, psychomotor, and cognitive). Thinking is the ability to challenge and eventually develop acquired knowledge to a higher attainment level.**

The proposed framework models here are intended for developing, stimulating, and engaging students' complex thinking process skills. This is a higher-order thinking level and consists of four subthinking skills, i.e., problem-solving, critical thinking, creative thinking, and decision-making. Common and supporting thinking skills of these four levels are identified and derived from the literature, and additional sublearning skills are defined as general capacities to perform a set of tasks and further development of students' higher-order thinking abilities. Furthermore, questions for focusing thinking or learning activities are developed to transform learned knowledge and skills into practical activities. Hence, course assignments (e.g., homework and quizzes) and learning tools (e.g., mind map, flowchart) were developed to engage students in developing their skills in these four thinking levels. Learning assignments and tasks, as related to complex thinking and related subthinking skills, can be mapped to students' learning outcomes, assessed, and eventually allow evaluating learning skills. Proposed teaching activities' initial assessments show high improvement in student learning and were applied successfully in higher education and partially tested first-grade students. Furthermore, it is implemented using a blended learning approach through providing skills-based assignments (e.g., homework, quizzes), interactive lectures, and using learning tools such as mind maps. Initial assessment of students' outcomes showed an improvement by 20% as compared with course sections with typical course delivery mode.

Keywords—Learning Skills, Higher-Order Thinking, Problem-Solving, Critical Thinking, Creative Thinking, Decision-Making

I. Introduction

The fourth industrial revolution involves the technological developments and interfacing capacities of digital media content across various educational and social media platforms. It is characterized by a fusion of technologies that is blurring the lines among the physical, digital, and biological dimensions, collectively referred to as cyber-physical systems. The effect of the fourth industrial revolution on education was positive to some extent, as it established the necessity for reform. The classical instructional methods are no longer effective using face-to-face-based teaching, while using advance pedagogy is not providing enough evidence to enhance teaching and learning performance. Between the classical teaching approaches and modern pedagogical learning and mentoring tools, a blurred or vague area is commonly known as "*learning skills.*" The students learning skills is represented in Figure 1.

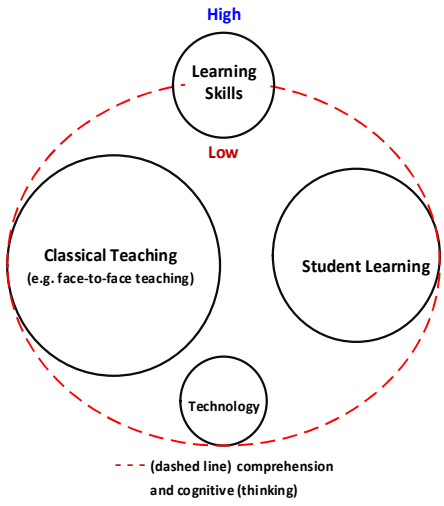

FIGURE 1-a

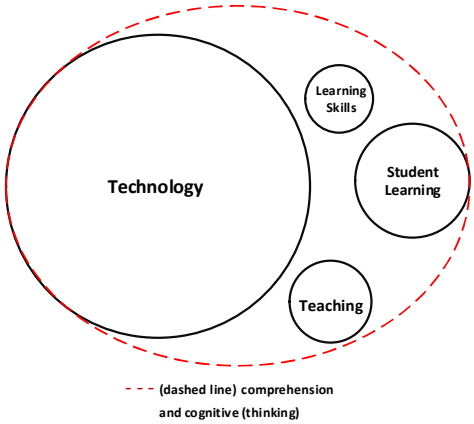

FIGURE 1-b

Figure 1 presents the effect of classical teaching methods on successful development of learning skills. Classical teaching is a language-focused learning that is based on developing students' skills through words (e.g., written and verbal), illustrations, photos, and videos. The

dashed line in Figure1-a indicates the development of students' cognitive process through learning, which eventually improves and refines their learning skills.

There are two important aspects in classical teaching. Classical teaching is language-focused, and it follows a specific three-part learning pattern. The mind must be first supplied with facts and images (e.g., illustrations, flow charts) and then given the logical tools (e.g., exercises) for organization of facts (e.g., mind map) and finally the ability to draw a conclusion. The more consistent development of classical teaching aspects, the higher improvements of learning skills.

Technology has an impact on every aspect of life, and education is one of the most affected due to different forms of educational resources and pedagogical tools for teaching. Technology has expanded the access to learning resources, and huge amounts of information (books, images, videos, audio) available through the Internet enables students to learn and empower themselves with knowledge. Modern technology has made it simple for students to learn from any place in the world through online education, e.g., sharing visual lessons and presentations, which are often more convenient and sometimes more fun. On the other hand, technology use for entertainment purposes is taking over students' attention and, sadly, affecting their learning significantly. Technology is maturing students' cognitive processes (*the cognitive process is the mental process of knowing how to do things but not necessary having the skills to do it efficiently or proficiently. A student may know how to do division using an internet applet but doesn't know how to carry out hand calculation*) in a manner faster than the natural developing process of their learning skills (see Figure 1-b). With the positive impact of technology on education, it is diminishing many important aspects of classical teaching that are needed for developing students' skills.

The challenges facing the educational process today is the attractive aspects of using technology for entertainment and the effective role in using technological tools in education. This research introduces a learning framework that is based on developing students' learning skills that are related to higher-order thinking. The development of skill-based learning model proposed here will be established by identifying and describing the higher-order thinking skills and related activities from highly cited studies, in addition to developing questions for focusing learning activities on how to implement these skills and improve student performance in class.

II. Litrature Review

Learning skill is the ability to acquire basic knowledge and concepts across multiple dimensions, i.e., cognitive (thinking), affective (emotion/feeling), and psychomotor (physical/kinesthetic). Boyatzis [1] defined learning skills as "a combination of ability, knowledge, and experience that enables a person to do something well within a specific situation and is subject to intentional development." Learning skills development requires higher-order thinking as well as teaching strategies that would promote strategic thinking and students' intuition.

Early scholars were involved in the initial developments of higher-order thinking skills such as critical thinking, creativity, and creative thinking. The great American thinker John Dewey (1859–1952) can be thought of as the father of modern critical thinking tradition. He perceived critical thinking as "reflective thinking" and defined it as the "active, persistent, and careful consideration of a belief or supposed form of knowledge in the light of the grounds which support it and the further conclusions to which it tends."

The original model of higher-order thinking skills, such as creative problem-solving, was developed through the views of Alex Osborn in his book *How to Think Up* [2], and, as Parnes [3] noted, "This unassuming mini-book was the seed from which most of today's applications of creative thinking and problem-solving germinated." Osborn's seven-step initial model for creative thinking includes: (1) *orientation* – pointing out the problem; (2) *preparation* – gathering pertinent data; (3) *analysis* – breaking down the relevant materials; (4) *hypothesis* – piling up alternatives by way of ideas; (5) *incubation* – letting up to invite illumination; (6) *synthesis* – putting the pieces together; and (7) *verification* – judging the resultant ideas.

Scholars have continued the development of Dewey critical thinking skills ideas over the years, and several higher-order thinking skills models have appeared in the literature in articulation of Osborn views. Treffinger [4] presented a "descriptive model of productive thinking," where he identified the use of creative problem-solving as complex level thinking.

Cohen [5] and Presseisen [6] emphasize the relationship between creative problem-solving and the complex problem by describing the four specific complex thinking processes: *problem-solving* (resolve a known difficulty), *decision-making* (choose the best alternative), *critical thinking* (understand a particular meaning), and *creative thinking* (create novel or aesthetic ideas or products). Lewis and Smith (1993) argue that critical thinking is a much broader concept, encompassing problem-solving, critical thinking, creative thinking, and decision-making.

"In 1991, the US Department of Labor convened an expert panel to describe what twenty-first-century work would require of education. The Secretary's Commission on Achieving Necessary Skills produced a report identifying the skills and competencies of productive work, including the ability to think critically and creatively, make decisions, solve problems, and reason (US Department of Labor, 1991, p. 13). Therefore, preparing students to think critically and creatively is essential to a competitive workforce" [7].

The United Nations Educational, Scientific and Cultural Organization (UNESCO) [8] emphasized the importance of developing problem-solving, critical thinking, creativity, and decision-making skills as the main twenty-first century competencies that should be developed by the educational system in different countries.

In the twenty-first century, successful universities will be those that prepare graduates with sufficient high-order thinking processes in the form of critical enquiry, innovative thinking skills, reflectivity, and problem-solving skills. "Further, employers will judge universities by their effectiveness in producing critical and creative thinkers who generate ideas that are usable, useful, desirable, economically viable, technologically feasible, and sustainable" [7].

III. Definitions of High-Order Thinking Processes

The main interest here is to propose how to teach and implement skills-based learning in a classroom. Although the purpose is not to define higher-order thinking processes, although some definitions from the literature are presented to reiterate their broad meaning and to understand how they are being perceived by professional educational experts and interested scholars in the field. Therefore, in-class activities and coursework assignment have been designed to stimulate, challenge, and promote thinking, build knowledge, learning skills, and promote problem-solving, improve critical thinking, and develop students' creativity, innovation, and decision-making.

A. Problem-Solving Thinking

Problem-solving is the initial stage of engaging in higher-order thinking processes. Common skills related to identifying solution tactics or strategies in problem-solving are called heuristics. George Polya (1887–1985) is a world-class Hungarian mathematician, professor, and author of five published classic books on problem-solving; these books are devoted entirely to the practical study of heuristics in mathematics. The most important skills and ideas developed in George Polya's masterpieces will be identified in the problem-solving thinking process herein. Additional proposed skills will be added in view of effective implementation of learning skills. Table I presents the proposed problem-solving framework, which includes common important definitions, crucial skills, and stimulating questions for this thinking process. The problem-solving skills suggested by George Polya are surveyed by Larson [9].

B. Critical Thinking

Critical thinking is defined by John Dewey as, "active, persistent, and careful consideration of a belief or supposed form of knowledge in light of the grounds that support it and the future conclusions to which it tends" [10].

"The Foundation for Critical Thinking defines critical thinking in higher education as a self-reflective process that involves elements of reasoning, intellectual standards, methods of assessment, and strategies for professional development" [11] as cited by NCSU [7]. Paul and Elder [11] frequently describe critical thinking as:

> *The intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication as a guide to belief and action in its exemplary form. It is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness* [12].

In view of the above definition, Table II presents the proposed critical thinking framework, which includes common important definitions, crucial skills, and stimulating questions for this thinking process.

C. Creative Thinking

Several creative thinking skills definitions have been developed in the literature. Csikszentmihalyi's [13] development of creative thinking appeared frequently in publications. Creative thinking is perceived as follows:

> *Creative thinking is generating new ideas within or across domains of knowledge, drawing upon or intentionally breaking with established symbolic rules and procedures. In the context of college teaching and learning, creative thinking deliberately and actively engages students in bringing together existing ideas into new configurations, developing new properties or possibilities for something that already exists, and discovering or imagining something entirely new.*

In view of the above definition, Table III presents the proposed creative thinking framework in which additional important definitions that pertain to other aspects of creative thinking, crucial skills, and stimulating questions for this thinking process.

D. Decision-Making Thinking

Decision-making is a process by which a person, group, or organization identifies a choice or judgment to be made; gathers and evaluates information about alternatives; and selects from among the alternatives [14]. An understanding of the process of decision-making can provide a student with tools and a knowledge background that are necessary to develop higher-order thinking process and, consequently, improve higher-level learning skills such as analysis, synthesis, and evaluation, i.e., "The skills needed to make sound decisions can be taught" [15]. The development of teaching techniques and activities that are necessary for developing decision-making skills can be achieved in the context of a conceptual judgment of pre-written scenarios or critical incidents and suggest a new concept using their knowledge through a variety of learning activities. Elias and Tobias [16] emphasize the importance of teaching decision-making skills in daily academic and social contexts that are related to "real life" situations.

Quantitative literacy (QL) is also known as quantitative reasoning (QR) or numeracy. QL is the skill of problem-solving or decision-making that is based on numerical-based argument. The Association of American Colleges and Universities[1] defines QL as follows:

> *Quantitative literacy (QL) – also known as numeracy or quantitative reasoning (QR) – is a "habit of mind," competency, and comfort in working with numerical data. Individuals with strong QL skills possess the ability to reason and solve quantitative problems from a wide array of authentic contexts and everyday life situations. They understand and can create sophisticated arguments supported by quantitative evidence, and they can clearly communicate those arguments in a variety of formats (using words, tables, graphs, mathematical equations, etc., as appropriate).*

QL is an important subskill in the decision-making process, especially in the analytical perspective of engineering. The decision-making arguments and criteria would be supported quantitatively by numerical modeling representations such as tables, charts, and other types of graphical representations.

[1] https://www.aacu.org/

In a comprehensive literature review, Mincemoyer [15] highlighted the most important skills and related subskills to be acquired by students to help in developing the decision-making thinking process and abilities. The most important decision-making skills were selected from this review, and related focus questions were developed to help guide glass activities. Table IV presents the proposed decision-making framework, which includes important definitions, crucial skills, and stimulating questions for this thinking process.

TABLE I. PROBLEM-SOLVING DEFINITIONS AND SKILLS

Problem Solving Framework		
Definition	**Technical Based Skills (e.g., mathematics, engineering, and science…etc.)**	**Proposed Questions for Focusing Thinking or Learning Activities**
1) Problem solving is the process of designing, evaluating and implementing a strategy to answer an open-ended question or achieve a desired goal [17]. 2) Problem solving is defined as an individual's ability to identify and define problems, generate alternative solutions, select and implement a solution, and evaluate the outcome [18]. 3) Problem solving is an analytical process for systemically 1) identifying a problem, 2) analyzing given information, 3) understand what is required to solve for, 4) suggest problem solving initiatives, 5) evaluate obtained solution, 6) critically reflect on obtained solution.	Search of a pattern [9] Draw a figure [9] Draw a free body diagram (FBD) Formulate an equivalent problem [9] Modify the problem [9] Choose effective notation [9] Exploit symmetry [9] Divide into cases [9] Work Backward [9] Argue by contradiction [9] Pursue parity [9] Consider extreme cases [9] Generalize [9] Find keywords Gather information/Define Problem Reflect on effectiveness of solution	1. What are the important keywords? 2. Can you draw a figure or flowchart to summarize information? 3. Can you summarize facts using notations? 4. Can you drive a solution from a similar problem or situation? 5. Is it possible to simplify/modify problem using notations? 6. It is possible to simplify or use more effective notation? 7. Is it possible to use symmetry relations or some notation to approximate a solution? 8. Is it possible to solve a problem by dividing it into cases? 9. It is possible to solve a problem backward? 10. What are the available possibilities or alternatives? 11. What is/are the most important/s parameter to solve for? 12. What would be the most important case or issue in this problem? 13. What is the general form of solution? 14. What are the important key terms? 15. How to define the problem? What are the solution parameters? 16. How to find information about a given problem? 17. Can you evaluate the proposed solution?
Definition (Brief List)	**Humanities Based Skills (e.g., ethics, literature...etc.)**	**Questions for Focusing Thinking**
A. Identifying a problem and finding reasonable solutions to it using critical-thinking skills such as organizing data, identifying relevant and important data, making inferences, making decisions, projecting consequences of actions, and applying theoretical knowledge to a specific situation [19]	Find keywords Arrange data Analysis and reasoning of facts	a. What is/are the most important keyword/s? b. How to arrange data. c. How important are the given facts?

IV. SKILLS-BASED TEACHING METHOD

Skill-based teaching aims to enhance students' learning by developing learning skills, especially self-directed learning skills. The self-learning skills focus on developing the ability to manage learning tasks without instructor help and facilitate lifelong learning. Several teaching approaches were used in the course of developing the higher-order thinking skills framework in this work. The most effective one can be summarized in the following process, which is called "*3S Learning.*"

A. Stimulus Intro

The stimulus phase is intended to introduce students with higher-order thinking processes and required skills. This phase stimulates students' skills by introducing and explaining thinking skills in the context of everyday life and activities. Students love this learning phase, as everyday activities are explained and understood scientifically.

B. Skills-Integrated Learning

Skills-based teaching is typically challenging, especially for engineering students. The proposed skills-learning frameworks are developed as part of the blended learning approaches developed by Alkhatib [20]. The learning approach is based on interactive lectures and "assignment-based skills," where students are required to answer course assignments and homework in a template with predefined higher-order skills and thinking focus questions. An example template is presented Figure 2.

C. Self-Learning Trial and Error Process

The self-learning is the process of involving students to develop their skills as out-of-class activities. This is the process of addressing homework and course assignments.

TABLE II. Creative Thinking Definitions & Skills

Critical Thinking Framework		
Definition	**Technical Based Skills**	**Proposed Questions for Focusing Thinking or Learning Activities**
1. "Critical Thinking involves actively interpreting one's experiences and self-consciously making expressing one's analytical, evaluating and interferential judgment regrading what to believe or do" (Facione, P. A., 1990)	a) Interpreting b) Inferring c) Analyzing d) Evaluating e) Expressing (Explanation) f) Monitoring (Self-Regulation)	Focusing questions are based on or drawn from Facione [21]. a. **Interpreting:** - What is the best way to characterize/categorize/or classify this? - What does this mean? What is its purpose? How to understand given information. b. **Inferring:** - What are the consequences of doing a certain action in a certain way or based on given conditions?/ What if scenarios? c. **Analyzing:** - What are the arguments pros and cons? - What is your basis for saying that or making this decision? d. **Evaluating** - How to judge or assess an argument. - How to assess an assumption. e. **Explanation** - What is the basis of a certain decision? - How to explain obtained results. - How to justify accepting or rejecting claims. f. **Monitoring** - How would you judge yourself/performance/or reflect on own reasoning or obtained results?
2. Critical Thinking is a habit of mind characterized by the comprehensive exploration of issues, ideas, artifacts, and events before accepting or formulating an opinion or conclusion[1].	Evaluate and examine given parameters critically. Use of "what if scenarios" Is it possible to develop a mindmap? Develop flow chart solution based on streamline of thoughts or logical steps Analyzing assumptions. Inquire about certain information	a. What are the differences between given parameters? b. Is it possible to use "what if" scenarios to evaluate alternatives and possible outcomes? c. Can you develop a mind map to analyze and understand all different concepts and issues involved? d. Is it possible to analytically develop sequential solution steps in a form of a flow chart? e. Why are assumptions important and what are their effect on a proposed solution? f. "Applying standards of good reasoning to your thinking when analyzing a situation and evaluating your actions" [19].
Definition (Brief List)	**Humanities Based Skills**	**Questions for Focusing Thinking**
A. Critical Thinking is disciplined, self-directed, rational thinking that supports what we know and makes clear what we don't know [22].	1. Rational thinking process 2. Inquire about certain information	1.1 What would influence the expected problem outcome? 1.2 "Applying standards of good reasoning to your thinking when analyzing a situation and evaluating your actions" [19].

TABLE III. CRITICAL THINKING DEFINITIONS & SKILLS

Creative Thinking Framework		
Definition (Brief List)	**Technical Based Skills**	**Proposed Questions for Focusing Thinking or Learning Activities**
1. Creative thinking is both the capacity to combine or ***synthesize*** existing ideas, images, or expertise in original ways and the experience of thinking, reacting, and working in an ***imaginative*** way characterized by a high degree of innovation, divergent thinking, and risk taking [17].	a) Synthesize b) Imaginative	**a. Synthesize** - How to solve the problem differently. - Can you solve the problem in simpler form or differently? - Dissect into parts and combine again. - Can you find the relationship between different parts? **b. Imaginative** - Can you use a modern tool to solve a problem or produce something new? - Can you use reverse-engineer to resolve a problem differently? - Can you use a tool to solve the problem? (Excel, software, table, or graph) - Develop an idea in a new context or for a new situation.
2. Creativity is an imaginative action that is aimed to produce outcomes which is both original and of value [23].	Creativity is perceived to have three dimensions[1] : a) Synthesizing b) Articulation c) Imagination	**a. Synthesize** - Can you develop an analogous concept or notation of a current situation? - Can you deduce original results from given information? **b. Articulation** - What new knowledge can be formed or developed and would lead to a new concept or solution based on given information? **c. Imagination** - Can you construct or imagine a relationship between different variables or thoughts to come up with a new idea or concept?
Definition (Brief List)	**Humanities Based Skills**	**Questions for Focusing Thinking**
A. Imaginative activity fashioned so as to produce outcomes that are both original and of value [24].	a) Rational thinking process b) Inquire about certain information	a. What would influence the expected problem outcome? b. Applying standards of good reasoning to your thinking when analyzing a situation and evaluating your actions" [19]

TABLE IV. Decision-Making Definition & Skills

Table 4: Decision-Making Framework		
Definition	**Technical Based Skills**	**Proposed Questions for Focusing Thinking or Learning Activities**
1. Decision-making an intellectual process leading to a response to circumstances through selection among alternatives [25].	Mincemoyer [26] decision-making process: 1. define the problem; 2. generate alternatives; 3. check risks and consequences of choices; 4. select an alternative; and 5. evaluate the decision.	**1. Define Problem** - Can you describe the problem? - Can you define process goals precisely? - Can you analyze given information and interpret information? - Do you have questions that would lead to the solution? - Can you use the problem-solving skills to define the problem? **2. Generate Alternative** - What are the possible alternatives? - Can you question alternatives and find new information about them ? - Can you analyze alternatives or selected choices and assess their credibility? - Can you create a combination of alternatives? **3. Check Consequences** - Can you describe advantages and disadvantages of a decision? - Can you develop criteria that can be used to evaluate the final solution or select among alternatives? **4. Select** - Can you make a choice from among the list of alternatives? - Can you select the most feasible, practical, or reasonable alternative? **5. Evaluate** - Can you determine the outcome of the selected option? - Determine the criteria for assessing worth of action taken? - Can you determine which decision is more reasonable than another?
2. Individuals with strong quantitative literacy (QL) skills possess the ability to reason and solve quantitative problems from a wide array of authentic contexts and everyday life situations. They understand and can create sophisticated arguments supported by quantitative evidence and they can clearly communicate those arguments in a variety of formats (using words, tables, graphs, mathematical equations, etc., as appropriate) [17].	- Select between two options? - Select most efficient product, process, or justify results obtained. - Select most economic & feasible scheme to develop desired outcome	▪ What are the differences between given options? ▪ What is the most efficient product? ▪ What is the most feasible solution? ▪ Do you accept the obtained outcome?

Student Name :	Problem:		Course:

Solve Problem According to the Following Focusing or Skills Given at Each Thinking Level:

Problem Statement:

This is a the given problem statement including all given parameters/drawing and required solutions variables.

1- Problem Solving: Focus Questions / Learning Activates: a) What are the important **keywords**? b) What is the problem is **asking for** ? or what are the required **solution parameters**? c) Can you **summarize** facts using notations? d) Draw a free body diagram or represent a problem by **sketch**. e) It is possible to solve a problem **backward**?	Student should identify important keywords in the problem statement, understand the required solution parameters, summarized the problem in a short form text or mathematical/graphical notation.
2- Critical Thinking: Focus Question / Learning Activates **a) Interpreting**: What is its purpose of given information? **b) Inferring**: What are the consequences of doing this? What id scenarios? **c) Analyzing:** What is your basis for making this decision/solution? **d) Evaluating**: How to assess an assumption? **e) Explanation:** How to explain obtained results? **f) Self-Regulation:** How would you judge yourself/performance?	Student should be able to develop a critical thinking skills through a process that would involve the suggested key elements.
3- Creative Thinking: Focus Question / Learning Activates a) **Synthesize** : Can you develop an analogous concept or notation of a current situation? b) **Articulation:** What new knowledge can be formed or developed and would lead to a new concept or solution? c) **Imagination**: Can you construct or imagine a relationship between different variables or thoughts to come up with a new idea or concept?	Creative thinking skills can be developed based on three activities that would transform some of the problem tasks into creative thinking abilities which would develop students creative thinking skills.
4- Decision Making: Focus Question / Learning Activates 1) **Define Problem**: Can you describe the problem? 2) **Generate Alternative**: Can you analyze alternatives? 3) **Check Consequences**: Can you describe advantages and disadvantages of a decision? 4) **Select**: Can you make a choice from among the list of alternatives? 5) **Evaluate**: Can you determine the outcome of the selected option?	This section aim to ask student about some of the problem tasks which would develop students abilities on deciding between two giving options (decision making). For example, what would be the most feasible option of the solution if such solution involve more than option.

FIGURE 2 – SKILLS BASED ASSIGNMENT TEMPLATE (VERSION 3 – 2017/2018)

V. CONCLUSION

This paper presented a teaching approach that is intended to develop thinking and independent learning skills. The teaching approach is part of the pedagogical development project for engineering courses that is intended to enhance students' learning skills and higher-order thinking processes. This project is still in progress, and assessment tools have been developed to measure student learning performance and thinking skills.

The assessment score represents educational effectiveness developed by measuring course learning objectives (CLOs) and expressed on a scale of one to five. In this course, four CLOs are assessed in each term, namely, CLO1, CLO2, CLO3, and CLO4. The course assessment results of CLOs are summarized in Table V. The P-Indicator is calculated before and after applying the proposed teaching method. The higher values were obtained of the P-Indicator [the average of various assessment tools such as students course work (SR), student opinion (SO), and instructor opinion (IO)] after implementing the proposed activities of higher-order thinking processes, which should be an essential performance indicator for each learning outcome. For instance, in the spring 2017 semester, the P-Indicator score was 3.8 (average) for all course learning outcomes. The course was assessed again in spring 2018 after applying the new teaching method, and the P-Indicator average value was noted to have a higher value of 4.6. The improvement of student attainment levels can be attributed to the effect of providing and supplementing assignments with "Questions for Focusing Thinking or Learning Activities," which enhanced students' thinking processes and induced better student interaction and performance in-class and with class assignments.

The work presented here is preliminary and still in progress. Future development will consider further development of higher-order thinking skills and related subskills, especially as related to creativity. In addition, further presentation of in-class activities, thinking-enhancing tools, e.g., flowcharts concept maps, etc., and, most important, a practical approach on how to assess learning skills quantitively.

TABLE V. BRIFE SUMMARY OF STUDENT RESULTS ASSESSMENT

Criteria	Spring 2017	Spring 2018
Number of Students	40	40
Delivery Mode	Typical PowerPoint presentations and problem-solving on white board	Interactive lecture modules with "Proposed Questions for Focusing Thinking or Learning Activities"
Assignments used in course assessment	Final and midterm exams, quizzes, homework, and term project	Final and midterm exams, quizzes, homework, and term project
CLO 1	3.8	4.5
CLO 2	3.8	4.6
CLO 3	3.9	4.5
CLO 4	4.0	4.6

REFERENCES

[1] Richard E. Boyatzis, and David A. Kolb. "From Learning Styles to Learning Skills: the Executive Skills Profile." *Journal of Managerial Psychology*, vol. 10, no. 5, 1995, pp. 3–17.

[2] Alex F Osborn. *How to Think Up*. McGraw-Hill, 1942.

[3] Sidney J. Parnes, Visionizing: State-of-the-Art Processes for Encouraging Innovative Excellence. Creative Education Foundation Press, 1992.

[4] D. J. Treffinger, Dimensions of creativity, Idea Capsule # 9004. Sarasota, FL: Center for Creative Learning, 1996.

[5] Jozef Cohen. *Thinking*. Rand McNally, 1971.

[6] B. Z. Presseisen, "Thinking Skills: Meanings and models revisited," in *Developing minds: A resource book for teaching thinking,* A. L. Costa, Eds. Alexandria, VA: Association for Supervision and Curriculum Development, 2001, pp- 47-57.

[7] North Carolina State University-NCSU, "Higher-Order Skills in Critical and Creative Thinking: Quality Enhancement Plan", *THINK Program, 2014.* [online]. Available: https://think.dasa.ncsu.edu/, [Accessed: Jan. 25, 2019]

[8] United Nations Educational, Scientific and Cultural Organization-UNESCO, "Assessment of Transversal competencies in education: Policy and practice in the Asian Pacific Region" Paris, UNESCO Bangkok Office, 2016.

[9] Loren C Larson. *Problem-Solving through Problems*. Springer-Verlag, 2006.

[10] John Dewey, and J. A. Boydston. *How We Think, and Selected Essays 1910-1911*. Southern Illinois University Press, 1985.

[11] R. Paul and E. Linda, *The Miniature Guide to Critical Thinking: Concepts & Tools*. Foundation for Critical Thinking, 2006.

[12] R. Paul, and M. Scriven, Critical thinking as defined by the National Council for Excellence in Critical Thinking, 1987. *Statement presented at the 8th Annual International Conference on Critical Thinking and Education Reform*, Berkeley, (1987)

[13] Mihaly Csikszentmihalyi, *Creativity: the Psychology of Discovery and Invention*. Harper Perennial Modern Classics, 2013.

[14] John S. Carroll, and E. J. Johnson, *Decision Research: a Field Guide*. Sage Publication, 1990.

[15] C. C. Mincemoyer, and D. F. Perkins, "Assessing decision making skills of youth".*ncsu.edu*. The Forum for Family and Consumer Issues (FFCI) 8(1) 2003. [Online]. Available: http://ncsu.edu/ffci/publications/2003/v8-n1-2003-january/ar-1-accessing. Php. [Accessed Jan. 27, 2019].

[16] M.J. Elias, S. E. Tobias, *Problem Solving/decision-making for social academic success*. Washington D.C.: National Education Association of the United States, 1990.

[17] Association of American Colleges and Universities (AAC&U). "Inquiry and analysis VALUE rubric" 2009. [Online]. Available: https://www.aacu.org/value/rubrics/inquiry-analysis. [Accessed Jan. 27, 2019].

[18] J. N. Raftery, C. M. Steinke, and A. B. Nickerson, "Engagement, Residential Treatment Staff Cognitive and Behavioral Disputations, and Youths' Problem-Solving." *Child & Youth Care Forum*, vol. 39, no. 3, pp. 167–185, 2010.

[19] L. S. Treas, and J. M. Wilkinson, *Basic nursing: Concepts, skills, & reasoning*. Philadelphia, PA: F.A. Davis Company. 2014.

[20] Omar J. Alkhatib, "An Interactive and Blended Learning Model for Engineering Education." *Journal of Computers in Education*, vol. 5, no. 1, 2018, pp. 19–48.

[21] P. A. Facione, *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction—The Delphi Report*, Millbrae, CA: California Academic Press. 1990.

[22] J. M. Wilkinson,. *Nursing process & critical thinking (5th ed.)*. Upper Saddle River, NJ, Prentice-Hall, 2011.

[23] Robert J. Sternberg, "Creative Thinking in the Classroom." *Scandinavian Journal of Educational Research*, vol. 47, no. 3, 2003, pp. 325–338.

[24] National Advisory Committee on Creativity and Cultural Education (NACCCE). *All our futures: Creativity, culture and education*. Report to the Secretary of State for Education and Employment and the Secretary of State for Culture, Media and Sport. London, UK: Department for Education and Employment, 1999.

[25] G.D. Nelson, *Assessment of health decision-making skills of adolescents*. Washington, DC: US Department of Education. 1984. (ERIC Document Reproduction Service No. ED220257).

[26] C. C. Mincemoyer, and Daniel F. Perkins. "Assessing decision-making skills of youth". *The Forum for Family and Consumer*: Issues 8(1), 2003.