ThinQ
think • inquire • question

The following are responses to questions during the ThinQ-FACE webinar which were not answered during the live stream. You can find a recording of the webinar at http://www.thinq.education/events/6

Q-1: May I know about inquiry-based learning?
[Sunanda Perla] [psunandareddy@gmail.com] [Q: 6:08 PM]

A-1: Inquiry-Based Learning (IBL) is the idea that students acquire a deeper and more lasting understanding of content knowledge through their own inquiry into the topic, rather than listening to a lecture, or reading a textbook. For example, according to this view, students acquire a deeper understanding of the theory of gravity and motion by constructing or discovering the theory through their own inquiry. IBL is also called Discovery Learning. For further details, see the Wikipedia entry on Inquiry-Based Learning at:
https://en.wikipedia.org/wiki/Inquiry-based_learning

The educational philosophy of ThinQ recognises the value of IBL as a pedagogical strategy to help students acquire conceptual understanding, but we also recognise the value of spoken or written exposition. We also go beyond the pedagogy of IBL to the educational goal of **Inquiry-Oriented Education (IOE),** the idea that it is important to help students develop the capacity for independent inquiry, and critical thinking as one of the integral components of inquiry. For further details, see "ThinQ's Conception of Education" at http://www.thinq.education/inquiry_and_integration_oriented_education

Q-2: How to built critical thinking in students?
[Shailesh pimpale] [shailesh_pimpale@rediffmail.com] [Q: 6:19 PM]

A-2: Watch Mohanan's INK talk "Questioning Authority" at
http://www.thinq.education/articles/3

Q-3: How can we test the Academic intelligence of a person?
[SREEJITH S NAIR] [sreeju2786@gmail.com] [Q: 6:27 PM]

A-3: This is discussed in detail in the following articles:

1. "Aptitude Tests, Talent Tests, and Achievement Tests." Tara Mohanan. Yojana, September 2013. (pdf downloadable from http://www.thinq.education/articles/15)

2. "Entrance examinations for science and technology." K P Mohanan. Current Science: Opinion. November 2010.(pdf downloadable from https://www.currentscience.ac.in/php/auth.php?authid=42773&author=Mohanan, K. P.)

Q-4: Is inquiry skills within a domain any different from inquiry skills across domains? If not, why then a term transdisciplinary inquiry?
[Naren PR] [prnaren@scbt.sastra.ac.in] [Q: 6:27 PM]

A-4: Discipline-specific inquiry abilities are narrow (though in-depth) manifestations of a specific region of transdisciplinary inquiry abilities. To put it differently, the inquiry abilities for a given field of specialisation are a specific case of transdisciplinary inquiry abilities (inquiry across disciplinary boundaries). For instance, the transdisciplinary ability to prove the truth of a statement (in mathematical proofs, experimental proofs, arguments for theories in science, proofs in the law court...) calls not only for classical deductive reasoning (what is used in mathematical proofs) but also probabilistic and defeasible deduction, probabilistic and defeasible induction, causal reasoning, and so on. The capacity to function well as an educated person requires a broader spectrum of reasoning.

Likewise, the *ability to design experiments* to test a causal hypothesis is a transdisciplinary ability. Students are expected to develop that ability, but what they are actually learning is how to design experiments only to test hypotheses on the social behaviour of fruit flies, or only to test the claims of efficacy of drugs. To move effortlessly across domains, one needs transdisciplinary abilities, which would focus on the elements of experiment design in general across domains, and not only on domain-specific requirements. For further details, watch "Transdisciplinary Thinking" at http://www.thinq.education/articles/4

Q-5: Is inquiry not fundamental to education at large, why there should be something termed as inquiry form of education. Is it not that any form of education (or let me say teaching) is to make the student/ pupil think, ask questions, find answers, analyze those answers and so on?
[Naren PR] [prnaren@scbt.sastra.ac.in] [Q: 6:29 PM].

A-5: While it is clearly true that inquiry abilities are fundamental to all forms of formal education, it is not true that students acquire inquiry abilities in current forms of mainstream education. School and college curricula (that is, the syllabuses, teaching-learning materials, pedagogical strategies, and assessment (final exams, entrance tests, ...) are not aligned to inquiry abilities. The use of the term Inquiry-Oriented Education (IOE) is therefore necessary to clearly bring out the differences in the goals of present education and IOE.

In the webinar, we were pointing to the need to incorporate inquiry abilities into mainstream education, by

a) introducing, in an undergraduate program, stand-alone courses that aim to develop inquiry abilities,
b) or incorporating the goal of developing inquiry abilities in all courses in an undergraduate program,
c) or both.

Q-6: Being a Mathematician how can I apply this logical reasoning
[Lalitha Pattabiraman] [arthimohan2010@gmail.com] [Q: 6:30 PM]

A-6: Mathematics is currently taught in schools and colleges as a matter of equations and formulae to memorise, and using them for making high-speed calculations without understanding. The reasoning component is completely missing in this system. Rigorous reasoning is an integral component of mathematics, as practised by professional mathematicians.

For further details, watch the video of ThinQ's webinar "How to Think Like a Mathematician" at our 'events' site (http://www.thinq.education/events) If you want to learn even more, join ThinQ's online course Inquiry and Integration in Education (http://www.thinq.education/iie)

Q-7: any book or link having such examples to practice the problem formulation and critical thinking?
[deepshikha kalra] [deepshikha_ishan@yahoo.co.in] [Q: 6:31 PM]

A-7: The easiest option would be to join ThinQ's online course Inquiry and Integration in Education (http://www.thinq.education/iie)

Q-8: Is there any distinct difference between inquiry in engineering domain to inquiry in science? Is that not inquiry is a set of skills, and it is just applications we are talking off?
[Naren PR] [prnaren@scbt.sastra.ac.in] [Q: 6:37 PM]

A-8: Take a look at the discussion of levels A-C in slide 12 of the handout. The distinction between scientific inquiry and engineering inquiry is relevant at level B, but at level A they share the same core characteristics. For details of thinking like an engineer, take a look at the references given on slide 13. For thinking like a scientist, take a look at *The Evolution of Physics* by Einstein and Infeld. (a pdf is freely downloadable from the web.)

Q-9: How do we make students get interest towards studies as most of them getting diverted because of mobiles movies etc and not concentrating on education
[VIKAS VIPPALAPALLI] [vikasdec23@gmail.com] [Q: 6:37 PM]

A-9: This is an important question. Our answer is: we are also trying to find out; we can work together to look for an answer. Having said that, we must add that if students are exposed to inquiry and critical thinking, they get excited, and they become highly motivated to learn. Perhaps you can try this with your students to find out if this works for you.

Q-10: Difference between level b and level c?
[Muruganandhan P] [mnandhan55@gmail.com] [Q: 6:43 PM].

A-10: Level C is specific to the subject of the students' major. For instance, the distinctions between thinking like a civil engineer, like an electrical engineer, like an aeronautics engineer, like a software engineer, like a bio-engineer, and so on appear at level C. At level B, all of these exhibit a set of shared characteristics common to thinking like an engineer.

Q-11: Dear sir, I know every person have different thinking ability. but I need to know how to enhance thinking ability of students.
[Madhan Mohankumar] [madhanesecme08@gmail.com] [Q: 6:47 PM]

A-11: The easiest option would be to join ThinQ's online course Inquiry and Integration in Education (http://www.thinq.education/iie)

Q-12: how to encourage the students in multidisciplinary aspects
[Kiran Kumar GR] [kirankumargr@pestrust.edu.in] [Q: 6:54 PM]

A-12: One way to do this is to take them through inquiry activities that call for an understanding of multiple disciplines.

Q-13: Sir, In the present internet ear, students are more inclined towards to fast track and having no patience to think critically and solve problems. Can you suggest us how to motivate them to meet the industrial expectations
[PUTRAVU LAKSHMINARAYANA]
[pvslakshminarayana_mme@mgit.ac.in] [Q: 6:55 PM]

A-13: See our answer to Q-9.

Q-14: logical thinking is enough for an engineering graduate?
[Karthikeyan K] [infrakarthik@gmail.com] [Q: 6:57 PM]

A-14: Logic/reasoning is only one of the components of inquiry. It is necessary, but not sufficient. For instance, take another look at the examples on slide 5 of the handout. These are tasks that call for conceptual inquiry, not just reasoning. Scenarios 7-10 in the handout call for abilities that go way beyond reasoning alone.

Q-15: How Indian education would compete world education?
[Shubham Joshi] [shubham.joshi@nmims.edu] [Q: 6:57 PM]

A-15: By ensuring that

a) whatever the learners need in their personal, professional, and public lives after they graduate is included in the curriculum,
b) not crowding the curriculum with information and skills that the learners do not need in their personal, professional, and public lives after they graduate, and
c) providing the foundations for trans-distiplinary inquiry and thinking in Year 1 of the undergraduate program.

As far as we know, a program that combines (a)-(c) does not exist in any part of the world. If the management and administration in any of the universities or engineering colleges in India are willing to go for (a)-(c), ThinQ is happy to help.

Q-16: How can developing critical thinking skills help you as a university student?
[Karthikkumar S] [karthikkumarms@gmail.com] [Q: 6:58 PM]

A-16: University students need to do two things:

1) do well in the exams and other forms of assessment.
2) learn what is valuable for engaging the challenges in their subsequent professional, public and personal lives.

Clearly, (1) has no relevance to (2). In contrast, (2) may have some indirect effect on (1). Critical thinking is crucial for (2).

Q-17: Is class room discussion required to be changed to enhance thinking ablities? pl carify
[DR Gajanan Kotharu] [gajanankotharu1@gmail.com] [Q: 6:58 PM]

A-17: Absolutely. To get a sense of how this can be done, watch the videos at the playlist for a five-day workshop on rational inquiry for 9th graders at https://www.youtube.com/watch?v=NfkQI4LZekM&list=PLyg1zG7Gd9VA8Cu54kllfqgpWNYHCv273 Even though these are 9th-grade students, the classroom activities can be used equally well in class sessions for year 1 undergrad students.

Q-18: For improving thinking abilities in engineering, can we have to change in curriculam /syallbus of engineering?
[Mr. Niraj R. Shingala] [niraj.shingala.me@vvpedulink.ac.in] [Q: 6:58 PM].

A-18: Absolutely. See our responses to Q-5 and Q-15.

Q-19: we are into AICTE model curriculum formulation now. How can we address the above problems?

Dr. Ajay Thakare, Sipna COET, Amravati[Ajay Thakare]
[apthakare40@rediffmail.com] [Q: 6:58 PM]

A-19: The model curriculum, as outlined in the MHRD document "Model Curriculum for Undergraduate Degree Courses in Engineering and Technology January 2018," (https://www.aicte-india.org/sites/default/files/Final Draft _Vol. I _AICTE UG _ Curriculum.pdf) is largely a specification of the structure of the curriculum (names of courses, number of lectures, etc.). It specifies the information and skills that each course ought to include, but it says nothing about

A) the understanding and abilities expected of educated individuals, regardless of their degrees, certificates, courses taken, and lectures attended
B) the understanding and abilities expected of engineering graduates, regardless of their areas of specialisation (e.g., bio-engineering vs civil engineering), and
C) the value of A and B in the personal, professional, and public lives of the graduates AFTER they graduate.

How one can meet the requirements of AICTE and at the same time provide valuable engineering education is a serious challenge. ThinQ is willing to assist.
See our responses to Q-5 and Q-15.

Q-20: We are working for what you have said sir.but the school system and the colleges we work need marks and results
[Mohammed Yacoob B A] [yacoob.mca@cahcet.edu.in] [Q: 6:59 PM].

A-20: We are aware of that state of affairs. But we can still ask, "Despite the system that constrains us, **what can we do** to help our students learn what is of value to them after their exams, certificates and degrees?" If you are a lone faculty member with no support from the management and admin, ask yourself if you can spend ten or fifteen minutes a week to help your class learn something valuable outside the requirements of exams and marks (at least for those students who are interested in what you offer). If you are part of the management and admin, ask yourself if you can allocate at least two hours of the curricular time to help students learn what is of value beyond exams and marks.

Q-21: Is the multiple choices of solution for an engineering problem increasing thinking abilities?
[MOHANRAJ K S] [ksmohanmit@gmail.com] [Q: 6:59 PM]

A-21. NO, if multiple choices are given to you. Quite the contrary. They destroy the natural potential for thinking. See our response to Q-3. If the endeavour is to explore and create new possible solutions, then they contribute towards increasing thinking abilities.

Q-22: Do you feel the present syllabus in engineering matching the expectation of Corporates
[VEERABHADRAM KANDALAM] [kvbvizag@gmail.com] [Q: 6:59 PM]

A-22: NO. All you have to do is to do a google search for 'employability of engineering graduates' to see that most high-end employers are extremely critical of engineering education in India. As a case in point, consider the *Business Today* article titled, "80% of Indian engineers not fit for jobs, says survey," at https://www.businesstoday.in/current/corporate/indian-engineers-tech-jobs-survey-80-per-cent-of-indian-engineers-not-fit-for-jobs-says-survey/story/330869.html 1/4

Q-23: Inculcating values, ethics, creativity and innovation are attributes which need to be inducted from primary levels of education. Can we really induct these in fully grown minds. It is difficut to bend a fully grown tree.
[Krishnakedar Gumaste] [krishnakedar.gumaste@walchandsangli.ac.in] [Q: 6:59 PM]

A-23: We agree that under ideal conditions, we must begin with primary schools. But given that the conditions are not ideal, when it comes to undergraduate education, we must ask: "Granted that school educationis hardly something to celebrate, is there something that can be done at the undergraduate level that will help our students learn what is of value to them after their graduation?" Our answer is YES.

Q-24: As we think that students should have thinking ability, critical thinking and all but scenario is that students are not ready to learn n think beyond syllabus. not even sometimes in syllabus as well
[Dr. Sheetal Dhande] [sheetaldhandedandge@gmail.com] [Q: 7:00 PM]

A-24: Agreed. But now let us ask, "What made them unwilling to learn beyond the syllabus, and not even what is in the syllabus?" Clearly, we the educators and the culture in of our formal education are responsible (By **'we'**, we are not talking about undergrad teachers alone, but everyone from the parents and teachers to education boards and education ministers.)

The next question is: "Can we undo even a little bit of the damage we have done to our children?" Our answer is YES. See our response to Q-23.

Q-25: With a number of specializations, how can we put constraint to the syllabus contents within a span of 4 years of Technical graduation ?
Ajay Thakare, Sipna COET, Amravati [Ajay Thakare]
[apthakare40@rediffmail.com] [Q: 7:00 PM]

A-25: This can only be done by drastically reducing the information overload and making space for 'general education' (what all educated people should understand and be able to do, regardless of heir specialisation and career choices).

Ask yourself how many of our engineering graduates would require Fourier transformation after they graduate. If your answer is, "Only a very small minority," then ask yourself why we are teaching this to the majority for whom it would be useless, instead of teaching them what would be useful.

Q-26: how to improve their thinking ability especially for academic focused students...
[DHAYANANDH S] [dhayacbe79@gmail.com] [Q: 7:00 PM]

A-26: Ask them to register for ThinQ's course Inquiry and Integration in Education (http://www.thinq.education/iie)

Q-27: what's your suggestions for young faculties, for future teaching learning process ?
[Teerthananda Sagar C S] [sagar@drttit.edu.in] [Q: 7:01 PM]

A-27: Register for ThinQ's course Inquiry and Integration in Education
(http://www.thinq.education/iie)

Q-28: what are the changes we have to make with respect to examination systems?
[Ramamoorthi R] [ramamoorthi@skcet.ac.in] [Q: 7:01 PM].

A-28: See our response to Q-3.

Q 29: Are you think Blooms Taxonomnoy enhances the thinking ability of students?
[Matheswaran M. M] [madhume01@gmail.com] [Q: 7:01 PM]

A-29: Bloom'sTaxonomy has several flaws. We won't go into them here. Suffice it to say that it is not particularly useful when it comes to such things as 'analytical skills', 'synthesis' and so on in the context of the subjects taught at the undergraduate level, as these concepts need to be grounded in the norms and practices of academic research, and Bloom did not have a deep understanding of research across disciplinary boundaries.

Q-30: Thinking ability may differ for an individual. How we as a faculty can satisfy the needs of all the students sir?
[Sudha. S Venkatraman] [sudhavenkat009@gmail.com] [Q: 7:02 PM]

A-30: By developing a curriculum for academic thinking in which students are exposed to the tools and modes of thinking in mathematics; the physical, biologica, and human sciences; and the humanities; and supplementing that with what is called 'design thinking' and what may be called 'pragmatic thinking'.

Q 31: one subject to be handled by practising engineer in each year can be made as mandatory by aicte to enhance thinking skill?[
T. Muthu Pandian] [drtmuthupandian@gmail.com] [Q: 7:02 PM]

A-31: If it is just one practising engineer, it is likely to be extremely narrow in its scope. A better alternative would be for a team of practising engineers who have an aptitude for inquiry to design a course on thinking like a practising engineer, drawing upon the habits of thinking from multiple specialisations in engineering.

Q 32: Is examination a good platform to improve the thinking ability in students while their grades are at stake?
[Channabasavanna S G] [channasg1994@gmail.com] [Q: 7:02 PM]

A-32: Yes, but **only** if the exam questions are designed to probe into thinking abilities. Given our exam/test culture:

students learn what they perceive to be important for them to do well in their exams and tests, and

teachers teach what they think is important for the performance of students in exams and tests.

No amount of training or policy documents will have any effect on students and teachers unless we change what is assessed in exams and tests.

Currently, our assessment (final exams, entrance tests, aptitude and talent tests), probe only into

a) recall of fragments of information (without understanding), and

b) high speed mechanical application skills (without understanding or thinking)

If we change the design of assessment tasks to probe into (deep, integrated and critical) understanding and thinking abilities, and then ensure that our syllabuses, learning materials, and classroom activities are aligned to what the assessment demands, there will be a sea change in what students end up learning in their degree programs.

The specifics of how this can be implemented are described in the references given under our response to Q-3.

Q 33: Is it a solution of including case studies for every unit a student goes through in order to improve the thinking abilities and enhancing the problem solving skills?
[Dr S Nagaraja Rao] [drsnrao.ece@gprec.ac.in] [Q: 7:02 PM]

A-33: The so-called 'case study method', extensively used in law schools, is indeed an excellent pedagogy. So is what is called Problem-Based Learning (PBL). And so is Project-Based Learning (also abbreviated as PBL)

But it is important to remember that these are pedagogical means to achieve educational goals. Without a clear sense of what outcomes of learning we are aiming at, the use of pedagogical strategies, even the best ones, are like throwing a stone without any idea of what you want the stone to hit.

Q 34: How can I motivate engineering students to creatively think for solutions for every problem they encounter? becoz being a faculty i teach subjects where students are following procedure rather than thinking why is happens this way? how can i make them to think for the problems? are there any courses or activities or books that i can suggest to students to import them the importance of thinking??
[SANKAR B] [bsmech@tce.edu] [Q: 7:02 PM]

A-34: Ultimately, you will have to create a set of initial problems yourself, and get the studens to engage with them.

Problem-finding and problem-formulating are much harder than problem-solving, so it is wiser to begin with problem-solving, and once the students get a hang of it and begin to enjoy it, you can nudge them to move to the next level.

This is like saying that for most novice cooks, it is easier to implement a recipe. Once they become proficient in recipe implementing, you can nudge them to modify existing recipes, and then to create their own recipes within a cusine. To be a master chef, they will have to create their own cuisines. [This is not the best sequencing for experiment design and experiment implementation. Here, experiment design comes first, but it is hardly ever taught in our schools and colleges.]

Q-35: Different people come from different environment conditions. how do we expect all should have common abilities. and how can we improve thinking abilities in colleges?
[Sarma Adithe] [adithesarma@gmail.com] [Q: 7:02 PM]

A-35: That one person has a talent for dancing, another for drawing, another for painting and yet another for poetry does not mean they cannot all attain basic proficiency in all of them. Likewise, one of our students may have a talent for discovering conjectures, another may have a talent for proving conjectures, and yet another for designing experiments. That does not mean they cannot all develop the baseline for all of these. That baseline is what we need to aim at first. After that, we can mentor special talents of particular individuals, like Bhimsen Joshi nurturing those who have a talent for Hindustani classical singing, or Leela Samson nurturing those who have a talent for Bharathanatyam.

Q-36: Is it that inquiry should be explicitly mentioned as part of the syllabus. Is that not a skill to be associated with any domain (subject). the syllabus is just the knowledge facet of a course / syllabus. In sense do you wish to see inquiry as a standalone course/ subject OR is it part of the any course. I look inquiry to be an non-negotiable essential skill much like analytical skills, so on. Your comments please.
[Naren PR] [prnaren@scbt.sastra.ac.in] [Q: 7:02 PM].

A-36: This is where the scheme in slide 12 in the handout comes in. There are certain common characteristics of transdisciplinary inquiry that are shared across domains (level A), and there are specific characteristics that appear in certain broad domains (e.g., math vs science vs philosophy vs engineering). This is level B. And with each domain, there will be differences between specialisations, such as software engineering vs. civil engineering. This is like saying that all vertebrates have a set of common characteristics, but mammals and non-mammals have characteristics that distinguish one from the other. Within mammals, elephants are obviously different from mice, and both are different from whales and bats. Within primates, humans and chimpanzees have distinct characteristics.

Distinctness does not negate what is common. (At IISER Pune, Mohanan teaches a course called Introduction to Research, in which he focuses on what is shared across mathematics, physical-biological-human sciences, and the humanities. That foundational intro course does not negate a specialised research course to introduce students to research on ants, or research in astronomy, any more than teaching math at a broad level in primary school, to be diversified later as geometry vs. number theory, and at a later stage as spherical geometry or discrete geometry.]

Q-37: Is it possible to transform thinking abilities to the students by giving extra activities in day by day lecture hours? Or Do we have to dedicate a separate tutorial hours to develop such skills? [S S Vivek] [vivek@civil.sastra.ac.in] [Q: 7:03].

A-37: How you juggle with these?

a) the job requirements of 'covering the syllabus' given to you and help students to do well in exams and tests, and
b) helping students become highly educated individuals capable of independent learning, problem-solving, inquiry, critical thinking, invention, and so on is ultimately up to you to decide.

But all of us should be able to spend at least fifteen minutes a week to help our students become educated individuals. Beyond that you can try various strategies such as giving them optional assignments that tap into higher order cognition, conducting optional extra classes, and so on.

Q 38: The kinds of problem-solving is different from mathematician and an engineer
[RAMESH B] [mailrameshece@gmail.com] [Q: 7:03 PM]

A 38: Yes, indeed. Take a look at the Wikipedia entry on unsolved problems in mathematics at https://en.wikipedia.org/wiki/List_of_unsolved_problems_in_mathematics or the list of unsolved problems in Wolfram at https://mathworld.wolfram.com/UnsolvedProblems.html and compare these with the unsolved challenges in eight of the greatest challenges in engineering at https://newengineer.com/insight/8-of-the-greatest-challenges-facing-engineering-1087103

Q-39: Is theoritical writing of exams necessary for an effective engineer??
[Karthikeyan K] [infrakarthik@gmail.com] [Q: 7:03 PM]

A-39: Hardly necessary. How many professional engineers would be asked to write essays on a topic given to them, sitting in an exam hall at a specified time, completing it within the stipulated time? However, most engineers will have to face the challenge of writing clearly and precisely to communicate what they want to say, an ability that is hardly ever tested in exams. See our answer to Q- See our answers to Q-3 as well as Q-32.

Q-40: Is critical thinking and design thinking more or less the same?
[Nirmal Kumar G] [nirmalkmr04@gmail.com] [Q: 7:05 PM]

A-40: No.Critical thinking is the process of evaluating the merit of something. It is relevant in mathematics, physical-biological-human sciences, the humanities, engineering , medicine, and politics. Design thinking is something that is taught in management schools and engineering schools.In involves the knid fo thinking needing for creating something useful to society/mankind.

Q 41: Is current examination system for engineering students correct?
[Jayapal N] [jayapal385@gmail.com] [Q: 7:07 PM]

A-41: See our responses to Q-3 and Q-32.

Q-42: Basic science plays an important role in understanding Engineering. so students should have thinking ability starting from school level too. Is my opinion is correct
[Srividhya Nagamuthu] [srividhyadharmarajan@gmail.com] [Q: 7:08 PM]

A-42: We agree. A great deal of problem-solving in engineering calls for the application of basic science (e.g., the GPS uses Einstein's theory of relativity, Nuclear bombs calls for the application of quantum mechanics.) But there are also instances where the relevant knowledge from basis sciences is not available. In such cases, engineers will have to create the knowledge themselves.