ThinQ
think • inquire • question

The What and How of Learning

By and large, most discourses on educational reform focus on pedagogies: how teachers teach and learners learn. They implicitly assume that learners need to learn a body of knowledge and the skills of application associated with that knowledge. What kinds of learning outcomes should we focus on beyond knowledge content and application? This question hardly ever gets any attention. ThinQ departs from this tradition by focusing on two strands of learning — inquiry and integration — as valuable learning outcomes of any education.

1. The Distinction between Syllabus and Pedagogy

A **syllabus** is a specification of what we expect learners to learn: the *goals* — the expected learning outcomes — of an educational program or course. Statements such as: "We want students to understand the concept of gravity," and "We want students to learn how to multiply a three digit number with another," are part of the syllabus.

Pedagogy is a configuration of the means — methodological strategies — to help learners learn what we expect them to learn. Statements such as: "We ought to employ cooperative learning and flipped classrooms," come under pedagogy.

A curriculum needs to be clear about both the goals we are aiming at, and the means we are going employ to achieve those goals. It needs to specify both the syllabi and the pedagogical strategies, and spell out how the two are *aligned*.

2. Components of a Syllabus

2.1 Knowledge Concepts

Most curricula specify their syllabi as a list of **topics**. For instance, the following topics are found in most school syllabi:

> Line, point, circle, ellipse, polygons, density, weight, mass, boiling point, gravity, force, acceleration, velocity, physical change, chemical change, atoms, molecules, electrons, valence, plants and animals, mammals, primates, health and illness, infectious diseases, democracy, nation, national identity, constitution, stone age, metal age, hunter gatherers, agriculture, Mauryan era, ...

The words in the above list denote **concepts** of knowledge. We may therefore say that the specifications of a syllabus include concepts of knowledge.

2.2 Knowledge Propositions

What is knowledge? A reasonable answer would be:

> *Knowledge is a body of rationally justified* **conclusions**, *a* **configuration of propositions** *that we currently judge to be true beyond reasonable doubt.*

Thus, the twenty first century scientific community judges these propositions as true:

- The *earth* and the other *planets revolve* around the *sun*.
- The earth *rotates* around an *axis tilted* to the *perpendicular* to its *plane* of *revolution*.
- An *atom* is *composed of* a *nucleus* and one or more *electrons*.
- A *prokaryotic cell* does not have a *nucleus*.
- *Stone age* precedes *metal age*.
- All existing and extinct *biological species* on the earth *evolved* from a single species of *unicellular ancestors*.
- *Acquired traits* cannot be *inherited*.
- A *point* has zero *magnitude*.
- A *finite line* has an *infinite* set of points.

The concepts of knowledge (the italicized words in the above statements) are important only to the extent that they allow us to express propositions of knowledge. Hence, the specifications of a syllabus need to include not only the *concepts* but also the *propositions* of knowledge.

2.3 Understanding, Critical Understanding, and Critical Thinking

We want learners to **understand** the concepts and propositions of knowledge. This does not mean that we want them to *accept* all those concepts and propositions. For instance, we may want them to understand that the earth has an ovoid shape, and that it revolves around the sun. We may also want them to understand what it means to say that the earth is flat, and that the sun revolves around the earth, and what the consequences of these statements are. But we cannot expect them to accept the second set of statements as true, nor do we want *them* to blindly accept whatever *we* accept.

To avoid indoctrination through schooling, it is important for schools to help the young to:

- ✓ understand the concepts and propositions currently accepted by the academic community; those that are currently controversial; and those that have been rejected; (broad **understanding**)
- ✓ understand the rational justification (evidence and arguments) for or against these concepts and propositions; (deep and **critical understanding**)
- ✓ develop the capacity to decide for themselves which of these concepts and propositions to accept, which ones to reject, and which ones to set aside for future evaluation. **(critical thinking)**

For this, a syllabus has to explicitly specify:

a) the concepts and propositions of knowledge it expects learners to understand;
b) the subset of these concepts and propositions for which it expects them to have a critical understanding; and
c) the abilities needed to critically evaluate their merit.

If critical understanding is to become an important ingredient of education, textbooks and classrooms need to present evidence and arguments for conclusions that have become what we recognize as the modern worldview (including: "The earth revolves around the sun," "Humans evolved from unicellular ancestors," and "All matter is made up of indivisible particles.") We should also encourage learners to doubt and question assertions made by textbooks, teachers, and "experts". This calls for a thorough rethinking of the nature of syllabi, whether in textbooks, classrooms, or assessment.

If we want learners to develop the capacity to decide for themselves what they should believe and what they should do, critical understanding needs to be combined with the capacity for critical thinking. By critical thinking, we mean *the process of examining the relevant factors for evaluating the merit of something*. This may be the evaluation of the truth of a proposition, the value of a concept, the effectiveness and efficiency of a course of action, the usefulness of a product, the beauty of a work of art, and so on.

2.4 Inquiry

Two strands of critical thinking are the evaluation of

the truth of knowledge propositions (e.g., Should we judge as true the proposition that the earth revolves around the sun?); and

the usefulness of concepts in knowledge building (e.g., Is the distinction between density and weight useful in the study of physical phenomena?)

Both these strands come under what we call **inquiry**.

By *inquiry*, we mean the *pursuit of a question that results in a conclusion that becomes part of our knowledge*. When the aim of inquiry is to make a contribution to the existing body of collective knowledge, we call it **research**. *Research*, then, is *inquiry that aims to make a contribution to the existing body of knowledge*. Such contribution requires deep state-of-the-art knowledge in a specialized domain, and may be beyond the knowledge levels of school students. However, even primary school children can engage in inquiry, if the curriculum provides them the opportunity.

The abilities that go into inquiry are:

- to notice and formulate interesting and worthwhile *questions* to investigate;
- to identify and implement appropriate *methodologies* to investigate the questions;
- to arrive at *answers*, and formulate them as *conclusions* to be presented as *knowledge claims*;
- to *justify* knowledge claims; and
- to *critically evaluate* knowledge claims and their justification.

One meaning of 'constructivism' is the idea that it is important for children to acquire the ability to construct and evaluate knowledge: the ability for inquiry.

2.5 Trans-disciplinary Integration

As mentioned above, research involves a high degree of discipline-specific specialization. In contrast, inquiry abilities relevant for a school curriculum are ***trans-disciplinary***: they cut across disciplinary boundaries.

To take an example, the ability to design and conduct experiments on fruit-flies to understand their social behaviour is highly discipline-specific, and so is the ability to design and conduct chemistry experiments. But the ability to design an experiment to test a hypothesis — whether in the physical, biological, or human studies — is trans-disciplinary. The ability to prove a mathematical conjecture is discipline-specific, but the ability to provide rational justification for a knowledge claim is trans-disciplinary. The ability to investigate concepts in political science (e.g., democracy, government) is discipline-specific, but the ability to investigate abstract concepts in general is trans-disciplinary.

A discussion of trans-disciplinarity in inquiry calls for a distinction between the concepts of ***trans-disciplinary*** on the one hand, and those of ***discipline-specific***, ***inter-disciplinary***, ***and multi-disciplinary***, on the other.

If we treat mathematics, astronomy, physics, chemistry, psychology, human history, economics, philosophy, and literature as *disciplines*, then pursuit of a question in any of these disciplines (e.g., what is the proof for the Pythagoras theorem?) is discipline-specific.

A question that lies at the intersection between two disciplines (e.g., the neural correlates of colour perception as located at the intersection between neuroscience and psychology) is inter-disciplinary. Hyphenated fields like neuro-psychology, neuro-linguistics, mathematical linguistics, physical chemistry, biochemistry, bio-linguistics, socio-biology, and bio-geography are examples of inter-disciplinary fields.

A multi-disciplinary approach involves the investigation of a question from the perspectives and knowledges of multiple disciplines. The problem of protein folding, for instance, calls for the perspectives and knowledges of mathematics, physics, chemistry, and biology, and hence is a multi-disciplinary problem. The investigation of consciousness is multi-disciplinary: it calls for the collaboration of mathematicians, neuroscientists, psychologists, computer scientists and philosophers. The so-called 'thematic' topics like water, light, or environment, belong in the multi-disciplinary realm. Many important questions that we need to address in today's world are multi-disciplinary in nature.

In contrast to these concepts, trans-disciplinarity requires going beyond the level of disciplines and disciplinary boundaries. To take a few examples, the concepts of physical change, chemical change, biological change, cultural change, economic change, and mental change are discipline-specific, but the abstract concept of change itself is trans-disciplinary: it appears in all disciplines, without belonging to any particular discipline. Likewise, the concepts of atomic structure, molecular structure, crystal structure, structure of the cell, skeletal structure, structure of a poem, structure of a word, structure of a sentence, and structure of an argument are discipline-specific, but the concept of structure itself is trans-disciplinary. So are the concepts of observation, correlation, cause, theory, model, laws, evidence, and reasoning.

Of these, the trans-disciplinary concepts of trait, change, structure, system, function, boundary, identity, and so on, are **knowledge concepts** in the sense that they are atomic building blocks with which we construct the edifice of knowledge. Other concepts like theory, model, law, analysis, interpretation, observation, observational report, data point, correlation, causation, explanation, prediction, reasoning, justification, evidence, proof, argument, and so on, are **inquiry concepts** in the sense that they are epistemic strategies for constructing and evaluating knowledge. Knowledge concepts and inquiry concepts that are trans-disciplinary are both important for the design of school syllabi. Trans-disciplinary knowledge concepts **integrate** the *pieces of knowledge* that are currently fragmented into disciplines (physics, chemistry, biology, sociology, history) and discipline groups (mathematics, sciences, 'social science'). Trans-disciplinary inquiry concepts integrate the *discipline-specific research skills* that are currently taught as "research methodology" in different disciplines and discipline groups.

3. Practicing Pedagogical Approaches

Words that refer to different strands of pedagogy include lecture, exposition, active learning, interactive learning, collaborative learning, experiential learning, student-centered learning, activity-based learning, task-based learning, project-based learning, problem-based learning, inquiry-based learning, discovery learning, blended learning, Socratic teaching, didactic method, learning paradigm, flipped classroom, and so on. In contrast, words pointing to different strands of learning outcomes (syllabus) include critical understanding, trans-disciplinary understanding, ability for independent learning, critical thinking, inquiry, teamwork, communicative ability, ethical sensitivity, and so on.

Any of the pedagogical approaches can be used for any of the learning outcomes in the syllabus. But some pedagogical approaches lend themselves better to certain learning outcomes; they are more appropriate, more effective, and more efficient than others. Therefore, given the available options in our pedagogical basket, it is important to make our selection after careful consideration, on a case-by-case basis.

To do this, we need to:

- define, as clearly and precisely as we can, the *pedagogical concepts* referred to by the pedagogy terminology;
- define, as clearly and precisely as we can, the *learning outcomes* implied by the syllabus terminology, and work out their components with as much specificity as we can; and,
- connect the two, by carefully working out the consequences for both in the formulation of syllabi, textbooks, classroom activities, and assessment.

In the absence of the above commitment, the words given to the teachers as 'theories' by 'experts' remain buzzwords and slogans with no practical consequences to what the students end up learning or how they learn.

4. Summary

<table>
<tr><th>Pedagogy</th><th>Syllabus: Learning Outcomes</th></tr>
<tr>
<td>
<u>Concepts</u>
LRN = ‘learning’
active learning
interactive LRN
collaborative LRN
experiential LRN
student-centered LRN
activity-based LRN
task-based LRN
project-based LRN
problem-based LRN
inquiry-based LRN
discovery LRN
blended LRN
lecturing
exposition
socratic teaching
didactic method
flipped classrooms
learning paradigm
…
</td>
<td>
<table><tr><td>independent learning, understanding vs. critical understanding, critical thinking, inquiry-oriented education, multidisciplinary vs. trans-disciplinary understanding, integration …</td></tr></table>
<table>
<tr><th>Discipline-Specific Knowledge</th></tr>
<tr><td>
<u>Concepts</u>
Line, point, circle, ellipse, polygon, density, weight, mass, boiling point, gravity, force, acceleration, velocity, physical change, chemical change, atom, molecule, electron, valence, plant and animal, mammal, primate, health and illness, infectious diseases, democracy, nation, national identity, constitution, stone age, metal age, hunter gatherers, agriculture, Moghal era, …
<u>Propositions</u>
The earth and the other planets revolve around the sun.
The earth rotates around an axis tilted to the perpendicular to its plane of revolution.
An atom is composed of a nucleus and one or more electrons.
A prokaryotic cell does not have a nucleus.
Stone age precedes metal age.
All existing and extinct biological species on the earth evolved from a single species of unicellular ancestors.
A point has zero magnitude.
A finite line has an infinite set of points. …
</td></tr>
</table>
<table>
<tr><th colspan="2">Trans-disciplinary Concepts and Abilities</th></tr>
<tr><th>concepts</th><th>abilities</th></tr>
<tr>
<td>
<u>knowledge concepts</u>
traits, similarities and differences, change, history, evolution, development, structure, system, function, organization, boundary, …
<u>inquiry concepts</u>
belief, rational knowledge, rational opinion, blind faith, rational faith, observation, observational report, data point, measurement, observational generalization, correlation (linear, non-linear, and periodic), variables (independent and dependent), causation, explanation, prediction, observational and theoretical frameworks, theory, model, laws, regularity and randomness, reasoning, logic, classical deduction, probabilistic deduction, defeasible deduction, probabilistic induction, defeasible induction, abduction, speculative deduction, analogical reasoning, justification, grounds, background assumptions, conclusion, claim, logical consistency, simplicity/ parsimony, generality/scope, coherence, …
</td>
<td>
<u>broad abilities</u>
notice and formulate interesting, worthwhile questions to investigate; choose and implement appropriate methodologies to investigate inquiry questions; arrive at answers and formulate them as conclusions to present as knowledge claims; justify knowledge claims; and critically evaluate knowledge claims and their justification …
<u>Specifics</u>
notice interesting phenomena and patterns; formulate the patterns as conjectures or hypotheses; construct and evaluate definitions; notice and formulate conjectures and hypotheses; prove conjectures and test hypotheses; detect logical contradictions; construct, justify, and evaluate explanations and theories; choose between competing explanations, interpretations, and theories; deduce the logical consequences/predictions of theories, …
</td>
</tr>
</table>
</td>
</tr>
</table>

ThinQ will be concerned with discipline-specific knowledge only when it serves to facilitate trans-disciplinary concepts or abilities.

For comments/criticism on this document,
please email: mohanan@schoolofthinq.com or tara@schoolofthinq.com