

higher-level thinking

Questions

Biology

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E D U C A T I O N

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Introduction

In your hands you hold a powerful book. It is a member of a series of transformative blackline activity books. Between the covers, you will find questions, questions and more questions! But these are no ordinary questions. These are the important kind—higher-level thinking questions—the kind that stretch your students’ minds; the kind that release your students’ natural curiosity about the world; the kind that rack your students’ brains; the kind that instil in your students a sense of wonderment about your curriculum.

But we are getting a bit ahead of ourselves. Let’s start from the beginning. Since this is a book of questions, it seems only appropriate for this introduction to pose a few questions—about the book and its underlying educational philosophy. So Mr. Kipling’s Six Honest Serving Men, if you will, please lead the way:



What?
What are
higher-level

thinking questions?

This is a loaded question (as should be all good questions). Using our analytic thinking skills, let’s break this question down into two smaller questions: 1) What is higher-level thinking? and 2) What are questions? When we understand the types of thinking skills and the types of questions, we can combine the best of both worlds, crafting beautiful questions to generate the range of higher-level thinking in our students!

Types of Thinking

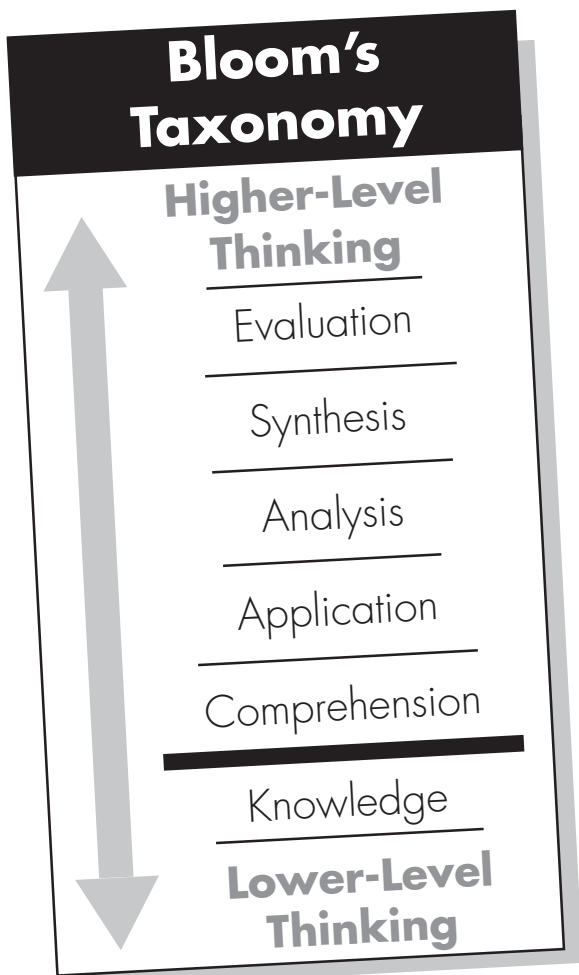
There are many different types of thinking. Some types of thinking include:

- applying
- associating
- comparing
- contrasting
- defining
- elaborating
- empathising
- experimenting
- generalising
- investigating
- making analogies
- planning
- prioritising
- recalling
- reflecting
- reversing
- sequencing
- summarising
- synthesising
- assessing
- augmenting
- connecting
- decision-making
- drawing conclusions
- eliminating
- evaluating
- explaining
- inferring consequences
- inventing
- memorising
- predicting
- problem-solving
- reducing
- relating
- role-taking
- substituting
- symbolising
- understanding
- thinking about thinking (metacognition)

This is quite a formidable list. It’s nowhere near complete. Thinking is a big, multifaceted phenomenon. Perhaps the most widely recognised system for classifying thinking and classroom questions is Benjamin Bloom’s Taxonomy of Thinking Skills. Bloom’s Taxonomy classifies thinking skills into six hierarchical levels. It begins with the lower levels of thinking skills and moves up to higher-level thinking skills:

1) Knowledge, 2) Comprehension, 3) Application, 4) Analysis, 5) Synthesis, 6) Evaluation. See Bloom’s Taxonomy on the following page.

The taxonomy was revised in 2001 by Lorin W. Anderson and David R. Krathwohl to incorporate new research into the framework.



Based on the work of Benjamin Bloom, the changes to the taxonomy were in three broad categories; terminology, structure and emphasis. The most notable changes were:

- Bloom's six major categories were changed from noun to verb forms
- the lowest level of the original, Knowledge was renamed and became Remembering
- Comprehension was retitled Understanding
- Evaluation became Evaluating and moved down below Synthesis, which became Creating.

In education, the term “higher-level thinking” often refers to the higher levels of Mr. Bloom's taxonomy. But Bloom's Taxonomy is but one way of organising and conceptualising the various types of thinking skills.

There are many ways we can cut the thinking skills pie. We can alternatively view the many different types of thinking skills as, well...many different skills. Some thinking skills may be hierarchical. Some may be interrelated. And some may be relatively independent.

In this book, we take a pragmatic, functional approach. Each type of thinking skill serves a different function. So called “lower-level” thinking skills are very useful for certain purposes. Memorising and understanding information are invaluable skills that our students will use throughout their lives. But so too are many of the “higher-level” thinking skills on our list. The more facets of students' thinking skills we develop, the better we prepare them for lifelong success.

Because so much classroom learning heretofore has focused on the “lower rungs” of the thinking skills ladder—knowledge and comprehension, or memorisation and understanding—in this series of books we have chosen to focus on questions to generate “higher-level” thinking. This book is an attempt to correct the imbalance in the types of thinking skills developed by classroom questions.

Types of Questions

As we ask questions of our students, we further promote cognitive development when we use Fat questions, Low-Consensus questions and True questions.

Fat Questions vs. Skinny Questions

Skinny questions are questions that require a skinny answer. For example, after reading a poem, we can ask: “Did you like the poem?” Even though this question could be categorised as an Evaluation question—Bloom's highest level of thinking— it can be answered with one monosyllabic word: “Yes” or “No”. How much thinking are we actually generating in our students?

We can reframe this question to make it a fat question: “What things did you like about the poem? What things did you dislike?” Notice no short answer will do. Answering this fattened-up question requires more elaboration. These fat questions presuppose not that there is only one thing but things plural that the student liked and things that they did not like. Making things plural is one way to make skinny questions fat. Students stretch their minds to come up with multiple ideas or solutions. Other easy ways to make questions fat is to add “Why or why not?” or “Explain” or “Describe” or “Defend your position” to the end of a question. These additions promote elaboration beyond a skinny answer. Because language and thought are intimately intertwined, questions that require elaborate responses stretch students’ thinking: They grapple to articulate their thoughts.

The type of questions we ask impact not just the type of thinking we develop in our students, but also the depth of thought. Fat questions elicit fat responses. Fat responses develop both depth of thinking and range of thinking skills. The questions in this book are designed to elicit fat responses—deep and varied thinking.

High-Consensus Questions vs. Low-Consensus Questions

A high-consensus question is one to which most people would give the same response, usually a right or wrong answer. After learning about sound, we can ask our students: “What is the name of a room specially designed to improve acoustics for the audience?” This is a high-consensus question. The answer (auditorium) is either correct or incorrect.

Compare the previous question with a low-consensus question: “If you were going to build an auditorium, what special design

features would you take into consideration?” Notice, to the low-consensus question there is no right or wrong answer. Each person formulates his or her unique response. To answer, students must apply what they learned, use their ingenuity and creativity.

High-consensus questions promote convergent thinking. With high-consensus questions we strive to direct students *what to think*. Low-consensus questions promote divergent thinking, both critical and creative. With low-consensus questions we strive to develop students’ *ability to think*. The questions in this book are low-consensus questions designed to promote independent, critical and creative thought.

True Questions vs. Review Questions

We all know what review questions are. They’re the ones in the back of every chapter and unit. Review questions ask students to regurgitate previously stated or learned information. For example, after learning about the rainforest we may ask: “What percent of the world’s oxygen does the rainforest produce?” Students can go back a few pages in their books or into their memory banks and pull out the answer. This is great if

we are working on memorisation skills, but does little to develop “higher-order” thinking skills.

True questions, on the other hand, are meaningful questions—questions to which we do not know the

answer. For example: “What might happen if all the world’s rain forests were cut down?” This is a hypothetical; we don’t know the answer but considering the question forces us to think. We infer some logical consequences based on what we know. The goal of true questions is not a correct answer, but the thinking journey students take to create a

Education is not the filling of a pail, but the lighting of a fire.

— William Butler Yeats

Types of Questions

Skinny

- Short Answer
- Shallow Thinking

Fat

- Elaborated Answer
- Deep Thinking

High-Consensus

- Right or Wrong Answer
- Develops Convergent Thinking
- "What" to Think

Low-Consensus

- No Single Correct Answer
- Develops Divergent Thinking
- "How" to Think

Review

- Asker Knows Answer
- Checking for Correctness

True

- Asker Doesn't Know Answer
- Invitation to Think

meaningful response. True questions are more representative of real life. Seldom is there a black and white answer. In life, we struggle with ambiguity, confounding variables, and uncertain outcomes. There are millions of shades of grey. True questions prepare students to deal with life's uncertainties.

When we ask a review question, we know the answer and are checking to see if the student does also. When we ask a true question, it is truly a question. We don't necessarily know the answer and neither does the student. True questions are often an invitation to think, ponder, speculate and engage in a questioning process.

We can use true questions in the classroom to make our curriculum more personally meaningful, to promote investigation and awaken students' sense of awe and wonderment in what we teach. Many questions you will find in this book are true questions designed to make the content provocative, intriguing and personally relevant.

The box above summarises the different types of questions. The questions you will find in this book are a move away from skinny, high-consensus, review questions toward fat, low-consensus true questions. As we ask these types of questions in our class, we transform even

mundane content into a springboard for higher-level thinking. As we integrate these question gems into our daily lessons, we create powerful learning experiences. ***We do not fill our students' pails with knowledge; we kindle their fires to become lifetime thinkers.***

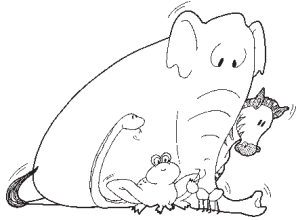


Why?

Why should I use higher-level thinking questions in my classroom?

As we enter the new millennium, major shifts in our economic structure are changing the ways we work and live. The direction is increasingly toward an information-based, high-tech economy. The sum of our technological information is exploding. We could give you a figure how rapidly information is doubling, but by the time you read this, the number would be outdated! No kidding.

But this is no surprise. This is our daily reality. We see it around us everyday and on the news: cloning, gene manipulation, e-mail, the Internet, Mars rovers, electric cars, hybrids, laser surgery, CD-ROMs, DVDs. All around us

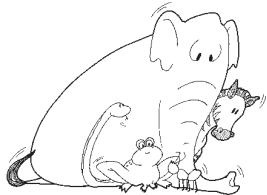


Animals

Question Cards

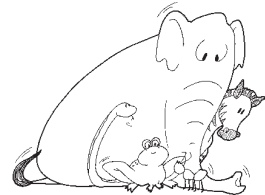
Animals

1 If you could be any mammal besides a human, what would you be? Why?



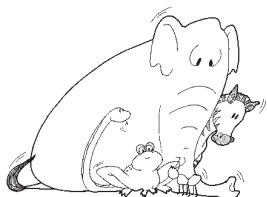
Animals

2 In one sentence how could you describe Kingdom Animalia?



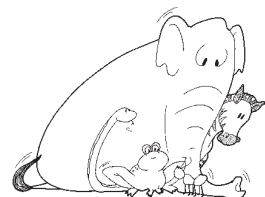
Animals

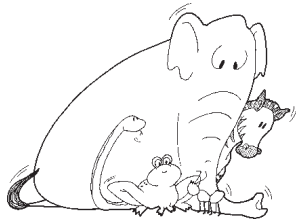
3 What steps are involved in the development of vertebrate eggs?



Animals

4 If you could create a new animal, what would it look like and what would its characteristics be?



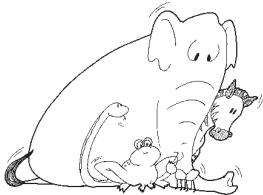


Animals

Question Cards

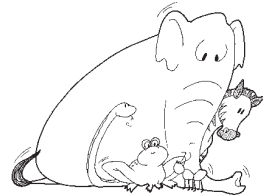
Animals

5 What is your opinion on keeping animals caged in zoos?



Animals

6 If you could pick one extinct animal to return to our environment, which would you pick? Why?



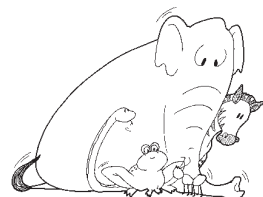
Animals

7 In your own words, what are the similarities and differences among the hearts of fish, birds and mammals?



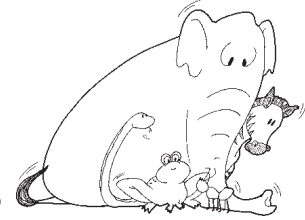
Animals

8 Compare and contrast the structure of echinoderms and arthropods.



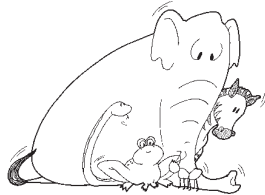
Animals

Question Cards



Animals

9 All animals share several key characteristics; identify these characteristics in picture or symbol form.



Animals

10 What characteristics make crustaceans similar to insects?



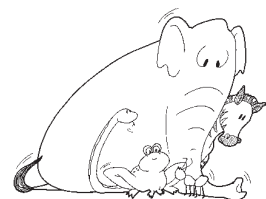
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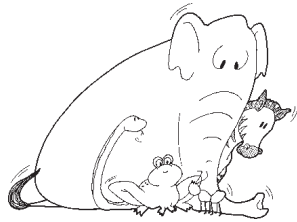
11 Describe why it is more efficient for cells to become specialised in a multicellular animal.



Animals

12 Throughout history, *Porifera* have been classified as plants and animals. What characteristics do they share with each kingdom?



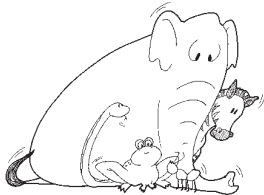


Animals

Question Cards

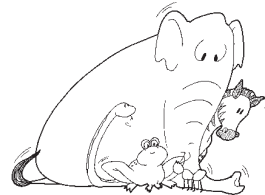
Animals

13 How is the movement of a squid similar to a balloon releasing gas?



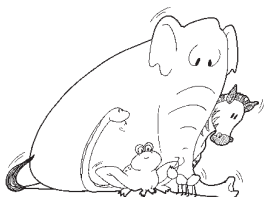
Animals

14 After heavy rain, earthworms are often seen on top of the ground. Why do you think this is so?



Animals

15 If you were the first vertebrate to inhabit the land, what would you have seen?



Animals

16 Compare and contrast the bone structure of a bird and a mammal. What benefits do each have for adaptation and survival?

