This writing looks at an elemental aspect of learning and communication, the question, and contends that questions can be viewed as a technology for education. Questions that we ask in the classroom, online, or in discussion can shape learning and develop skills in students, and they should be more systematically employed in education. This article examines the various ways questions are used in education and builds a research-based taxonomy for effective question use.

The article begins with examining the common use of questions in the classroom, often simple and content focused, but rapid, and disconnected from students; more complex and directed questions that engage students; and the application of questions in online and computer-based education. Structuring our instruction through the use of questions can be effective at developing better, more effective learners, with the goal of development of questioning skills in the learner.

“I have learned a good question is greater than the most brilliant answer.” (Kahn, 1973)

1 The American architect and educator Louis Kahn succinctly summarized the deep value of questions, outlining a challenge for us as educators and learners to explore. He recognized the value of questions both in his work (which includes the Salk Institute, the Phillips Exeter Library, and the British Museum at Yale University) and in his teaching of young architects at the University of Pennsylvania (Kahn, 1973).

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Introduction

In education, the term “technology” has generally referred to electronic, network, and computer systems, and the field of educational technology deals almost exclusively with these narrow aspects of the definition. However, defining technology more broadly as “any systematized practical knowledge” (Gendron, 1977, p. 23) can lead us to examine other aspects of instruction and learning which are essential and elemental parts of the educational process. This essay deals with one of these essential and elemental parts: the question, as employed by teachers, generated by students, and integrated into instruction in all media. These most basic aspects of the instructional method, which lie at the “atomic” level of what we do in the classroom, must be considered, used, and carefully selected, as are more complex technologies like computers or instructional methods.

The goal of this exploration of the question as a technology is to encourage question use in education based on research and in a systematic manner. This will help us make more effective use of the other (perhaps more electronic) technologies that are present. Much of this writing utilizes the premise that computer and electronic methods for instruction are generally developed from theories and research on classroom instruction. Research in the classroom, whether involving computers or not, can and does inform instructional designers in their work. Most of the methods of computer-based and online instruction have their roots in classroom research.

In this discussion, the examination of questions will be informed by research in other venues, and subsequently “transferred” to use in a more extended electronic environment. This writing explores the idea that questions are a technology in and of themselves, while examining some of the research on the use of questions in education that benefit both traditional instruction and the use of electronic media.

This writing will examine common conceptions of technology, engaging a broad definition that includes questions; reviews and summarizes research on questioning; and presents a structured taxonomy for question use in education.

How can technology be defined and what are the implications? What are your limits as to what is a technology? More than twenty years after Richard Clark’s call for a concentration on instructional methods instead of instructional media (1983, 1994), the world view of many in the field of instructional design has remainedcentered on the physical artifacts of technology, such as computers, networks, and mobile devices, and not on the procedures of instruction (cf. Ertmer, 1999). A broader definition of technology, however, one that would include software, systems of knowledge, human components, and the physical artifacts mentioned above, could make a significant difference in how we deliver education.

Economist John Kenneth Galbraith advocated a broader vision of technology: “Technology means the systematic application of scientific or other organized knowledge to practical tasks” (1966, p. 12), and this definition is affirmed in the Definition of Educational Technology published by the Association for Educational Communications and Technology (AECT) (Januszewski & Molenda, 2007). It is widely acknowledged, including discussions within this publication, Educational Technology, and in other writings in the field.

If the term “technology” is to be completely understood, in either ancient or modern terms, it should be seen as a system of practical knowledge not necessarily reflected in things or hardware. In the past, many technological innovations have emerged that involved little or no changes in tools or machines. For example, in the three-field system of crop rotation, often called “the greatest agricultural novelty of the Middle Ages in Western Europe,” no tools or machines were involved (Saettler, 1991, p. 3).

This more inclusive definition of technology would also include genetic engineering, organizational structures such as those used by insurance companies, and at the micro level, questions. Technologies vary in scale and complexity; some are very complex, while others are smaller and comparatively simple. Society has a number of knowledge technologies in common use, such as alphabetization or the Linnaean organization of species. Both calculus and statistics are codified methods for understanding numerical abstractions, and can be considered technologies.

As with any technology, a prime concern is how the technology is used. The use of questions in instruction will determine their value and the value of the questioning methodology. Educators must understand the multiple and divergent uses of the technology, the impacts of their use, and the possibilities for improvement or extended use. At their most basic level, teaching and education have one principal heuristic, that is, encouraging the learner to think harder, i.e., to spend more time concentrating on and engaged with the subject matter at hand. In modern pedagogy, this is effectively accomplished through active learning in

Each of the section titles are in the form of questions as a way of applying the technology presented in this writing, and a means to more fully engage the reader. They seek to connect with the individuals reading this piece by engaging their thinking and structuring the material.

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1 “Pedagogy” in this writing is used as a broad term that includes both pedagogy (the education of children) and andragogy (the education of adults) and is meant to describe the strategies of instruction. In contrast, “education” is an encompassing term that describes both teaching and learning of technical skill, behavior, and knowledge. Teaching and instruction are activities to help others learn.
The underlying notion is that teacher questions stimulate student thought processes. To stimulate more thinking, the teacher should ask more questions, and to stimulate higher thinking, higher questions" (Dillon, 1988, p. 104).

The application of questions begins with early learning in pre-kindergarten and extends to a doctoral dissertation and beyond, eventually creating self-generating learners. As with other forms of technology, it is critical to examine how the details of this technology are effective in practice, whether within the classroom, addressing a text, or as part of online learning.

What is the nature of question use in education? How do you use questions in your teaching? In everyday speech, questions are used in many ways: as requests for information, as exclamations of surprise, and as logical tactics of an argument. They are often used as a form of greeting. While questions themselves are a relatively common part of ordinary discourse, within the classroom most questions posed by teachers are inherently a call for a response and engagement. Most often, they are not a request for information, but rather a part of the educational interaction of the classroom, one that has a power to compel an answer. "Every question, by its very structure, poses a demand for a response...Thus, the primary function of every question...is to elicit a response" (Sigel & Saunders, 1977, p. 9).

Questions are used by teachers in classroom settings for a variety of reasons, including classroom management, verifying student preparation and progress, and information distribution. Of principal interest here is the use of questions as a method of engaging students in the content material; that is, as part of the pedagogical structure of education. Questions are the most frequently used form through which education and educators interact with learners regarding content. They focus learners' attention on information and ideas presented through lecture, reading, or other media, and encourage recall, synthesis, and development of understanding of materials. This interactivity must be balanced with the goals of instruction and with the abilities of the learners. Effectively used, questions can move students from a state of stasis to one of engagement or wonder.

Question asking serves to provide direct confrontation to the equilibrated state of the child, thereby challenging the existing system... Thus, question asking instructional strategies provide a critical exogenous set of stimulations, which creates the conditions for a shift from one cognitive level to another. (Sigel & Saunders, 1977, p. 3)

Piaget's disequilibrium (1960) is the impetus for thought, the ignition of curiosity, one that causes questions as a typology to be powerful. This spark of a question engages the engine of thought, which, as with an internal combustion engine, is a complex, interdependent machine: "To answer a teacher's question, a series of complex cognitive actions occur in the learner; attention to and decoding of the question by the learner; developing a 'covert' or private response, answering through an 'overt' response, and revising one's response due to other answers or stimuli" (Gall, 1984, p. 42). This cognitive effort builds schema or knowledge structures within the brain.

One ongoing premise of education is that an increase in cognitive activity aids retention; question use is meant to increase cognitive activity, and hence, learning. "Currently, advocacy of question-asking as an instructional strategy rests on pragmatic sources, namely, question-asking promotes thinking" (Sigel & Saunders, 1977, pp. 1–2). (See also Walsh & Sattes, 2005.) And from this premise begins much of the effort of instruction. Through this common premise, there is an expectation of question use, one that may drive the extensive use of questions in education.

How have questions been used in instruction? Does questioning increase thinking and learning? Many means of teaching, from classroom recitation to textbooks to online discussion sessions, are based on instructor questioning (Berge & Mulineburg, 2000). Specifically, within the classroom, a structured sequence of questions posed by teachers is a common method of instruction. Educators view classroom questioning as an important element in their instructional palette: "...indeed, the professional consensus today is that teachers' questioning of students is an important variable in student achievement" (Redfield & Rousseau, 1981, p. 245).

Historically and conventionally, questions have been the backbone of instruction; research has been completed on the use of questions in education for over 100 years (see, for example, Floyd, 1960; Gall & Ashchner, 1963; Stevens, 1912; Yamada, 1913). The hundreds of questions the typical American teacher asks on a typical day reflect the great popularity of the recitation method. A recitation is basically a series of teacher questions (usually about textbook content), each eliciting a student response and sometimes a teacher reaction to that response. (Gall, 1984, p. 40)

Two principal generalizations connect much of the research on classroom questioning. First, in general, teachers ask a large number of questions over the course of typical class sessions. This is an observation which is consistent over time and within divergent cultures (Dillon, 1982, 1987). Stevens (1912) estimated 80% of classroom time was devoted to questions, and that the average school day included 395 questions per teacher. The recitation form of instruction, a rapid interaction centered on the use of teacher questioning, was also found to be prevalent in classrooms by other, later

Research has also found questions were often posed at a rapid rate, with little time allowed for student reflection or student response. Studies citing question rates of greater than one per minute are common, and elementary teachers have been observed asking more than two questions per minute. Both McGee (1980) and White and Lightbrown (1984) observed four questions per minute in the classroom.

Questions posed by teachers can be categorized as fact or text-based, recall questions, and more complex, deeper, thought-based questions. Bean (1985), for example, generally labels questions as being either text-explicit or higher-order. “Fact questions require students to recall previously presented information, whereas higher cognitive questions require students to engage in independent thinking” (Gall, 1984, p. 40).

In practice, most posed questions deal with factual recall of information. “The majority of questions entail the recall and recitation of actual information previously taught or studied; some few questions bear on speculative, evaluative, and other cognitive manipulation of information; and the remainder are conversational and managerial” (Dillon, 1988, p. 103).

Deep thinking is not sought through challenging questions in most classrooms: “Only about 4% of the questions asked by teachers are deep questions” (Sigel & Saunders, 1977, p. 3). This finding is stable across many research studies and across research methods, and is a generalizable characteristic of the use of questions in the classroom, in spite of the broad acceptance of higher-order thinking as a goal.

Educators generally agree that teachers should emphasize the development of students’ skill in critical thinking rather than in learning and recalling facts. Yet research spanning more than a half-century indicates that teachers’ question have emphasized facts. (Gall, 1970, p. 712)

The presence of questioning in the classroom and in education is clear and dominant. As questions are the principal form of discourse within the classroom, question content, ordering, structuring, and the purposeful use of questions are challenges for every teacher and in every educational venue. Those aspects have been well-examined through research, which can inform use of questions in education.

How is questioning related to learning? In general, the use of questions does improve retention. Research by Gall et al. (1978) indicates question-based recitations increase content learning when compared to individual review of educational materials without questions. In comparing various instructional protocols using recitation and non-recitation-based instruction, they found question-based recitation substantially improved retention. This finding is supported by Rosenshine et al. (1996), who compared three large correlational studies and found that student retention-based learning supported by teacher questioning was most substantial when questions were focused and “narrow.”

Research has also shown that retention can be improved by increasing the intervening time or after posing a question and after receiving a response (Rowe, 1974). As noted earlier, classroom questioning is rapid, and many teachers typically wait about one second before posing the next question or responding to student answers. Rowe (1974) found teachers commonly asked subsequent questions less than one second after a student response. Extending the wait time has been found to have beneficial effects, including increasing the number of responses and improving classroom engagement (Swift & Gooding, 1983; Tobin & Capie, 1982). This simple change could broadly affect teaching and learning.

How can questions improve reading? Wait time after questioning is primarily a concern of oral instruction. In contrast, reading has some cognitive advantages: Readers can review and revisit various parts of the text, and response time for written questions generally is not a concern. Similarly, electronically enhanced instruction, which often is based on written text, can be programmed to allow sufficient time during questioning for student responses. Asynchronous online education inherently allows reflection time for learners in responding to questions.

Research on reading can provide a means to examine when questions are most effective within the learning process. Questions may be posed before, within, or after a reading. In each case, instructor/author posed questions affect how learners retain what they read, as well as develop their own skills in understanding texts; see Table 1. And, given the significant engagement with reading in an online environment, examining each mode of questioning could give guidance to the development of text-based online learning and the effectiveness of electronic materials.

Pre-reading questions can help instructors mentally prepare learners for a text, helping structure their understanding. Unfortunately, simple, focused, or fact-based pre-reading questions tend to (negatively) economize the reading of the learner, focusing their attention on the direct solutions needed (Bean, 1985). In contrast, higher-order or more open-ended pre-reading questions tend to encourage a deeper understanding of texts (Gall, 1970).

Integrated or interspersed questions may also help in understanding and retention of written material. As pre-read questions help learners mentally organize prior to reading, integrated questions assist in mentally structuring the material, and retention is increased. Summative research by Andre (1979) and Faw and Waller (1976) on
textbooks with and without inserted questions indicated that learning is enhanced with inserted questions.

However, as with any interruption, integrated questions may cause some readers to lose concentration, while others, less able to read extended passages of text, may be helped and use the questions as stepping stones. As with pre-reading questions, internal text-based questions ".may discourage critical reading and encourage rote memorization" (Bean, 1985, p. 342). Finally, questions posed after reading of texts may help understanding of the material (Bean, 1985), particularly if used in conjunction with instructor-led discussion about the read materials. Presence and location of questions does have an impact on learning from text.

What's the broader view on the use of questioning? How could questions advance higher-order thinking? With all types of instructional questions, there is strong practice and research-based argument that questions used for instruction can improve learning. While this improvement is most demonstrable with information-recall questions, its value may be limited as teachers seek to educate more than rote learners. As Dillon sarcastically noted:

Factual teacher questions do seem to help students learn factual information, as measured by their answers to factual test questions that in effect repeat the factual teacher questions previously asked and answered during classroom lessons. Yet tested achievement of factual information is only one specific of the class, learning. Educators also posit attitudes, habits, skills, and behaviors to be learned. (1988, p. 110).

Implied and directly stated in Bloom et al. (1956) through Anderson et al. (2000) is a recognition of the need to educate students beyond the retention of facts, and to develop within them higher-order abilities to synthesize, analyze, and generate new ideas. This recognition leads us, as educators, to examine how questions can be used to develop higher-order thinking, directly, and on a long-term basis, through the technology of the question.

Use by teachers of higher-order questions does appear to increase learning, although this has been more difficult to generalize through research. Two major meta-analyses, using the same core data, reached conflicting results. Winne (1979) and subsequently Redfield and Rousseau (1981) both examined the same 17 research studies of the use of higher-order questions in the classroom. A greater number of studies surveyed by Winne found little or no improvement through the use of higher-order questions, and he concluded that higher-order questions were not effective at increased learning.

Aggregating the full data set, Redfield and Rousseau (1981) employed a more advanced meta-analysis (from Glass 1977) of combined effect sizes to "determine the magnitude of the treatment" (p. 359) and found a positive effect size of .729 standard deviations where higher cognitive questions were predominately used in the classroom. With predominant use of higher cognitive questions, there appeared to be a positive effect on student achievement.

How individual learners respond to higher-order questions varies as to the context and the skills of the learners. Lower performing students respond better to fact-based questions, while more skilled students benefit more from higher-order questions (Carlson, 1991; Gall, 1984). In addition, students often base their mental efforts on their anticipation of testing format gleaned from questions posed by teachers. For example, a fact-based recitation structure implies a fact-based examination. Given a goal of more than simple learning, teacher questions should include multiple formats, using fact-oriented questions and the higher-order questions within the same context; both addressing a range of student skill levels and continuing to develop the deeper thinking skills among all students.

Teachers' questions that require students to think independently and those that require recall of information are both useful but serve different purposes. The challenge for teachers is to use each type to its best advantage. (Gall, 1984, p. 41)

Who should be asking questions? Questions, like any technology, need to be used appropriately for the context to be more effective for learning. And while thus far this writing has examined the common and valued use of questions in teaching, it is also important to recognize the learners' use of questions as a means to knowledge and higher-order thinking. Essential to the development of good, knowledgeable thinkers is their own ability to

<table>
<thead>
<tr>
<th>Question location</th>
<th>Positive effects</th>
<th>Negative effects</th>
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<tbody>
<tr>
<td>Before reading</td>
<td>Focuses attention of the learner; more efficient reading.</td>
<td>Cherry picking by reader of important materials; less overall understanding.</td>
</tr>
<tr>
<td>Within reading</td>
<td>Helps structure material while reading; enhances learning; helps readers complete longer passages.</td>
<td>Interrupts flow of reading concentration.</td>
</tr>
<tr>
<td>Post-reading</td>
<td>Works with post-reading discussion; structures understanding.</td>
<td>Does not structure reading experience.</td>
</tr>
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Table 1. Effects of questions and reading.
generate questions to understand experience and to develop new knowledge and skills.

Researchers in cognitive science and education have routinely advocated learning environments that encourage students to generate questions.... There are several reasons why the process of question generation might play a central role in learning. The most frequently articulated rationale is that it promotes active learning and construction of knowledge.... Another reason is that question asking has the potential for enhancing motivation because information acquisition is student centered. Yet another reason is that question asking encourages the learners to develop sophisticated metacognitive skills. (Graesser & Olde, 2003, p. 526)

Within the classroom, however, questions usually aren't asked by students, which separates them from the generation of knowledge by at least one step; “Classrooms are full of questions but empty of inquiry” (Dillon, 1988, p. 115).

How could students ask more questions? Many factors conspire to discourage student questions; factors which are both instructional and sociological. Most instructional methods, such as recitation and lecture, do not allow ample time for student questioning; classes are often rigidly scheduled to cover content through information distribution (Dillon, 1987; Graesser & Person, 1994). In addition, other forces discourage student questioning, such as:

...peer norms within the classroom society and without; relationships between adults and children; socialization into institutional and situational authority roles; the predominant goals of education and structures of schooling. Students have good reason not to ask questions. (Dillon, 1988, p. 106)

Through media and previous schooling, students have been inadvertently trained to be passive receivers of information, not responsible for their own learning. And, as would be expected, students are often unskilled in monitoring their own understanding: “The truth is that the vast majority of learners have trouble identifying their own knowledge deficits and ask very few questions” (Graesser & Olde, 2003, p. 526).

What about learners who ask questions? The recent reorientation of education, to a more constructivist approach, encourages a corresponding change in the initiator of questions and answers. No longer are teachers the sole authors of questions, as questions from learners are coming to the fore. The cognitive value of student-initiated questions has been seen; questions generated by the learner are most likely to generate knowledge in the learner (Dillon, 1988). This change in learning philosophy is exemplified by the theories of problem-based learning, active comprehension, cognitive tools, and constructivism (cf. Hannafin, 1994; Jonassen, 1995; Jonassen & Reeves, 1996).

In solving more complex problems or higher-order tasks, however, the challenge cannot easily be codified in terms of a sequence of steps or sub-routines. Generalizable strategies or heuristics must be used to understand, analyze, and resolve these problems. “It could be argued that questions are at the heart of virtually any complex task that an adult performs. That is, any given task can be composed into a set of questions that a person asks and answers” (Graesser & Olde, 2003, p. 524). Having the ability to ask salient questions is a basic step in solving complex problems, from reading prose to designing a building or managing a business (Kahn & Twombly, 2006; Martin, 2007; Rosenshine et al., 1996).

When students do ask questions they tend to ask the type and quantity of questions which have been modeled by teachers. As most classroom teachers pose fact-based simple questions, most student questions are also fact-based. However, when instructors ask higher-order questions, students are prone to ask more higher-order questions as well (Dillon, 1982). And training in question generation and asking does prove to be successful in developing questioning skills and behavior in learners (Wong, 1985).

The educational value of student questioning is strong. Generating questions focuses learner attention on the task at hand, giving the learner an active role in the process. While authoring questions, cognitive processing is often deeper and more thorough than is caused by externally generated questions. “...the relationship between student questioning behavior and subsequent academic achievement—‘learning’—is positive” (Dillon, 1988, p. 106).

Generating questions does not lead directly, in a step-by-step manner, to comprehension. Rather, in the process of generating questions, students need to search the text and combine information, and these processes help students comprehend what they read. (Rosenshine et al., 1996, p. 182)

Higher-order question development also encourages more higher-order processing, which should result in better understanding (Rickards & Di Vesta, 1974; Wong, 1985). Wong reviewed a series of 27 studies which examine whether students, taught to generate their own questions, developed a greater understanding of read materials. The generation of higher-order questions positively correlates with higher exam scores (Graesser & Person, 1994).

The authorship of questions is part of complete development as a learner in any domain (Davey & McBride, 1986; Rosenshine et al., 1996). The generation of questions by students within learning tasks also helps develop their questioning skills for transfer to other
contexts. As meta-cognition and ‘learning to learn’ are often shared goals of instruction and of instructional design, the ability to author questions is an important learner-based skill.

[Research] findings suggest that effective question generation can provide readers with a meta-cognitive strategy (heightening awareness of their own comprehension adequacy) as well as a cognitive strategy (generating and answering higher level think-type questions). (Davey & McBride, 1986, p. 260)

Developing the curiosity of a lifelong learner requires a shift from teacher-initiated questions to learner-generated questions. Developing skill in the authorship of questions leads to an independent ability to learn; "...toward a continual, ongoing search for better opinions, decisions, or judgments” (Browne & Keeley, 2007, p. 2).

Recent developments in curriculum development have moved in the direction of problem-based learning, seeking more complexity and authenticity in learning. This type of mental challenge encourages the learner to take more responsibility for learning, and the complexity and challenge of the problem, endless, seems to pull learners forward, engaging them with their own questions. Problems could be defined as complex, multi-level questions; within each problem, there inherently are multiple sub-problems or questions to be solved.

Problem-based or design-based learning shifts the cognitive effort and learning from the instructor to the student (Dillon, 1987). It also shifts the generation of questions to the mind of the learner.

To ask a question of someone implies more than a need for information. It also implies a proper structure of knowledge with which to formulate the question and to interpret the response. Thus, the ability of a person to think of an appropriate question on a topic matter is a complex function of the knowledge of that topic. (Miyake & Norman, 1979, p. 357)

Questions that learners pose are highly reflective of students’ own understanding of the content. First, the number of questions posed by learners may have some significance. Experts ask more questions than novices, hypothetically because they have a knowledge structure to which to attach new knowledge, and can recognize gaps in their knowledge structure. Instruction or content which is well matched to learners will generate the greatest number of questions. In general, if few questions are asked by learners, material may be too difficult or (ironically) too simple.

Learners who have an understanding of the material should have sufficient structure of domain knowledge and an ability to identify discordances/shortfalls in their structure, which could be expressed through questions.

**Table 2. Using questions.**

<table>
<thead>
<tr>
<th>Levels of question use in classrooms</th>
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<tbody>
<tr>
<td>• Questions as method of control</td>
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<tr>
<td>• Questions for simple content retention, rapid speed,</td>
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<tr>
<td>often without answer</td>
</tr>
<tr>
<td>• Questions paced to elicit responses; waiting for an</td>
</tr>
<tr>
<td>answer</td>
</tr>
<tr>
<td>• Deeper questions resulting in more advanced answers</td>
</tr>
<tr>
<td>• Questioning as model for learner’s own questions</td>
</tr>
<tr>
<td>• Learner-developed questions as means for evaluation</td>
</tr>
<tr>
<td>• Question use strongly integrated in curriculum</td>
</tr>
</tbody>
</table>

Evaluation based on answers may eventually be supplanted by a better understanding of learners through an evaluation of their questions (Abrandt-Dahlgren & Öberg, 2001; Graesser & Olde, 2003).

Graesser and Person (1994) did find that question format (of student-authored questions) correlated with exam scores; higher-order questions or deeper questions were generally authored by more advanced learners. Here again, question types are readily discernible. Higher-quality questions are described as “meaning-oriented, relational, and value-oriented” (Abrandt-Dahlgren & Öberg, 2001, p. 264); “live” (Paul & Elder, 2006, p. 120), and “...corresponding to ‘why’, ‘why not’, ‘how’, ‘what if’, and ‘what if not’...” (Graesser & Olde, 2003, p. 533).

**What does this mean for education and instructional design?** Much as the field of instructional technology continues to develop a methodology regarding the use of computing, educators should develop an organizing structure for the intentional use of questions in instruction and learning, that is, a methodology of question use. As directed by the research reviewed earlier, this methodology should include posing questions within instruction to challenge learners to think rather than solely as a means of checking learners’ memory (or homework); to pose questions that need new answers as well as known answers; to seek answers that are complex (e.g., analysis, synthesis, judgment, creation) as opposed to simple; and to become skilled at generating their own questions; see **Table 2**.

Questions could be integrated into the full curriculum, at all forms and levels of instruction, and interspersed throughout instruction. Questions can be used to ready learners, to help pace their reading experience, and to encourage them to develop an understanding of the content; here, specifically, higher-order questions are needed as part of a range of question types.
For the instructor or designer, there is also a necessity to employ the technology of the question with skill. Within instruction, it begins with posing questions to appropriately challenge learners; as a scaffolding and structuring method to help learners understand, and also as appropriately paced oral instruction. Instructors need to actively solicit student questions from students, if they truly wish to encourage independent thought in their learning, and to carefully work with each student response. Learner responses must be truly valued, and the pace of discourse should allow time for reflection and thought. In this case, the dynamic and evaluative nature of the human instructor is critical (Carlsen, 1991; Gall, 1984; Redfield & Rousseau, 1981; Swift & Goodyng, 1983; Tobin & Capie, 1982).

Curricula should also seek to build skills in the technology of questions. In other words, specific attention should be paid to training in the posing of questions by learners, and in the development of an understanding of the value of questions. Specifically, the goal must be to develop an understanding, or more accurately, a “literacy” in the use of questions by learners. These advances in the use of questions, from simple to complex, and from teacher-developed to student-generated could change the instructional paradigm of education (Abrandt-Dahlgren & Öberg, 2001; Dillon, 1982). See Figure 1 for a visual summation of these concepts.

**How could the use of questioning affect assessment?** As questions are reflections of one’s understanding of a topic, evaluation of questions could form a strong element of instruction. A current clear signal to perceptive students is that evaluation indicates educational value, and valuing questions in this way could build the ability of students to ask questions on an ongoing basis (Dillon, 1982; Graesser & Olde, 2003). In brief, what is evaluated indicates that which should be learned, both in terms of form and content.

A formal structure of question use, that is, a taxonomy, may be of some value. Taxonomies are ordered and abbreviated sets of guidelines, i.e., codified heuristics of larger, more complex theories and methodologies of practice. For example, Bloom et al. (1956) summarized a wide range of educational theory and research into a focused and easily applicable taxonomy that is widely used by many teachers. While the specifics within each instructional context will vary, a taxonomy of question use could pilot teachers and developers of instructional materials: “Thinking about questions in terms of some scale of cognitive difficulty is probably still heuristically useful for teachers, but inherently imprecise for research” (Cazden, 1988, p. 453). Taxonomies and heuristics for question use would encourage greater question use, more higher-order questions, more complex questions or problems, and an eventual shift to student-initiated questions (cf. Hokanson & Hooper, 2004). Significantly,

![Figure 1](https://example.com/figure1.png)

**Figure 1. Application of classroom question use.**

the following taxonomy supports the development of learner-initiated questioning and the development of meta-cognitive skills.

**How can we structure question use?** Questions within education can also be conceptualized through a num-
Table 3. A taxonomy of question use.

<table>
<thead>
<tr>
<th>Epistemology</th>
<th>Questioning becomes a way of learning and knowing for teachers and students; question quality is used as a means for evaluation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Strategy</td>
<td>Questioning is integrated by learners in their regular process, applied in other domains.</td>
</tr>
<tr>
<td>Instructional Method</td>
<td>Questioning is planned; delivery and pacing intentional; questions range from recall to complex. Pacing allows for thought and response from learners. Generally teacher-centric.</td>
</tr>
<tr>
<td>Instructional Tool</td>
<td>Question use is narrow, focused, and unplanned; answers less relevant. Teacher-centric.</td>
</tr>
</tbody>
</table>

number of terms commonly used in education, here used to structure a taxonomy, as in Table 3.

The lowest level of question use in the classroom is as a tool. Vygotsky (1978) contended that tools could refer to words and other intangibles; tools are generally conceptualized as being single-purpose or task-focused. As with other divergent conceptualizations, questions could act as tools as well as exist within the broader definition of a technology. Questions are used as a management and monitoring device by teachers, and in terms of course content, as a modestly interactive way of restating information. Describing questions as a tool in the classroom describes their use to check learning, control conversations, deliver information, and demand attention.

A more advanced level of question use would be as part of a skilled instructional method. As instructors recognize the value of skilled use of questions, the methodology of teaching will change, as evidenced by increased planning and organization of classroom questions; by an increased skill in the delivery and pacing of questions consistent with educational context; and by a diverse range of type of questions, using both recall and higher-order questions (Bean, 1985; Carlsen, 1991; Gall, 1984; Redfield & Rousseau, 1981).

Shifting question initiation to the learners is a significant level beyond skilled teacher questioning, and follows from a learning environment with complex questions and problems. Questioning becomes part of the learners' regular cognitive strategy; it is a valuable skill present in the development of most advanced learners (Abrandt-Dahlgren & Öberg, 2001; Dillon, 1988; Wong, 1985).

The highest level of this taxonomy is the creation within the learner of an epistemology of questions; the ongoing use of questions in the development of their own knowledge, presupposing an understanding as how knowledge is acquired. While this is perhaps closest to the best use of questions, the term technology may be more functional in this context, recognizing a conscious use of questions as a technology for both teaching and learning, and recognizing the full range of question use from tool to epistemology.

Translating these concepts to the design of instructional materials (whether on paper or online) may be more achievable than in the live classroom. With instructional materials, pacing and structuring of questions (which is critical to success) can be developed in a more considered and planned environment than in the live classroom. Evaluation, however, may be more difficult than previous electronic instruction as answers become more divergent (Abrandt-Dahlgren & Öberg, 2001; Dillon, 1982; Graesser & Olde, 2003).

In any case, most machine-based and online instructional systems could easily be used to solicit questions in lieu of answers, shifting the cognitive effort to the learners. Humans would still evaluate the work, much as they do now, and/or other learners could be engaged in the evaluation through answering as well, which could also have significant cognitive benefits.

Research on the use of questions in instructional design and in teaching remains valuable. Research may also be of value to develop an understanding of self-generated questions vs. task-generated questions, i.e., intrinsically or extrinsically motivated questions.

What are the results of this redirection? How will you change your use of questions? Questions assist learning through mental challenge and engagement. More challenging, better used, and higher-order questions are more effective at improving learning. Improvement within education will come from encouraging learners to ask their own questions and in their developing their own knowledge structures. This shift occurs through student questioning, "active comprehension," and problem- or design-based learning. These are valuable directions for the field of instructional design to support; the field has recognized the need to move the technology to the learners; here, in this writing, the technology is the question itself.

Posing questions as a technology recognizes the diverse levels of use and the scale of integration which are needed. Learners, instructors, and instructional designers all need to be literate with this technology. The conception of questions as a technology means questions are not solely used as a small-scale tactic but as a holistic and active strategy, one which can reorder education.
In piercing the fourth wall of this journal article (as theatre productions often extend their acting into the audience off the three-walled proscenium stage), the reader is now personally challenged to apply the concepts presented, and to answer the questions: How do you use questions in your teaching? Or in your online classroom? How could one use questions as a technology in teaching? How do you solicit questions from your learners?

References


