

Chapter 2:

Background Information

Men occasionally stumble over the truth, but most of them pick themselves up and hurry off as if nothing ever happened. (Sir Winston Churchill)

A pessimist sees the difficulty in every opportunity; an optimist sees the opportunity in every difficulty. (Winston Churchill)

This book is about some roles of games in informal and formal education. Many people see Games-in-Education as an opportunity to help improve our educational system. Others see the difficulties and downsides of using or increasing the use of games in education. (See the two quotes from Winston Churchill at the beginning of this chapter.)

For many people, games are intrinsically motivating. Educational research tells us that intrinsic motivation contributes substantially to learning. From an educational point of view, the issues are what does one learn through playing games, how does this learning relate to helping students achieve agreed upon goals of education, and what roles should teachers and other mentors play?

This chapter provides some background that will help us explore some possible roles of games in improving our informal and formal educational systems.

Types of Games Considered in this Book

In this book, the word *game* is taken to include both electronic and non-electronic games and puzzles. Crossword puzzles, brain-teaser puzzles, card games, board games, and a variety of computer games are all included. The discussion in this book is also applicable to both computer and non-computer *simulations* of real world physical sporting games such as Baseball, Basketball, Football, and Soccer. However, the discussion is not designed to cover physical sports as one finds in the winter and summer Olympic games.

Many games are playable both in a computer mode and a non-computer mode. For example, many solitaire card games and Poker games require only a standard 52-card deck. Many of these can also be played on a handheld electronic game device, a game machine, or on a computer. In this book, the term *computer game* is taken to include all electronic games, whether they are played on inexpensive battery powered handheld devices, game machines, computers, or computer networks such as the Web.

The 84-page document ([Mitchell and Savill-Smith, 2004](#)) is a British government-funded review of the computer game literature. The following quote from this document helps to define the words *play* and *game*.

First, **play**: something one chooses to do as a source of pleasure, which is intensely and utterly absorbing and promotes the formation of social groupings (Prensky 2001, page 112). Fun, in the sense of enjoyment and

pleasure, puts us in a relaxed receptive frame of mind for learning. Play, in addition to providing pleasure, increases our involvement, which also helps us learn (Prensky 2001, page 117).

...

Second, a **game**: seen as a subset of both play and fun (Prensky 2001, page 118). A game is recognised as organised play that gives us enjoyment and pleasure (Prensky 2001). Dempsey et al. (1996, page 2) define a game as: ...a set of activities involving one or more players. It has goals, constraints, payoffs and consequences. A game is rule-guided and *artificial in some respects*.

The Mitchell and Savill-Smith document draws upon the work of Prensky (2001). Four chapters of that book can be accessed free on the Web.

The (Mitchell and Savill-Smith, 2004) survey of the literature was oriented toward learning and educational values of games. This may help explain the mention of learning that appears in the definition of play. As I think about this, I am reminded of a statement I have heard many times—that the “job” of young children is to play.

Here is another definition:

Garris et al. (2002) define game play as “voluntary, nonproductive, and separate from the real world” (p.459). On the other hand, Jones (1999) points out that **for some people, computer and video games are real and sometimes, they are more engaging than reality**. Computer games can be categorized as adventure games, simulation games, competition games, cooperation games, programming games, puzzle games, and business management games (Hogle, 1996, citing from Dempsey et al., 1993; Jacobs & Dempsey, 1993). During the past 40 years, computer games have been played from a floppy disk, CD-ROM, with the use of email, or online through the Internet. Computer games can be played individually, against the computer, or against other people face-to-face or on-line. ([Asgari & Kaufman, n.d.](#)). [Bold added for emphasis.]

Notice the bolded statement in the above definition. For many people, games are attention grabbing and attention holding. They are intrinsically motivating, and they may be addictive. This is an important idea to keep in mind as you explore possible roles of Games-in-Education. I am interested in how games can be used to improve education. At the same time, I am fully aware that games can damage a person’s education and other aspects of their life. For example, it is well known that gambling games have seriously damaged or destroyed many lives!

Here is another quite useful way to think about games (Costikyan1994):

Games provide a set of rules; but the players use them to create their own consequences. It's something like the music of John Cage: he wrote themes about which the musicians were expected to improvise. Games are like that; the designer provides the theme, the players the music.

A game is a form of art in which participants, termed players, make decisions in order to manage resources through game tokens in the pursuit of a goal.

My doctorate is in mathematics. Thus, it is not surprising that I pay particular attention to games that have been developed to help teach mathematics. For the most part, the examples that I have studied tend to have both poor attention-grabbing characteristics and poor entertainment value. They do not compete with games that children chose to play for entertainment. However, a later part of this book will explore some math games.

Goals of Education

Education has many goals, and each person tends to have their own ideas as to what constitutes a good education. David Perkins' 1992 book *Smart schools: Better thinking and*

learning for every child, contains an excellent overview of education and a wide variety of attempts to improve our educational system. He analyzes these attempted improvements in terms of how well they have contributed to accomplishing three basic and enduring goals of education.

The following list of educational goals is an extension of his work.

1. **Acquisition and retention of basic, important, knowledge and skills.** There is considerable agreement that reading, writing, arithmetic, speaking, listening, and information retrieval are basic and important for all students. Even then, however, there is disagreement about ways to achieve these goals in a cost effective manner that has a very high probability of success. There is less agreement on what students should learn in the fine and performing arts, health, science, social science, physical education, and other commonly taught disciplines.
2. **Understanding of one's acquired knowledge and skills.** *Understanding* tends to be difficult to define and measure. However, there is considerable agreement nowadays that education must proceed far beyond rote memorization.
3. **Active use of one's acquired knowledge and skills.** This includes being able to transfer one's learning to new settings, and being able to analyze and solve novel problems. We expect our educational system to:
 - a. Provide challenging and rigorous programs of study designed to help each student become a literate, responsible, creative adult citizen.
 - b. Help each student learn to learn, learn to take responsibility for their own learning, understand his or her capabilities and limitations as a learner, and to develop persistence and other lifelong habits of learning.
 - c. Help each student learn to help others learn. In this, it is helpful to think of each student as a teacher. For example, students often help each other and their siblings to learn, and parents spend a lot of time in "teacher" mode.
 - d. Help each student learn to cope with technological, social, and other forms of change that will be occurring during his or her lifetime.

This book explores a variety of games in terms of how they contribute to achieving the types of goals listed above. You will note that these goals are quite general—they do not speak to students gaining knowledge and skill in specific disciplines. In that sense, these goals fit in well with a student gaining in cognitive development and cognitive maturity.

However, learning in specific disciplines is an important aspect of getting a good education. There is quite general agreement that students should gain a substantial level of expertise in reading, writing, math, science, and social science. Many people support the idea that all students should acquire knowledge and skill in using calculators and computers as a general aid to problem solving. Even within these disciplines, however, there are considerable differences of opinion as to what students should learn and how they should demonstrate their knowledge and skills.

Games-in-Education as a Discipline of Study

The field of education can be divided into many different disciplines. Similarly, the field of games and gaming can be divided into many different disciplines. This book explores some of the overlap between education and games. As illustrated in Figure 2.1, the overlap can be thought of as a discipline called Games-in-Education.



Figure 2.1. Venn diagram illustrating Games-in-Education.

The Games-in Education discipline received increased legitimacy in October of 2003 when the Massachusetts Institute of Technology announced an initiative to study educational roles of computer games (Games-to-Teach Project, n.d.). Many colleges and universities now offer undergraduate and graduate degree programs in computer games—a rapidly growing component of the entertainment field.

Games-in-Education is a large and rapidly growing discipline. This book provides a limited introduction to some of the important ideas in this discipline.

Expertise

It is useful to think about learning in terms of how it contributes to increasing one’s level of expertise in a discipline or in some particular more limited area. Figure 2.2 shows a general-purpose expertise scale.

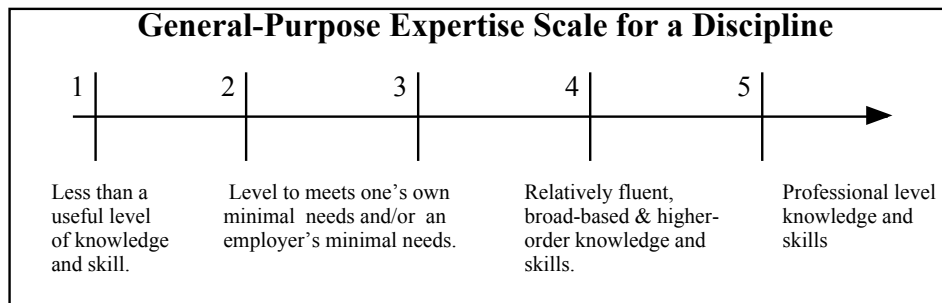


Figure 2.2. Expertise scale.

The words *expert* and *expertise* do not mean the same thing. From an informal and formal education point of view, through training, education, and experience, a person can gain increased expertise in a particular area. If the person has an appropriate level of “natural” ability and works long enough and hard enough at increasing his or her expertise in an area, the person develops a high level of expertise. If this level is sufficiently high, the person may be considered to be an expert. In comparing experts in a discipline, we sometimes talk about someone as being a national expert or world-class expert.

There has been substantial research on the natural ability, education and training, perseverance and determination, time and effort, and so on that it takes for a person to gain a very high level of expertise. As a rough rule of thumb, it takes 10,000 to 15,000 hours of hard work to “be all you can be” in a particular area.

For example, consider a six-year-old girl who seems to have the physical ability to become a good gymnast, ice skater, or swimmer. Twelve years later, this girl (now a young woman) competes in the Olympics. She has probably put in about 10,000 hours achieving her current level of skill. She has had excellent coaches and training facilities for a good part of this time.

Many years ago I earned a doctorate in mathematics and began to write papers that were accepted for publication in refereed journals and to work with doctoral students. I had probably put in 12,000 hours achieving my PhD level of mathematical research expertise. I was good, but by no means world class.

After completing my doctorate, I became interested in writing books to support my teaching interests. I have authored or co-authored about 40 such books. I estimate that I have spent more than 20,000 hours writing—developing, honing, and using my writing skills.

Chess players ranked in the top 10 in the world are likely have put in 15,000 to 30,000 hours or more gaining their chess skills. In 2006, the average age of the top 10 players in the world was about 30 years. People who play chess at this level usually put in well over 2,000 hours a year developing, honing, and maintaining their chess skills.

Benjamin Bloom (probably best known for Bloom’s Taxonomy) was the editor of a 1985 book *Developing Talent in Young People*. The authors of this book studied 120 people in six different disciplines who rose to world class levels. The time they had spent in their specialty areas varied somewhat with the specialty. The pianists who were identified and studied had a mean age of about 23 when they achieved world-class stature. On average, they had been begun taking piano lessons at age 6.

I find it interesting to compare these numbers with the amount of formal schooling that students receive in K-12 education. K-12 education in the United States is about 14,000 hours in length. Estimates are that only about 1/2 to 2/3 of this time is actually used productively. However, we can add to the total the time that is productively spent on homework and informal educational activities. Thus, we might conclude that the focused, productive time students spend in K-12 education is about the amount of time it takes for a person to develop a high level of expertise in a narrow discipline such as chess, gymnastics, math, piano, or swimming.

Bloom’s analysis of young people achieving at a world-class level provides many examples of students doing well in school while putting in a thousand or more hours per year in their specialty area. This requires careful scheduling of time and a high level of sticking to the task. The single mindedness of purpose and high standards that these young people deal with tend to be very helpful in later careers.

K-12 formal schooling time is divided among a substantial number of different discipline areas that are taught in various schools around the country. Many of these disciplines have national standards that have been developed by professional societies and other groups. See, for example, the lists provided by the Mid-continent research for Education and Learning at <http://www.mcrel.org/standards-benchmarks/>.

The research data on how long it takes a person to achieve their potential in a discipline can be compared with data on how much time our K-12 schools are able to devote to teaching various discipline areas. Suppose, for example, that a school system places a very strong emphasis on reading and writing, with two hours per school day just in this area. This means that a student would get about 4,600 hours of formal schooling in this area during K-12 education. Suppose, at the same time, the school system devotes an hour a day to math. This amount to about 2,300 hours in total.

This sort of analysis suggests why college education is so helpful. It also suggest why schools tend to focus so much attention on the “hard core” basics, and downplay or eliminate the “frills.” I hear many people say:

How could we possible let a student who is struggling in math and reading spend any significant amount of school time on art, music, sports, or games? At the current time, many people are saying, “If it isn’t on the state or national tests, then we should not be wasting school time on it. We need to spend all of our school time getting students to meet the state and national standards. We need to do a lot better in international competitions in the areas of these standards.”

Indeed, there are continuing demands to increase the length of the school day and the length of the school year.

Two of the things missing from the above (in my opinion, quite short sighted) point of view are each individual student’s intrinsic motivation, and striving to meet individual needs and interests of individual students. Intrinsic motivation and striving to meet the individual needs of different students are two of the most important ideas in education. The basics are important. However, there are many other important educational goals that are not on the state and national tests. A few examples include:

1. Learning to learn and to help others learn; learning about one’s strengths and weaknesses as a learner.
2. Learning to work both individually and collaboratively in problem solving. Working with a team, on a large, long, challenging project.
3. Learning for transfer of learning.
4. Learning to improve one’s creativity.
5. Learning that helps increase one’s level of cognitive development and cognitive maturity.
6. Learning to make effective use of new aids to solving problems and accomplishing tasks, such as computer modeling and other aspects of Information and Communication Technology.
7. Learning to make use of all of the above in doing things—developing products; doing performances and presentations; solving challenging, complex problems; and accomplishing challenging, complex tasks.

There are many ways to approach these important educational goals. This book presents ways in which Games-in Education can help.

Competition, Independence, Cooperation

Each game can be analyzed from a point of view of its:

- Cooperation/collaboration .
- Independence (not cooperative, not competitive) ,
- Competition leading to the determination of winners and losers.

Of course, a game may have components falling into each of these categories. Sometimes, it is not easy to decide which categorization best describes a particular game.

Let's use a crossword puzzle from the morning newspaper as an example. Suppose I work alone (independently) doing a crossword puzzle. I am not competing "head-to-head" with anybody, and I am not cooperating with anybody.

Later in the day, I might talk to a friend who also does the crossword puzzle from the same morning newspaper. We might talk about how hard or easy the puzzle seemed to be. We might talk about how long it took us to complete the puzzle, or how many clues we were unable to decipher. We might even discuss a particular clue, in a cooperative effort to figure it out.

Thus, we see how the independence of puzzle solving can be modified to being somewhat competitive and/or somewhat cooperative. Moreover, a social interaction dimension can be added to the overall activity. Often such social interaction can be considered as being cooperative/collaborative in nature.

Some games have a strong social interaction characteristic. This can be seen in many board and card games that children play. Many people play Bridge or Poker mainly for the social interaction. However, Bridge and Poker can also be played as highly competitive games. Thus, one might analyze a social Bridge-playing or Poker-playing event both in terms of its cooperation (for social purposes) and its competition (who wins; who loses).

The idea of independence is worthy of further exploration. Suppose I am a recreational bowler. I bowl alone, but I keep a careful record of my scores. Thus, I can tell if I am doing better, about the same as, or worse than I have in the past. This can be thought of as me competing with myself. However, in my opinion that is a poor use of the idea of competition. Competition is a win-lose situation.

This is a very important idea in education. Suppose education is considered as a type of game that is designed for independence, rather than for competition or cooperation. As a learner, my goals might be to learn, to get better at learning, to learn to use my learning, to better myself, and so on. I take satisfaction in the process of learning, in having learned, and in using what I have learned.

However, it is very helpful to have measures (for my own personal use) of how well I am doing. Am I a better reader than I was last month? Do I understand quadratic equations better than I did a week ago? Can I sight read music and play it on a piano better than I could two years ago?

Moreover, keep in mind that each person is different, and that there are quite large differences in abilities, interests, drive, and so on. I may well want to have some information about what others are doing and able to do, but my focus is upon myself as a learner. In some sense, I want to "be all I can be."

As an example, consider learning to keyboard for input to a computer. Personally, I can keyboard much faster than I can handwrite or print, and my keyboarded materials are far more legible than my handwriting or printing. Moreover, keyboarding in a word processing environment is a great aid to my writing, as the spell checker and grammar checker find many of my errors, and the word processor aids my in my revision efforts. From time to time, I feel a certain amount of envy of people who can keyboard faster and more accurately than me, or who are better at spelling. In essence, however, keyboarding for me is neither competitive nor cooperative. My (independent) expertise in keyboarding is at a sufficient level to be a great aid to achieving my writing goals.

Contrast independence this with a competitive model of education. The competition can be with other students, or it can be with “norms” that have been established for various state and national tests. The learner’s goal becomes one of winning.

- “I got the top score in our class on this test!”
- “I am the best speller in my school!”
- “I am the fastest keyboarder at my grade level in our school!”

Another type of competition is scoring high enough to meet some specified requirements.

- “I have passed both the reading and math tests required for graduation!”
- “I scored high enough on my SATs to get into an Ivy League school!”

Still another way to look at competition-independence-cooperation is to consider competition versus cooperation. Competitiveness is a genetic characteristic, and all people are competitive. However, people vary considerably in the nature of their competitiveness, and competitiveness is strongly influenced by one’s home environment, community environment, and culture.

Moreover, research suggests that males (on average) are more competitive than females. Put another way, the research suggest that on average, females are more cooperative/collaborative than males.

Knowing this, how should we design our educational systems? Research in education supports the cooperative/collaborative approach over the competitive approach. This research indicates that designing schooling along cooperative/collaborative approaches is more effective than designing them along competitive lines. See the three quotes given below:

It takes Kohn an entire book to summarize the massive data indicating that competition in our society is harmful. Yet, our culture proclaims (without adequate supporting data) just the opposite, that competition is efficient, healthy, and fun. Actually, hard research data documents that people achieve more if they work cooperatively with others (than if they work competitively). We are so brainwashed, we find that hard to believe. (Think of it this way: trying to do your best is very different from trying to beat everyone else.) On the other hand, we can readily accept that a competitive job, school, or social situation, where someone wins by making others fail, causes dreadful stress, resentment of the winner, contempt for the losers, low self-esteem, and major barriers to warm, caring, supportive relationships. What is the solution? Kohn recommends replacing competition with cooperation, i.e. working together, assuming responsibility for helping each other do our best, and uncritically valuing each other's contributions. We need lots of research to help us to know when and how to reduce our competitiveness. To change our goals in life from competition to cooperation, we need new values and a new philosophy of life (see chapter 3). Competition implies a hierarchy; cooperation implies equality. (Tucker-Ladd, 2000)

Gorriz and Medina (2000) also examined children using computer games, finding that girls prefer collaboration, non-closure and exploration, and games that require both thought and puzzle-solving skills while boys prefer competition. (C.O.P.E.,n.d.)

Despite a recent surge of popular journalistic books (e.g., Fillion, 1997; Simmons, 2002; Tanenbaum, 2002), academic interest in competition among women was almost nonexistent until the 1980s. Initial research (Gilligan, 1982; Goodwin, 1980; Lever, 1976) found that girls tended to avoid competition in favour of tactics that diffuse conflict and preserve interpersonal harmony. When competition is made inevitable, girls used apologies and excuses to mitigate their behaviour (Hughes, 1988) or "double voicing" to promote their own cases while simultaneously taking into account the positions of their rivals, thereby preserving their relationships (Sheldon, 1992). This attenuation of competition in favour of sustaining positive relationships is thought to reflect socialisation into cultural norms against the overt expression of conflict among females (Miner & Longino, 1987; Tracy, 1991) and the greater centrality of intimate friendships to girls than to boys (Brown, 1998). (Campbell, 2004)

Here is a brief summary of this section:

1. With a little effort, a person can find games that meet his or her interests in or orientation toward competition, independence, and cooperation. There are lots of games in each category, and many games have overlapping characteristics.
2. If we think about our overall educational system as a game, we can see competitive, independence, and collaborative aspects of this game. In many cases, we can see a mismatch between the characteristics that an individual student desires and the characteristics that our educational system forces on the student.
3. The field of Games-in-Education can contribute to creating a school environment that better fits the individual competition-independence-collaboration needs of students.

Learning to Learn

While some people learn faster and better than others, we are all quite good at learning. We are all lifelong learners.

There has been quite a bit of research on how to help students learn faster and better. Somewhat surprising to me is that this is an area in which our educational system **has not** done a good job of translating theory into practice. You might test this out on yourself. Can you name any research that educators have done in the past two decades that specifically focuses on how to help students learn faster and better? Can you point to specific school wide and school district wide curriculum designed to help students learn to make use of these research results?

For example, metacognition and other reflective practices are very important in learning. Research indicates that even preschool age children can learn to do metacognition and can learn to reflect on their problem-solving and other activities. Are such metacognitive and reflective practices a routine part of the teaching/learning in schools that are familiar to you?

As another example, consider the fact that the Web is now the world's largest library, and that most students have access to the Web. Just because one has access to the Web does not mean that one has gained the knowledge and skills to make effective use of this global library as an aid to solving problems and accomplishing tasks. Moreover, this library is quite different than a static, print material based library. It is dynamic, with a significant portion of its content

changing over the course of a day. Moreover, this library is interactive, and a significant part of its content is in the form of “I, the computer, can do it for you.” A search engine, for example, does a tremendous amount of work for the person making a search. The Web provides access to many computer programs that are designed to solve certain categories of problems. Relatively few students are learning to learn and solve problems in this environment.

As a third example, consider computer-assisted learning and distance learning via the Internet. While these modes of teaching and learning are growing in importance, few students are receiving explicit instruction on how best to make use of these aids to learning. Individual students are not learning whether or how well such teaching/learning environments fit their individual needs.

For a final example, consider the idea of self-assessment and of becoming an independent, self-sufficient learner who takes responsibility for his or her own learning. If anything, our current educational system seems to be moving away from this idea. Certainly, our schools could be doing a much better job of empowering students.

Situated Learning and Transfer of Learning

Situated learning and transfer of learning are two important components of the discipline called **learning theory** (OTEC, n.d.).

Situated Learning

Brown, Collins, and Duguid (1989) is a seminal article on situated learning. Quoting from the introduction to this paper:

The breach between learning and use, which is captured by the folk categories "know what" and "know how," may well be a product of the structure and practices of our education system. Many methods of didactic education assume a separation between knowing and doing, treating knowledge as an integral, self-sufficient substance, theoretically independent of the situations in which it is learned and used. The primary concern of schools often seems to be the transfer of this substance, which comprises abstract, decontextualized formal concepts. The activity and context in which learning takes place are thus regarded as merely ancillary to learning pedagogically useful, of course, but fundamentally distinct and even neutral with respect to what is learned.

Recent investigations of learning, however, challenge this separating of what is learned from how it is learned and used. The activity in which knowledge is developed and deployed, it is now argued, is not separable from or ancillary to learning and cognition. Nor is it neutral. Rather, it is an integral part of what is learned. Situations might be said to co-produce knowledge through activity. Learning and cognition, it is now possible to argue, are fundamentally situated. [Bold added for emphasis.]

Situated learning is a learning theory focusing on the situation or environment in which a particular learning activity occurs. For example, suppose that you are walking down a jungle path and you hear a particular sound that your brain/mind does not immediately recognize. You “freeze,” carefully look around, and see a large snake.

Your brain/mind recalls that a friend of yours was seriously injured several weeks ago by a snake, and the description the friend gave seems to fit this snake. You immediately learn that the sound you have heard in this jungle trail environment is associated with a dangerous snake. Likely, this learning will last a lifetime. Moreover, the learning occurs very quickly—this is apt to be an example of one-trial learning.

Contrast this with being a student sitting in a classroom that is in a large school located near your home. You live in a large city, and there are few or no dangerous snakes within miles of your home. You are viewing a video discussing dangerous snakes. You see and hear video of approximately the same scene as the jungle walker. However, the room you are in is hot and stuffy, you have just had lunch and you are sleepy, and the audio is turned up too high for your ears. What do you learn, and how long does this learning stay with you?

One of the reasons why a game can be a good learning environment is that the game player is immersed in the environment (the situation) of the game. The attention grabbing and attention holding characteristics tend to shut out distractions.

Low-Road/High-Road Transfer of Learning

The low-road/high-road theory of learning has proven quite useful in designing curriculum and instruction (Perkins and Solomon, 1992). In low-road transfer, one learns something to automaticity, somewhat in a stimulus/response manner. When a particular stimulus (a particular situation) is presented, the prior learning is evoked and used. The human brain is very good at this type of learning.

Low-road transfer is associated with a particular narrow situation, environment, or pattern. The human brain functions by recognizing patterns and then acting upon these patterns. Consider the situation of students learning the single digit multiplication facts. This might be done via work sheets, flash cards, computer drill and practice, a game or competition, and so on. For most students, one-trial learning does not occur. Rather, a lot of drill and practice over an extended period, along with subsequent frequent use of the memorized facts, is necessary.

Moreover, many students find that they have difficulty transferring their arithmetic fact knowledge and skills from the learning environment to the “using” environment. One of the difficulties is recognizing when to make use of the memorized number facts. In school, the computational tasks are clearly stated; outside of school, this is often not the case.

This helps to explain why rote memory is useful in problem solving, but critical thinking and understanding are essential in dealing with novel and challenging problems. It also supports the need for broad-based practice even in low-road transfer. We want students to recognize a wide range of situations in which some particular low-road transfer knowledge and skills is applicable.

Math education in schools tries to achieve an appropriate balance between rote memory critical thinking by making extensive use of word problems or story problems. In word problems, the computations to be performed are hidden within a written description of a particular situation. The hope is that if a student gets better at reading and deciphering word problems—extracting the computations to be performed and the meaning of the results—that this will transfer to non school problem-solving situations.

It turns out that it is quite difficult to learn to read well within the discipline of mathematics. Many students have major difficulties with word problems and with learning math by reading math textbooks. Their depth of understand of math and their ability to read math for understanding stand in the way of their being able to deal with novel, challenging math problems that they encounter.

High-road transfer for improving problem solving is based on learning some general-purpose strategies and how to apply these strategies in a reflective manner. The *build on previous work*

strategy is an excellent candidate to use to begin (or, expand) your repertoire of high-road transferable problem-solving strategies. To do this, think of a number of personal examples in which you have used this strategy as an aid to problem solving. Mentally practice what you did in each case. In the near future, each time you make use of this strategy, consciously think about its name and the fact that you are using it. Also, in the future when you encounter a challenging problem, consciously think through your repertoire of high-road transferable problem-solving strategies. Your goal is to increase your ability to draw upon this repertoire of aids to use when faced by a challenging problem.

The *break it into smaller pieces strategy* is another example of a high-road transferable strategy. This strategy is often called the divide and conquer strategy, and that is the name that will be used in the remainder of this book. It is helpful to have short, catchy names for strategies. A large and complex problem can often be broken into a number of smaller, more tractable problems. It is likely that many of your students do not have a name for the strategy and do not automatically contemplate its use when stumped by a challenging problem.

Here is a summary of some key ideas in problem solving. Suppose you are faced by a problem. Then your approach might be:

1. If the problem fits a memorized pattern in which you can apply stimulus/response, low-road transfer, your mind/body may react automatically and the problem may be quickly solved.
2. If (1) is not successful, think about the domain or general discipline of the problem and whether you have encountered the problem or a quite similar problem in the past. If you have specific knowledge and skills relevant to the problem or problem areas, draw upon this contextual, situational knowledge and skill in a conscious and considered manner to attempt to solve the problem.
3. If (2) is not successful, draw upon your general knowledge and skills in how to attach a new, challenging problem. Here, a large repertoire of high-road transferable problem-solving strategies is helpful.

Figure 1.3 illustrates these three approaches and provides an indication of how fast each may be in a particular situation.

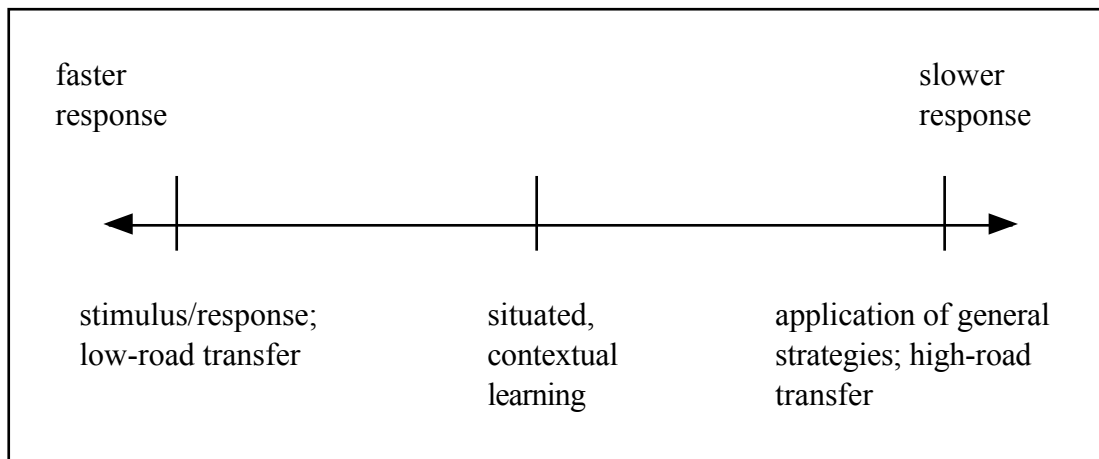


Figure 1.3. Often used approaches to problem solving.

In our exploration of strategies, we will emphasize teaching and learning for high-road transfer within the games domain and to other domains. Here is a strategy for such teaching and learning:

1. Identify the generalizable strategy that is being illustrated and used in a particular problem-solving situation.
2. Give the strategy a name that is both descriptive and easily remembered.
3. Working with your students, identify a number of different examples in other disciplines and situations in which this named strategy is applicable.
4. Have students practice using the strategy in a variety of areas in which it is useful, and where students have appropriate general and domain-specific knowledge.
5. In your everyday teaching, you will frequently encounter situations in which a particular problem-solving strategy is applicable, and you have previously helped your students gain some initial expertise in using the strategy. Take advantage of such situations by clearly naming the strategy (or, asking your students to name the strategy) and working with your students to refresh their memories on use of the strategy in a variety of situations.

Learning in a Game Environment

Think about your roles as a parent, teacher, or other adult figure facilitating a child learning to play a game and then playing the game. What might you do to increase the child's cognitive, social, emotional, and kinesthetic growth in a manner that will transfer to other games and to non-game environments? As you think about this, you will realize that Games-in-Education is a very challenging discipline!

You know that for a child, learning to play a game and then playing the game are closely interconnected. Indeed, much of the learning occurs during the playing. This is a good example of a learn-by-doing, hands on learning environment. The learning is in context (situated learning). The learning is immediately useful, contributing to being able to play the game and/or to play the game better.

This is sort of an immediate gratification situation. Contrast it with the delayed gratification that is common in most formal schooling. Many students are not impressed by statements such as: “You need to learn this so that you can use it in your course next year” or “Your need to learn this because it will be on the test next week.”

Teachers understand the gratification issue. They recognize the value of having students immersed in a combination of learning and doing. This ties in closely with discovery-based learning. Thus, many teachers try to create learning environments in which students make immediate use of their new learning. However, this is a challenging educational problem, and often teachers do not succeed very well in meeting this challenge.

For example, suppose that students are learning how to solve a particular type of math problem. Their use of this new knowledge and skill consists of doing a whole bunch of this type of problem. Contrast this with a student learning a new type of chess opening and then immediately using it in a chess game against an appropriate opponent. The new opening is used in the context of playing the overall game, and it adds to the fun of playing the game. It becomes part of the chess player’s repertoire of openings. The chess literature contains detailed analyses of thousands of different chess openings (that is, sequences of opening moves). A good chess player is apt to have memorized a large number of opening sequences.

Think for a minute about the opening move in competitive game such as chess or checkers, and the opening sentence in a piece of writing. There are many different types of writing situations. While rote memorization of a range of first sentences might be helpful, a much better approach is to understand the various types of writing situations and what one is trying to accomplish in an opening sentence in these different situations. Thus, you can see that the writing challenge is much more complex than the opening move challenge.

Moreover, if you teach writing, you may see that we have raised an interesting topic you can discuss with your students. Rote memorization is quite useful in improving one’s skill as a chess player. How useful is it in improving one’s skill as a writer? When playing a game such as chess, one gets relatively quick feedback on how well one is doing. Contrast this with the feedback situation in writing. This line of thinking suggests to me that it is very important for writers to learn to provide immediate feedback to themselves. As a writer, I also know that delayed feedback from others is also essential to improving the quality of a document that I have written.

Precise Vocabulary and Notation

Figure 1.4 shows a chessboard. Notice that the columns (the files) of the 8 x 8 board are lettered a, b, ... h, and the rows (the ranks) are numbered 1, 2, ... 8. In chess, the person playing the White pieces always moves first. The lettering and numbering notation used to identify the spaces on the board is convenient and natural from the point of view of the person playing the White pieces.

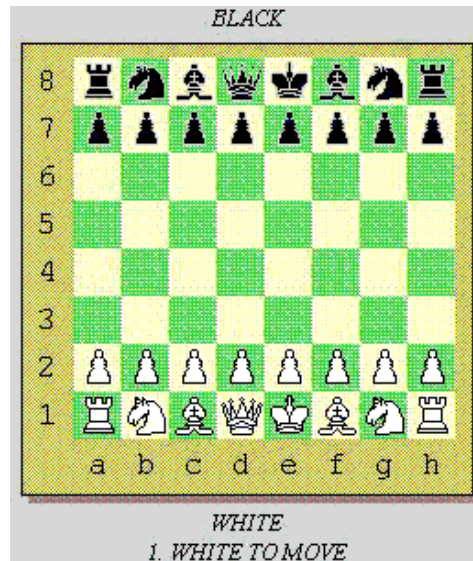


Figure 1.4. Lettering of columns and numbering of rows.

The names of the pieces are abbreviated as follow: K=King, Q=Queen, R=Rook, B=Bishop, N=Knight, and P=Pawn. This board coordinate system and the piece name abbreviations make it quite easy to record all of the moves in a game. For example, here are the first few moves of a game. The listing indicates that White's Bishop captures Black's Knight on White's fourth move.

1. Pe4 Pe5
2. Nf3 Nc6
3. Bb5 Pa6
4. BxN

This, and other notational systems that are widely used in chess, allow players to precisely record the moves in a game (Calvin, n.d.). Such a written record can be used in writing about, talking about, and studying a game.

Keeping a detailed record of one's chess games and studying both one's own and other people's games is a strategy used to improve one's level of expertise in chess. Is this type of strategy applicable to other games? Is it applicable to non-game learning and problem-solving situations? Of course it is. So, let's give this strategy the name. Let's call it the *record one's moves strategy*. This is what a researcher does when conducting research in any field. Details of the research need to be precisely recorded so that the researcher and/or others can duplicate the experiment. Thus, it should be part of the repertoire of high-road transferable problem-solving strategies that you and your students routinely draw upon.

The *record one's moves strategy* helps to explain why each discipline tends to have some special notation and definitions of terms that are unique to the discipline. It is absolutely essential that people working in a discipline be able to accurately record the work they are doing so that it can be precisely communicated to others and to themselves. A novice in a discipline needs to learn the precise notation and vocabulary in order to take advantage of the accumulated

knowledge in the discipline. That is, part of learning a discipline is to learn to read (for understanding) in the content area of the discipline.

Although our educational system places considerable emphasis on students learning to read in the content areas, this is such a challenge to readers that our schools do not experience a high level of success in the endeavor. Part of the process of learning to read in the content areas is to develop an understanding of what it means to read for understanding, and to be able to self-assess one's understanding. My analysis of research on reading in the content areas suggests that if a person gets good at reading in one content area, there can be substantial transfer of the "reading in a content area" skill to reading and learning to read in another content area.

A Few Important Research Findings

A Google search conducted 6/6/06 on

games OR gaming AND research AND education

produced about 167 million hits. Obviously, this search needs to be substantially narrowed! However, it suggests that many people are involved in conducting or writing about Games-in-Education.

Some parents and teachers feel that substantial and useful learning from games will occur merely through providing a child the opportunity to play games. However, Conati and Klawe (2000) indicate this is not sufficient:

These results indicate that, although educational computer games can highly engage students in activities involving the targeted educational skills, such engagement, by itself, is often not enough to fulfill the learning and instructional needs of students. This could be due to several reasons.

One reason could be that even the most carefully designed game fails to make students reflect on the underlying domain knowledge and constructively react to the learning stimuli provided by the game. Insightful learning requires meta-cognitive skills that foster conscious reflection upon one's problem solving and performance [2, 4, 24], but reflective cognition is hard work. [Bold added for emphasis.]

The Conati and Klawe research helps to make clear important roles of teachers when teaching in a computer game environment. See also Kirschner et al. (2006). With the aid of teachers, students can learn to be more reflective in such learning environments, and learning goals can be made more explicit. Students can be taught to do metacognition (thinking about their thinking) and to use this reflective practice as an aid to their cognitive development.

Finally, to end this section, here is some quoted material about research on multiplayer games, first person shooter (FPS) games. It is representative of some of the research on social aspects of multiplayer games.

We argue that the playing of FPS multiplayer games by participants can both reproduce and challenge everyday rules of social interaction while also generating interesting and creative innovations in verbal dialogue and non-verbal expressions. When you play a multiplayer FPS video game, like *Counter-Strike*, you enter a complex social world, a subculture, bringing together all of the problems and possibilities of power relationships dominant in the non-virtual world. (Wright et al, 2002)

Final Remarks

Games have long been an important component of the lives of many children and adults. The advent of computer games means that on average, people spend much more time playing games now than in the past. In recent years, children in the United States have been spending more time playing electronic games than they have been spending watching television. It is generally

believed that the combination of television and electronic games is having a negative impact on education because they compete for student attention and time. However, both television and games have educational values, so research in this area is not definitive.

The discipline of Games-in-Education is of growing importance in both informal and formal education. The research literature on the design and use of educational games—especially electronic games—is growing. We know that people learn from whatever situation or environment they experience. By combining ideas from situated learning theory and transfer of learning, we can learn how to make better educational use of games.

Activities for the Reader

This section contains some questions and activities for the person reading this book. Some are designed for people who are taking a workshop or course using materials from this book. The individual reader working alone may also find many of the questions and activities to be useful.

1. Think back to your own game playing experiences. Make a list of some of the things that you learned through this game playing.
2. Give some examples of games that you have played that you considered fun. Use these examples to explain what, for you, what makes a game fun.
3. Are there any games that you have played in both computer and non-computer mode? If so, select one and do a compare and contrast of the playing experience and learning experience.
4. Spend some time observing children playing some games. Write a brief report about what you observe going on. The report should include some conjectures about the learning that you think is occurring.
5. This chapter contains a discussion of opening moves in chess versus opening sentences in writing. This discussion illustrates a type of transfer of learning from game playing to writing. Find and discuss another example of transfer of learning from games to a core academic subject.

Activities for use with Students

This section contains some ideas for use with students. It is assumed that the teacher, parent, or other person making use of these suggestions will adjust the activities to fit the needs of the students.

1. What are some games that are fun to play. Engage an individual student or a group of students in a brainstorming activity designed to make a long list of games that they have played and enjoyed. As the list is being created, divide its items into three categories:
 - a. Board games, card games, and other types of non-electronic games that are not organized sports.
 - b. Electronic games.
 - c. Organized sports.

Use this activity to promote a discussion about whether a game can fit into more than one category, what is a game, is a puzzle a game, what makes a game fun, can a game be fun for one person and not for another, and so on.

2. Engage students in a discussion about what they have learned by playing a particular game that they have found useful in playing some other game or that they have found useful in a non-gaming situation. This might begin with an oral discussion and then lead to a written activity in which each student answers the question. During the oral discussion, introduce the terms *transfer of leaning* and *metacognition*, and help the students add these important concepts to their vocabulary. Transfer of learning is one of the most important ideas in education, and metacognition (including reflection) is a key aspect of learning.