High Intellectual and Creative Educational Multimedia Technologies

LARISA V. SHAVININA, Ph.D.

ABSTRACT

This article presents high intellectual and creative educational multimedia technologies (HICEMTs)—a new generation of educational multimedia technologies, that will constitute one of the innovative breakthroughs in science and technology of the 21st century. HICEMTs emerge at the interdisciplinary crossroad of many branches of psychological science, contemporary education, and multimedia technology. The general and specific nature of HICEMTs is considered. The importance of HICEMTs is discussed from a technological, economical, societal, educational, and psychological perspective.

We have to find a new view of the world . . . If you can find any other view of the world which agrees over the entire range where things have already been observed, but disagrees somewhere else, you have made a great discovery. It is very nearly impossible, but not quite . . .

——*Richard Feynman, Nobel Laureate*

INTRODUCTION

AND SUCH A GREAT DISCOVERY is in the heart of any innovative breakthrough of the 21st century that, in turn, is also very nearly impossible, but not quite, if it appears at the interdisciplinary boundaries of contemporary science and technology (including information and communication technologies in general and multimedia in particular). Today new ideas—having a potential to revolutionize the area of multimedia—may only be brought from quite distant fields as, for example, psychology.

These ideas, in turn, emerge at the intersection of many branches of psychology including general, cognitive, developmental, educational, personality, media, and applied psychology, and education.

Taken together, the existing level of development in interactive technology and psychological science form a basis for the appearance of a completely new generation of educational multimedia: high intellectual and creative educational multimedia technologies (HICEMTs). The term "high intellectual and creative educational multimedia technologies" was first introduced by Shavinina in 1997.[1] These technologies are psychoeducational multimedia technologies whose general content is elaborated in accordance with fundamental psychological mechanisms, processes, states, and phenomena, and whose special content is developed, structured, presented, and delivered according to the underlying principles of an individual's intellectual functioning and creative performance. In order to make the ti-

Ontario Institute for Studies in Education, University of Toronto, Ontario, Canada.

tle of HICEMTs more comprehensible, it is necessary to emphasize that the word "high" implies a significant saturation of the special content of these technologies by the educational materials directed to the actualization and development of human intellectual and creative abilities. Before proceeding with a characterization of HICEMTs, it seems appropriate to discuss the issue of their importance or, in other words, why human beings need them.

WHY DO WE NEED HICEMTS?

The importance of HICEMTs can be argued from various multidimensional perspectives, but five of them—technological, economical, societal, educational, and psychological—being closely related, are especially critical perspectives.

The technological perspective refers to the realities of the information era and its challenges for human beings. For example, one of the modern realities of the information age is an exceptionally fast development of information and communication technologies; the challenges to people range from a tremendous change of an individual's life and a predetermination of its qualitatively new level in public, professional, and home environments to a strong need to understand and to use the extraordinary quantity of developed software and numerous computer applications. Nearly every day, promising inventions and discoveries in the area of information and communication technologies stimulate companies' management to rapidly introduce them in practice. For instance, all Bill Gates' 12 rules for succeeding in an information age[2] are connected with new technologies. However, corporations' management forget that they deal first of all with people, who use today's information and communication technologies. But the human mind does not improve as rapidly as new technologies! Whereas their extraordinary development during the last 10 years fascinates the imagination, by comparison, an individual's mind did not change at all! Hence, contemporary realities of the information society demonstrate an exceptional need in the elaboration of special technologies, whose primary goal would be the development of human mental resources. Consequently, the appearance of HICEMTs is more than appropriate.

The importance of HICEMTs strongly manifests itself from an economical viewpoint. For example, today it is quite obvious that economical, industrial, and technological competition is more and more harsh, and corporations (for their survival and success) must bring new products and services to the international market with amazing speed. But the speed of human thought is not the same as the speed of the global market! Consequently, there is an actual need to develop special technologies for the mind, and especially HICEMTs, in order to accelerate the speed of human intelligence to generate novel solutions in accordance with the demands of the international market. Certainly, corporations should have highly able employees, whose innovative ideas that result in exceptionally new products are a guarantee of corporations' flourishing. The development of innovative minds is one of the purposes of HICEMTs.

The importance of HICEMTs also expresses itself from a societal perspective. Thus, contemporary society has a lot of unsolved problems, including political, economical, moral, social, demographical, medical, environmental, and so on. Consequently, modern society is distinguished by the strong need for intellectual and creative minds for its advanced development in the 21st century. These minds are needed to productively solve numerous problems and make appropriate decisions.

On the other hand, today's information society produces many challenges to citizens, who must be highly able individuals in order to bring innovative solutions to these challenges and, therefore, contribute to the further societal progress. In brief, intellectually creative citizens are the guarantee of political stability, industrial innovations, economical growth, cultural flourishing, scientific enrichment, psychological health, and general prosperity of any society in the new millennia.

The importance of HICEMTs is also quite evident from an educational perspective. As argued elsewhere,[1] the real goal of education should be seen not in a knowledge transfer, but in the development of an individual's intellec-

tual and creative resources. Consequently, today's children and adults must have in their disposition a variety of productive educational and training technologies in order to reach this goal. The main aim of HICEMTs consists just in the development of human mental abilities, which allow people to successfully apply their existing knowledge in practice and to create new knowledge.

On the other hand, education is in its essence a psychological process that is based on the underlying psychological mechanisms. The nature of HICEMTs coincides with the goal and essence of education and with the basic processes and mechanisms of the functioning of users' minds. Only in this case of a maximal matching between HICEMTs and the goal of education, from one hand, and between these innovative technologies and fundamental mechanisms of the functioning of human intelligence and creativity, on the other hand, can we assert about successful learning and training. Therefore, if any society wishes to improve the quality of education, than this society should direct primary attention to the actualization and development of people's intellectual and creative abilities via HICEMTs.

Finally, among many possible psychological arguments in favor of HICEMTs, it is necessary to mention at least two. First, the human mind is a unique phenomenon in nature, and its development should be realized by individual means, which are appropriate for the increase of mental resources of a given person. Although educational multimedia provides a good opportunity for education when, where, and how the users want it, only with the appearance of HICEMTs do people receive an excellent possibility for proceeding in learning and training according to personal abilities, wishes, speed, and time. HICEMTs bring an exceptional opportunity for individualized, personalized, differentiated, and flexible learning and training because the underlying idea of these novel technologies is the following: Many people can find the individual means (i.e., the individual approach) for actualizing their own mental potential and the subsequent development of their own intellectual and creative abilities in HICEMTs.

Second, the results of psychological expertise

of existing educational multimedia products[3] demonstrate that at the moment there is no educational multimedia technology that could satisfy all the above-discussed features of these five perspectives as they manifest themselves in their contemporary requirements to the human mind in general and to its intellectual and creative resources in particular.

THE FIRST GENERATION OF EDUCATIONAL MULTIMEDIA TECHNOLOGIES

In the light of this article it seems expedient to briefly look at the current realities of the modern international market of educational multimedia. Active involvement in the psychological expertise of the existing educational multimedia products and services prevailing on the educational multimedia market around the globe has allowed the author to conclude that current educational multimedia applications constitute the first generation of educational multimedia, which, undoubtedly, will be substituted by the second generation of educational multimedia, HICEMTs.[3,4] The first generation includes five types of educational multimedia: (a) learning manuals used in the framework of traditional school/college curricula and higher education (i.e., physics, mathematics, biology, languages; for example, "Mathematics for schools: 2nd year"); (b) multimedia products on general cognition concerning various knowledge domains (for example, "Universe," "World of animals"); (c) reference sources (i.e., various encyclopedias, dictionaries, atlases (for example, "The atlas of the world." "The encyclopedia of the human body"); (d) edutainment (i.e., different games with educational aspects, multimedia versions of the famous tales, interesting stories; e.g., "Alice in Wonderland", "Cinderella"); (e) cultural cognition (i.e., on-line and/or off-line multimedia applications on arts and culture; e.g., "The best museums of the world," "100 years of the poetry," "Leonardo da Vinci").

By analyzing today's educational multimedia applications from the point of view of their content, it was found[5] that they in fact are "domain-specific" products and services, which

now dominate on the global market. Domain-specific educational multimedia is directed to knowledge acquisition and skills development in one special—and very often narrow—domain (e.g., language, mathematics, chemistry, physics, literature, biology, history, and so on). As argued elsewhere (4), these domain-specific products and services are in fact computer versions of printed textbooks and learning manuals (i.e., they were simply "placed" on CDs or/and Internet). Undoubtedly, the modern multimedia technology changes the mode of presentation of usual textbooks. But the nature of their content is not transformed! This is the main limitation of the contemporary educational multimedia technologies and the biggest problem for their subsequent evolution. In its present form, domain-specific educational multimedia does not have real chances for further development.

Considering today's education multimedia applications from the point of view of multimedia technology (i.e., specific features of multimedia itself), it was found that the contemporary educational multimedia products and services simply use multimedia effects without any attempts to present and perhaps modify these effects in accordance with user's psychological organization.*[3–5] It seems that companies elaborate educational multimedia applications simply because they have multimedia technology to do so. This direction is not promising in the development of educational multimedia technologies. For example, the Corel Corporation developed a good technology for the creation of educational multimedia products, but how do Corel and other companies use this technology?

The future belongs to HICEMTs, which will be characterized by new principles of the construction of their content. The content of educational multimedia products and services is especially crucial for the advancement of the field because the most innovative developments can be done just here. In this light it is

not surprising at all that chairs of multimedia corporations connect their economical success with significant improvements in the content of educational multimedia applications. For instance, the president of Quebecor Multimedia, Ms. Lefebvre, has asserted that "We must stop putting the emphasis on electronic might and more on content."[6]

GENERAL CHARACTERIZATION OF HICEMTS

The essence of HICEMTs can be described via a set of the general and specific characteristics. The general characteristics of HICEMTs include the following: (a) general psychological basis; (b) direction toward fundamental cognitive mechanisms; (c) new addresses of educational influences; (d) better adaptation to individual's psychological organization; and (e) "psychoedutainment" as a general framework for the development of HICEMTs. In fact, these five characteristics represent by themselves clusters of characteristics. Each of them includes many different aspects, and they are strongly interrelated between themselves.

"General psychological basis" means that HICEMTs are based on psychological processes, states, and phenomena, and especially on the mechanisms of human intellectual and creative functioning. General psychological processes and phenomena include perception, attention, short-term and long-term memory, visual thinking, knowledge base, mental space, concept formation process, analytical reasoning, metacognitive abilities, cognitive styles, critical thinking, motivation, and many other psychological mechanisms. One of the strong arguments to considering psychological foundations at the heart of any educational multimedia technology is an obvious fact that educational process is a psychological process. Any learning, teaching, and training are based on the fundamental psychological mechanisms. Examples of concrete psychological processes and phenomena and their appropriateness for the development of educational multimedia technologies were considered elsewhere.[3–4]

HICEMTs are directed to the activation of the

---

*The specificity of the user's psychological organization implies an individual's perception of color, sound, written texts, attentional resources, information processing, cognitive and learning styles, and many other psychological processes, mechanisms, and phenomena.

fundamental cognitive mechanisms, which play an important role in human intellectual and creative functioning. These mechanisms form a necessary foundation for the further successful development of an individual's creative and intellectual abilities,[7] because the enhancement of people's mental potential must be based on already actualized cognitive resources. Conceptual structures,[8,9] knowledge base,[10,11] mental space,[5,12] metacognitive processes,[13–15] specific intellectual intentions,[16,17] objectivization of cognition,[12,18] and other phenomena are some of those cognitive processes that are considered extremely important in modern theories of human intelligence and creativity. These should be embedded in HICEMTs. An exceptional saturation of HICEMTs by the fundamental processes and phenomena of the human cognitive system allows HICEMTs to be "know-how" learning and training multimedia technologies because they provide an underlying educational basis for the subsequent development of an individual's mind.

HICEMTs bring new addresses of educational influences. The conventional wisdom of developers of the current educational multimedia technologies is to address the content of their products to the abstract "user" as a whole. For example, by analyzing the existing educational multimedia products, we can always ask ourselves: "To what exactly—in the structure of user's intelligence or personality—is the given educational multimedia technology directed?" However, from the psychological point of view, it is difficult to find the answer to this question. It is an unproductive approach to direct educational multimedia technologies to user(s) in general because people are complex psychological systems that including many hierarchical components and structural relationships. Consequently, to address educational influences to these complex systems as a whole means to decrease the quality of the educational process. Because of this, the precise addresses of contemporary educational multimedia technologies are lost; although the choice of the right addresses of educational influences implies the productive learning and training.

The basic mental processes and phenomena

in HICEMTs, which underlie an individual's intellectual and creative functioning, are viewed as the exact addresses of educational influences. The appearance of HICEMTs means the transition from the traditional addresses or audience of the current educational multimedia technologies (i.e., from the "user as a whole") to the underlying mechanisms of an individual's intelligence and creativity. In this light, the main goal of education is also changing from a simple knowledge transfer to the development of human mental abilities.

The above-considered characteristics of HICEMTs allow these technologies to be better adapted to the individual's psychological organization in comparison with the current educational multimedia technologies. It implies that HICEMTs take into account numerous psychological features of users (i.e., child and/or adult), such as behavioral, developmental, emotional, motivational, personality, and social features. A new generation of educational multimedia technologies is directly built on the psychological specificity of users: For example, HICEMTs generate the necessary conditions for the emergence and maintenance on the appropriate level of an individual's motivation to learn, his or her cognitive behavior, emotional involvement, personal satisfaction with the gradual progress through the educational content, and many other even more exciting qualities. Contemporary achievements of information and communication technologies allow today's developers of educational multimedia to reach such a goal. The major idea is that HICEMTs should fit to the internal psychological structures of an individual's intellectual, creative, behavioral, cognitive, developmental, emotional, motivational, and other systems.

As it was argued and predicted elsewhere, the emergence of "psychoedutainment"—a new reality on the international education multimedia market—is an inevitable event.[4] This innovative interdisciplinary multimedia field, which appears at the intersection of the available multimedia domains (i.e., education, entertainment, and/or edutainment) and a new area (i.e., psychology) is the only one scientifically possible framework for the elaboration of HICEMTs. Taking into account that (a) educa-

tion is in its essence a psychological process, (b) entertainment has its own psychological mechanisms of game, and (c) play is a preferable and leading form of children's activity,[19,20] one can conclude that a new generation of educational multimedia technologies cannot be developed otherwise than by the synthesized regrouping of contemporary fields of multimedia. The nature of HICEMTs cannot be associated with one particular multimedia domain, they may be created only in the space of "psychoedutainment."

Consequently, the five features described above provide the general characterization of HICEMTs. The other substantial features of HICEMTs concern special characterization.

SPECIFIC CHARACTERIZATION OF HICEMTS

HICEMTs have special characteristics: (a) "intellectual" content, (b) "creative" content, and (c) "intellectually creative edutainment." Because the first two characteristics deal with the specific content of HICEMTs, they therefore explain "what" should be in these technologies. Intellectually creative edutainment, on the other hand, represents by itself a big part of critical features that concern the mode of the presentation of this content. In other words, intellectually creative edutainment describes "how" specific content might be embedded in HICEMTs.

Although "intellectual" and "creative" contents cover many different, multidimensional, and interrelated aspects, it is not possible to present all of them here because these contents vary significantly and depend on developers. At the contemporary level of the development of psychological science there are many theories of human intelligence and creativity.[21–39] These theories predetermine developers' conceptions of creative and intellectual contents. Just a variety of the psychological approaches in the field of individual intelligence and creativity will strongly influence differences in the special content of HICEMTs via concrete developers' conceptions. And such a variety pre-

determines what is intellectual and creative in these innovative technologies.

One of the promising ways to elaborate the special content of HICEMTs can be considered here that presents the writer's understanding of human intelligence and creativity. Using the recent psychological findings in the field, and particularly Kholodnaya's[12] investigations on individual intelligence and the author's own research, it is expedient to construct the intellectual and creative content of HICEMTs according to four levels in the structure of human intelligence: basis of intelligence and three levels of the manifestations of intelligence (i.e., cognitive, metacognitive, and extracognitive levels). The basis of intelligence is formed by one's conceptual cognitive structures (i.e., conceptual thinking), knowledge base, and mental space. The first, cognitive level of the manifestations of intelligence is presented by intellectual productivity, individual specificity of the intellectual activity (i.e., cognitive styles), and creative qualities (i.e., fluency, originality, and flexibility of thinking, the ability to generate new ideas and metaphors). The second, metacognitive level of the "body" of intelligence consists of metacognitive specificity (i.e., metacognitive abilities, self-knowledge, and regulatory processes). The third, extracognitive level of the manifestations of intelligence is composed of specific intellectual intentions (i.e., intellectual criteria), which include specific beliefs, the feeling of direction, and specific preferences.[16,17] Consequently, HICEMTs should be built in accordance with the elements of these four levels. It is necessary to emphasize that, in this account of the specific content of HICEMTs, the main creative qualities are embedded in the structure of intellectual abilities.[7]

Joining entertainment and education has resulted in the emergence of "edutainment," a rapidly developing multimedia field. As it was mentioned above, adding psychology to edutainment implies the appearance of "psychoedutainment," a new promising multimedia area. Similarly, the combination of intelligence and creativity with edutainment leads to "intellectually-creative edutainment," where HICEMTs can be developed. A new genera-

tion of educational multimedia technologies will significantly transform "edutainment." Therefore, modern multimedia technology, educational games, and entertainment in general built on the underlying psychological processes and basic principles of human intellectual functioning and creative performance form "intellectually-creative edutainment." This provides a real opportunity to elaborate the innovative learning and training multimedia technologies: HICEMTs.

HOW MANY HICEMTS?

Unlimited diversity of HICEMTs can be developed for at least two scientific reasons. First, as it was mentioned above, the variety of psychological approaches in the areas of human intelligence and creativity, which provide a foundation for developers' conceptions of creativity and intelligence, excludes in principle a limited number of HICEMTs. Second, the complex multidimensional nature of intellectual and creative abilities (toward the actualization and development of which HICEMTs are directed) excludes only a single educational multimedia technology would be more productive than other technologies because the development of mental abilities can be achieved through various psychoeducational methods. Finally, technological and economical reasons also exclude a limited quantity of HICEMTs.

CONCLUSION

Therefore, by rethinking the role of education in the information era, using contemporary multimedia technology, findings of psychological science in general, and knowledge on human intelligence and creativity in particular, and by elaborating "intellectually-creative entertainment", an entirely new generation of educational multimedia technologies—HICEMTs—can be developed that will dominate the global educational multimedia market in the 21st century. It is very nearly impossible, but, as R. Flynmar asserted, not quite yet.

REFERENCES

1. Shavinina, L.V. 1997, July 9. Educational multimedia of "tomorrow": High intellectual and creative educational technologies. Paper presented at the 4th European Congress of Psychology, Dublin, Ireland.
2. Gates, W.H. III. 1999, March 22. Bill Gates' new rules. *Time,* 153(11):30–35.
3. Shavinina, L.V. & Loarer, E. 1999. Psychological evaluation of educational multimedia. *European Psychologist,* 4(1):49–60.
4. Shavinina, L.V. 1998. Interdisciplinary innovation: Psychoeducational multimedia technologies. *New Ideas in Psychology,* 16:189–204.
5. Shavinina, L.V. 1997, September 21. High intellectual and creative technologies as an educational multimedia of the 21st century: Towards a new generation of educational multimedia technologies. Paper presented at the European Open Classroom II Conference: School Education in the Information Society, SiSi, Creete, Greece.
6. Lefebvre, M. 1997. For better or for worse: The multimedia reign. *Focus,* 3:20–22.
7. Shavinina, L.V. & Kholodnaya, M.A. 1996. The cognitive experience as a psychological basis of intellectual giftedness. *Journal for the Education of the Gifted,* 20(1):3–35.
8. Case, R. 1995. The development of conceptual structures. In: Damon, W., Kuhn, D., Siegler, R. (eds.) *Handbook of child psychology.* New York: Wiley, pp. 745–800.
9. Kholodnaya, M.A. 1983. *The integrated structures of conceptual thinking.* Tomsk: Tomsk University Press.
10. Chi, M.T. & Greeno, J.G. 1987. Cognitive research relevant to education. In: Sechzer, J., Pfafflin, S. (eds.) *Psychology and educational policy.* New York: The New York Academy of Sciences, pp. 39–57.
11. Rabinowitz, M., & Glaser, R. 1985. Cognitive structure and process in highly competent performance. In: Horowitz, F., O'Brien, M. (eds.) *The gifted and talented: Developmental perspectives.* Washington, DC: American Psychological Association, pp. 75–97.
12. Kholodnaya, M.A. 1997. *The psychology of intelligence.* Moscow: APN Press.
13. Brown, A.L. 1978. Knowing when, where, and how to remember: A problem of metacognition. In: Glaser,

R. (ed.) *Advances in instructional psychology*. Hillsdale, NJ: Erlbaum, pp. 77–165.

14. Brown, A.L. 1986. Metacognition, executive control, self-regulation, and other even more mysterious mechanisms. In: Weinert, F., Kluwe, R. (eds.) *Metacognition, motivation, and learning*. Hillsdale, NJ: Erlbaum, pp. 60–108.

15. Flavell, J.H. 1979. Metacognition and cognitive monitoring: A new area of cognitive-development inquiry. *American Psychologist*, 34:906–911.

16. Shavinina, L.V. 1995. The personality trait approach in the psychology of giftedness. *European Journal for High Ability*, 5:145–152.

17. Shavinina, L.V. 1996. Intellectual intentions. In: Cropley, A., Dehn, D. (eds.) *Fostering the growth of high ability: European perspectives*. Norwood, NJ: Ablex Publishing Corporation, pp. 373–381.

18. Shavinina, L.V. 1996. The objectivization of cognition and intellectual giftedness. *High Ability Studies*, 7(1):91–98.

19. Piaget, J. 1962. *Play, dreams and imitation in childhood*. New York: WW Norton.

20. Kaplan, S.N. 1980. The role of play in a differentiated curriculum for the young gifted child. *Roeper Review*, 3:12–13.

21. Detterman, D.K. (ed.) 1994. *Current topics in human intelligence. Vol. 4: Theories of intelligence*. Norwood, NJ: Ablex Publishing Corporation.

22. Miller, A. 1996. Insights of genius: Visual imagery and creativity in science and art New York: Springer-Verlag.

23. Pressley, M., Borkowski, J., Schneider, W. 1987. Cognitive strategies: Good strategy users coordinate metacognition and knowledge. In: Vasta, R. (ed.) *Annals of Child Development*, Vol. 4. Greenwich, CT: JAI Press, pp. 89–129.

24. Runco, M.A. (ed.) 1998. *Handbook of creativity*. Norwood, NJ: Ablex Publishing Corporation.

25. Runco, M.A. & Albert, RS. (eds.) 1990. *Theories of creativity*. Newbury Park, CA: Sage.

26. Shavinina, L.V. 1998. On Miller's insights of genius: What do we know about it? *Creativity Research Journal*, 11(2):183–185.

27. Simonton, D.K. 1988. *Scientific genius: A psychology of science*. New York: Cambridge University Press.

28. Sternberg, R.J. 1985. *Beyond IQ: A new theory of human intelligence.* New York: Cambridge University Press.

29. Sternberg, R.J. (ed.) 1988. *The nature of creativity*. New York: Cambridge University Press.

30. Sternberg, R.J. 1990. *Metaphors of mind: Conceptions of the nature of intelligence.* New York: Cambridge University Press.

31. Olson, D.R. 1986. Intelligence and literacy: the relationships between intelligence and the technologies of representation and communication. In: Sternberg, R., Wagner, R. (eds.) *Practical Intelligence*. New York: Cambridge University Press, pp. 338–360.

32. Borkowski, JG. 1992. Metacognitive theory: A framework for teaching literacy, writing, and math skills. *Journal of Learning Disabilities*, 25(4):253–257.

33. Keating, DP. 1996. Habits of mind: Developmental diversity in competence and coping. In Detterman, DK. (ed.). *Current topics in human intelligence*, Vol. 5. Norwood, NJ: Ablex Publishing Corporation, pp. 31–44.

34. Vandervert, L.R. in preparation. A Provocative view of information growth in cybereducation: Long-term implications for forecasting and guidance. In: Vandervert, L.R., Shavinina, L.V. (eds.) *Provocative and doable futures for cybereducation: Leadership for the cutting-edge.* Larchmont, NY: Mary Ann Liebert Publishers.

35. Popper, K. 1972. Objective knowledge: An evolutionary approach. Oxford: Oxford University Press.

36. Bereiter, C., & Scardamalia, M. 1993. Surpassing ourselves. Chicago, IL: Open Court.

37. Bjorklund, D.F. & Schneider, W. 1996. The interaction of knowledge, aptitude, and strategies in children's memory development. In: Reese, H. (ed.) *Advances in child development and behavior*, Vol 26. San Diego, CA: Academic Press, pp. 59–89.

38. Sternberg, R.J. (ed.) 1982. *Handbook of intelligence*. New York: Cambridge University Press.

39. Ferrari, M., Taylor, R., VanLehn, K. 2000. Adapting work simulations for schools. *Journal of Educational Computing Research.* (in press).

Address requests for reprints to:
Larisa V. Shavinina, Ph.D.
Department of Human Development
and Applied Psychology
Ontario Institute for Studies in Education
University of Toronto
252 Bloor Street West, Toronto, Ontario
M5S 1V6 Canada

E-mail: L.Shavinina@mailcity.com