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ARTIFICIAL INTELLIGENCE AND IDIOMATICITY[1]

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Abstract

Despite immense progress in Artificial Intelligence (AI) technologies, the deployment of AI knowledge systems for idiom learning has yet to receive attention in either research or development. This article speculates about how AI technologies might be used to foster knowledge of idiomaticity in the future. It argues that the deployment of AI knowledge systems for idiom learning require critical examination. It is suggested that AI knowledge systems can aid the development of idiomatic competence, and should be incorporated into the design of multimedia programs for first and second/foreign language learners as early in their education as possible. Potential applications of future AI knowledge systems for idiom learning are discussed.

Introduction

Since the early 1950s, the study of Artificial Intelligence (AI)—the creation of machines that can emulate intelligent human behavior, learning, and adaptation—has been paralleled by its rapidly expanding use. Today, AI theories and technologies are used in medicine (e.g., for diagnosing contagious bacterial infections of the blood, recommending treatments, and synthesizing information, using rule-based system programs such as MYCIN and XCON); automotive/robotic industry and image understanding (e.g., for using binary images to locate objects on a conveyor belt, as with the program CONSIGHT); advanced-level computer languages (notable computer languages over the years include, but are not limited to, LISP, LOGO, SHRDLU, PARRY, HACKER, SAM, STUDENT, SIR, PROLOGUE, AUSDA, and EGRESS); genetic algorithms and programming; machine vision field; missile systems; heads-up displays; construction of pilots and commanders for virtual aircraft; optical character recognition (OCR), handwriting recognition (the automatic conversion of text as it is written on a special digitizer or PDA), speech recognition (interpretation of human speech), and facial recognition (recognizing a person from a digital image by comparing selected facial features in the live image and a facial database) systems; steadying camcorders and digital displays (using fuzzy logic); and entertainment (especially in chess and video games) and computer graphic industries for building sophisticated AI intelligence tools and middleware (world-class games, simulations, and 3-D animation environments using real-time character/crowd simulation and actions, physics aware intelligent navigation) to mention but a few prominent examples. In the years to come, the deployment of AI technologies in fields from telecommunications to

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cybernetics will certainly continue to impact our lives in more ways than we can imagine today. (For a comprehensive page that links to 868 pages around the web with information on AI, visit: http://www.cs.berkeley.edu/~russell/ai.html. See also McCarthy 2004; Nilsson 1998; Poole, Mackworth & Goebel 1998; Russell & Norvig 1995.)

One area of AI technologies that has yet to receive attention, in either research or development, is the deployment of AI knowledge systems for first and second/foreign language idiom learning. This article speculates about how AI technologies might be used to foster knowledge of idiomaticity in the future. It argues that the deployment of AI knowledge systems for idiom learning require critical examination before such systems can aid the development of *idiomatic competence*—that is, the ability to understand and use idioms appropriately and accurately in a variety of sociocultural contexts, in a manner similar to that of native speakers, and with the least amount of mental effort (Liontas 1999). It is suggested that AI knowledge systems for idiom learning should be incorporated into the design of multimedia programs for first and second/foreign language learners as early in their education as possible. Potential applications of future AI knowledge systems for idiom learning are also discussed.

Deploying AI Knowledge Systems for Idiom Learning

For several decades now, AI researchers and cognitive scientists have been working to design intelligent machine systems that can simulate human mental processes. However, despite concerted efforts to develop 'expert systems' (i.e., computer programs that can solve difficult technical problems by simulating the problem-solving techniques of human experts in a particular domain), an infallible, complete system that can fully understand natural (human) language has yet to be developed, as Underwood (1994) and Winograd (1984) observe. Indeed, the development of such AI expert systems for natural language understanding is in many respects directly linked to the design principles embodied in these systems. For the most part, many of these systems were initially constructed under the assumption that applying the 'computational metaphor' to human language use was a sound approach. The 2005 Cornell study by Spivey, Grosjean, and Knoblich casts serious doubt on the theory that the mind works like a computer, in a series of distinct stages. Instead, the study strongly suggests that mental processing (language comprehension) is a continuous process. To quote Spivey:

> For decades, the cognitive and neural sciences have treated mental processes as though they involved passing discrete packets of information in a strictly feed-forward fashion from one cognitive module to the next or in a string of individuated binary symbols—like a digital computer… More recently, however, a growing number of studies, such as ours, support dynamical-systems approaches to the mind. In this model, perception and cognition are mathematically described as a continuous trajectory through a high-dimensional mental space; the neural activation patterns flow back and forth to produce nonlinear, self-organized, emergent properties—like a biological organism.
>
> (From *Cornell University News Service*, June 27, 2005, p. 30.)

Further, for information to be stored and processed in a computer, the underlying knowledge supporting the comprehension process must be reduced to coded data that is systematized in accordance with the rules and principles of formal logic, as embodied in a few general principles. In contrast, human modes of cognition, including kinetic, emotive, and symbolic knowledge, are based on the ability to use diverse kinds of knowledge in unique and 'non-linear' dynamic ways. To reduce these modes of cognition to artificial data is thus to suggest that real-life discourse understanding can be reduced to comprehending isolated sentences and individual words, without regard to the contributions they make to the whole text, or to the linguistic and sociocultural contexts (the pragmatic perspective on discourse) in which they are found. If an understanding of a group of sentences in a given language can be attained by knowledge of grammatical rules alone, then the understanding of figurative language (i.e., metaphor, simile, metonymy, synecdoche, irony, allegory, parable, paronomasia, onomatopoeia, personification, aphorism, proverb, cliché, idiom, collocation, slang, colloquialism) should come about in the same way. Such prominent linguists as Bloomfield (1926, 1933), Chomsky (1957, 1965), De Saussure (1916), Greimas (1966), Harris (1951), Lyons (1963, 1968, 1977), Martinet (1962), Ullmann (1957, 1962), and Ziff (1960) have, however, steered clear of such a conclusion. Similarly, the development of AI knowledge systems for idiom learning in particular has yet to be undertaken by AI researchers and cognitive scientists.

For the purposes of this discussion, it will be helpful to familiarize the reader with some of the key arguments made by cognitivists regarding the processing mechanisms necessary to understanding language. The following section presents a brief summary of the central tenets of the *Cognitive theory* in an effort to address the pedagogical consequences of how AI knowledge systems can positively condition the processes of cognitive formation for idiom learning.

Cognitive Theory Revisited

Based on the work of psychologists and psycholinguists such as McLaughlin, McLeod, Levelt, Segalowitz, Hulstijn and Hulstijn, *Cognitive theory* is considered a derivative theory because it represents the application of a broader framework (contemporary cognitive psychology) to the domain of second language learning. As such, the theory focuses on the role of cognitive processes in second language acquisition (SLA), which is viewed as the acquisition of a complex cognitive skill involving, generally speaking, memory, learning, and automatization and restructuring.

Regarding Memory. Schiffrin and Schneider (1977) view memory as a large collection of nodes that become *complexly interassociated* through learning. Each node is a grouping or set of information elements. Most of these nodes are inactive and passive (long-term store), but through some kind of external stimulus, a small number of these nodes are activated (short-term store) through controlled and automatic mode of information processing. Controlled processing is *not* a learned response, but a temporary activation of nodes in a sequence. Such processes are tightly capacity-limited, and require more time for their activation. They are easy to set up, alter, and apply to novel situations. Automatic processing, on the other hand, is *a learned response over many trials* and involves the activation of certain nodes in memory every time the appropriate inputs are present. To develop fully, automatic processing requires an appreciable amount of training. Once learned, automatic processing occurs rapidly and is difficult to suppress or alter.

Regarding Learning. Learning, according to the Cognitive theory, is a *cognitive* process because it involves internal representations that regulate and guide performance. These representations are based on the language system, and include procedures for selecting appropriate vocabulary, grammatical rules, and pragmatic conventions governing language use. Learning involves the transfer of information to long-term memory, and is regulated by controlled processes. Thus, "controlled processing can be said to lay down 'stepping stones' for automatic processing as the learner moves to more and more difficult levels" (McLaughlin, Rossman & McLeod 1983: 141).

Regarding Automatization and Restructuring. To learn a second language, various aspects of a task must be practiced and integrated into fluent performance, which requires the automatization of component sub-skills. Tasks consist of sub-tasks and their components, so that execution of each part of the task requires the completion of various smaller components. More specifically, a task requires either a relatively large amount of processing capacity, or it proceeds automatically and demands little processing energy. In turn, the development of any complex cognitive skill involves building up a set of well-learned, automatic procedures so that controlled processes will be freed for new tasks. This notion of capacity-free (automatic) process provides an explanation for *improvement in performance*: Repeated performance of the components of the task through controlled processing leads to automatized routines. Thus, a task that once taxed processing capacity may become, through practice, so automatic that it demands relatively little processing energy.

Because humans are limited-capacity processors, communication tasks require the integration of a number of different skills, each of which has previously been practiced and made routine. The acquisition of skills involved in any communication task requires assessment and coordination of inferences from a multitude of perceptual, cognitive, and social domains. Skills are learned and routinized (i.e., they become automatic) only after the earlier use of controlled processes. These processes regulate the flow of information from short-term to long-term memory. However, as more learning occurs, internalized cognitive representations change and are restructured. *Restructuring* occurs because, as performance improves, learners attempt to simplify, unify, and gain control over their internal representations; that is, to link isolated procedures into a unified representational framework (Karmiloff-Smith 1986). Once these procedures become automatized and consolidated, learners set up a metaprocedural level, which generates representational change and restructuring. Expressed differently, components of the task are restructured so that they are coordinated, integrated, or reorganized into new units. As a result, old components are replaced by more efficient procedures involving new components. Limitations in performance are overcome by restructuring the task procedure.

This integration of hierarchically ordered skills requires practice (i.e., 'building up strengths through practice' following Anderson 1983 and McLelland, Rummelhart & the PDP Research Group 1986) as learners devise new structures for interpreting novel information and for imposing a new organization on information already stored (Cheng 1985). During restructuring learning is thought to occur in a discontinuous fashion. This discontinuity may account for a learner's perception of sudden moments of insight or 'clicks of comprehension.' At such moments, the learner can be said to understand the material in a new way. Often learners report that this experience is followed by rapid progress, as old linguistic information and skills are fitted into this new way of understanding (see also McLaughlin's 1990 account of 'restructuring').

Hence, learning is *not* a unitary process; it involves a constant modification of organizational structures: in *accretion*, new knowledge is added to existing memory; in *structuring*, new conceptual structures or schemata are formed requiring significant effort; in *tuning*, categories or schemata, are modified (i.e., knowledge is adjusted to a specific task usually through practice); in *restructuring*, new structures involving some form of reflection or insight (i.e., metacognition) are added that allow for new interpretation of facts (Rumelhart & Norman 1978, 1981). These two notions—*automatization* and *restructuring*—are central to *Cognitive theory*.

Cognitive Approach and Multimedia CALL Software Design

The application of a *cognitive approach* (involving theories of information processing and problem solving) to the design and evaluation of the user interface of multimedia software is not new in the CALL literature (see, for example, Barnard 1991; Card, Moran & Newell 1983; Gardiner & Christie 1991; Kieras & Polson 1985; Landauer 1991; Plass 1998; Weizenbaum 1976). According to Plass (1998), the *cognitive approach* (as opposed to the *craft approach,* the *enhanced software engineering approach,* or the *technologist approach*) is "the only one that puts both the user and the learning task in the center of the design process" (p. 38) precisely because this approach is "characterized by an attempt to measure the user's performance time and memory load for a given task, to identify prerequisite and acquired knowledge for a task, and to describe the user's mental models and mental processes for performing a task" (p. 37). More importantly, the user interface of multimedia software in its application to SLA, according to Plass, has to facilitate the development of linguistic and pragmatic skills/competencies the software application is addressing while supporting the cognitive processes involved in these skills and competencies (e.g., encoding/retrieving task-relevant declarative information, monitoring performance, correcting errors in performance). (For a more complete account of SLA competencies/skills and learner activities and cognitive processes involved in learning, see Plass 1998, Tables 1 and 2, p. 38.)

Discovering which design features and evaluation criteria produce ideal conditions for SLA while using multimedia CALL was equally a major focus in Chapelle's (1998) paper on multimedia CALL software in which she outlines a relevant theory of SLA in an attempt to better articulate what makes input comprehensible and how it is processed. By expanding upon Krashen's (1982) notion of comprehensible input (i.e., input is necessary for acquiring aspects of L2) and simplifying Gass's (1997) SLA model, and following an interactionist research perspective (Pica 1994; Long 1985, 1996), Chapelle's model of SLA includes both linguistic (input and output) and learner knowledge and processes (apprehension, comprehension, intake, integration, and linguistic system). On the basis of identifying relevant hypotheses about ideal conditions for SLA, she then proposes seven helpful hypotheses germane for developing multimedia CALL software, followed by pedagogical implications for multimedia task design. The seven hypotheses are (Chapelle 1998: 23-26):

1. The linguistic characteristics of target language input need to be made salient.
2. Learners should receive help in comprehending semantic and syntactic aspects of linguistic input.
3. Learners need to have opportunities to produce target language output.
4. Learners need to notice errors in their own output.
5. Learners need to correct their linguistic output.
6. Learners need to engage in target language interaction whose structure can be modified for negotiation of meaning.
7. Learners should engage in L2 tasks designed to maximize opportunities for good interaction.

Though neither Plass nor Chapelle specifically address issues of idiomaticity in their design and evaluation of the user interface of multimedia CALL software, the application of their proposed criteria, nonetheless, provide a fruitful ground upon which future frameworks for the development of AI knowledge systems for idiom learning might be established. According to Chapelle (1998: 26),

> CALL developers need to consider how software can provide learners with opportunities believed to facilitate SLA. In other words, it is useful to view multimedia design from the perspective of the input it can provide to learners, the output it allows them to produce, the interactions they are able to engage in, and the L2 tasks it supports.

These design features are discussed in the following section. Collectively, they represent this author's 'ideal' view of idiom learning via AI knowledge systems. As such, the description is only *in part* a non-empirical account, describing a theoretical system that could be realized easily in the years to come given continued progress in AI user interface design and evaluation. A great many of the user interface design features discussed next have already been tested empirically with 60 third-year adult learners of Spanish, French, and German (18 male, 42 female, and ranging in age from 18 to 55 years). For the purposes of this discussion, and to avoid duplication of information already covered elsewhere, only the results of Part Three of Questionnaire II (Q2III) will be presented here. Appendix A provides Part Three of Questionnaire II. (For a detailed account of Questionnaire I [Parts I, II, and III] and Questionnaire II [Parts I and II], see Liontas 2002a.)

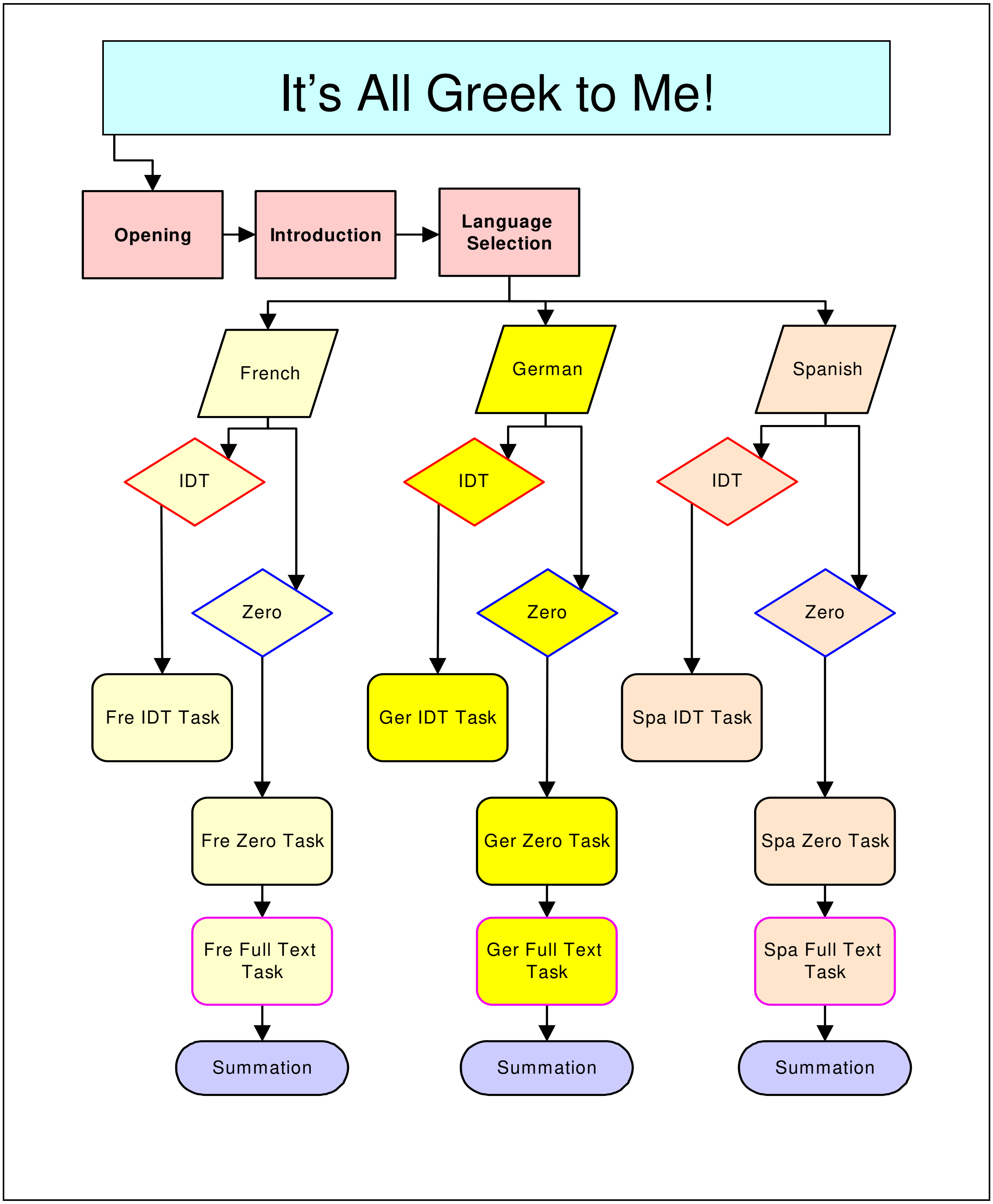
Q2III, containing 24 items and using a five-point Likert scale, solicited participants' opinions regarding their (dis)agreement with statements concerning the user interface design and effectiveness of the *It's All Greek to Me!* computer program. The weighted mean scores for all twenty-four statements included in this part of the questionnaire are presented in Table 1. Data analysis indicates that the lowest mean score was 3.92 (Statement 13) and the highest 4.59 (Statement 6), suggesting that participants in all three language groups had a common ground of agreement with regard to the issues brought forth in the questionnaire statements slightly below the midpoint of 'neutral/unsure and agree' on the low end and slightly above the midpoint of 'agree and strongly agree' on the high end. Further, only two statements (Statements 1 and 13) received mean scores of less than 4.00, while the mean scores of the remaining twenty-two statements (91.66 percent of them) ranged from a low of 4.05 to a high of 4.59. When participants were asked at the end of the study the reasons for scoring Statement 1 below a 4 or a 5, the majority said that they were unsure if the program was indeed free of technical problems or programming errors, hence their tendency to score this question lower. With respect to Statement 13, many of them felt that the *Idiom Detection Task* (i.e., locating idioms within authentic texts), albeit at times challenging, was not nearly as difficult as the other two tasks—the *Zero Context Task* (i.e., presentation of idioms without contextual support) and the *Full Context Task* (i.e., presentation of idioms with full contextual support). This is clearly evident in the higher mean scores given for these tasks (Statements 14-17); in turn, these scores validate the actual performance task data (see Liontas 2002a, Table 3, p. 299).

Table 1. Questionnaire II, Part III

It's All Greek to Me !					
Questionnaire II (Part III)	**Statements**	**Spanish**	**French**	**German**	**Mean**
Presentation	**1**	3.9	4.1	4.1	**3.99**
	2	4.3	4.3	4.8	**4.43**
	3	4.2	4.6	4.9	**4.48**
	4	4.4	4.4	4.6	**4.43**
Content	**5**	4.3	4.4	4.5	**4.38**
	6	4.5	4.6	4.9	**4.59**
Instructional Quality	**7**	4.4	4.4	4.9	**4.49**
	8	4.4	4.4	4.7	**4.50**
	9	4.4	4.4	4.8	**4.46**
	10	4.4	4.2	4.6	**4.42**
Learner Interaction	**11**	4.1	3.9	4.4	**4.15**
	12	3.9	4.1	4.6	**4.12**
Idiomatic Tasks	**13**	4.0	3.8	3.9	**3.92**
	14	4.3	4.4	4.7	**4.44**
	15	4.4	4.6	4.8	**4.52**
	16	4.4	4.6	4.9	**4.57**
	17	4.3	4.4	4.8	**4.42**
Attitude	**18**	4.4	4.4	4.8	**4.46**
	19	4.2	4.1	4.4	**4.27**
	20	4.3	4.1	4.6	**4.33**
	21	3.9	4.2	4.3	**4.05**
	22	4.1	3.9	4.6	**4.19**
	23	3.9	4.1	4.6	**4.12**
	24	4.2	4.4	4.6	**4.37**

Perhaps the biggest compliment to the multimedia CALL program discussed here is the high marks it received in the sub-section 'Attitude' (Statements 18-24). Such high marks indicate that a multimedia computer program combining sound technology (in terms of Presentation, Content, and Instructional Quality) with language learning tasks that clearly challenge learners' knowledge of idiomaticity (Idiomatic Tasks) can potentially be highly satisfying to those who are asked to use it and interact with it (Learner Interaction). Participants' great degree of satisfaction with the program was equally echoed in post-study discussions and semi-structured interviews with several respondents. The mutual satisfaction found in all language groups, including the English and Modern Greek language groups consulted during and after the pilot testing of the program and the two questionnaires, helps to validate the promising use and continual development of this program for investigating more systematically the process of SL idiom understanding (i.e., the combined comprehension and interpretation process). The design of this initial program is presented graphically in Figure 1.

Figure 1. *It's All Greek to Me!* Computer Program



The Future of AI Technologies for Idiom Learning

Even though adequate empirical study of and scholarship on AI technologies for idiom learning is currently lacking, such technologies hold much promise in the foreseeable future. Among these are programmed intelligent tutoring systems (ITSs) such as LOGO, GUIDON, LISP, WHY, WEST, and IMPART; interactive learning environments; virtual reality environments; computer-mediated communication; intelligent agents (or 'virtual humans') and interfaces for idiom learning; support systems; computer-assisted instruction authoring languages; and, finally, computer simulation. (For a discussion of the definitions of knowledge, expert systems, intelligent tutoring systems, and virtual reality, see Brown 1999; Halff 1986; Moore 1996.)

To date, ITSs have had wide appeal in the field of education. Burns and Capps (1988) offer a valuable introduction regarding the knowledge foundations of ITSs. They state that ITSs must pass three tests of intelligence (Burns & Capps 1988: 1):

1. Subject matter, or domain, must be known to the computer system well enough so that it can draw conclusions,
2. The system must be able to deduce a learner's approximation of that knowledge,
3. The system must be able to implement strategies to limit the differences between the system and the user.

Moreover, such systems will require, according to the authors, at the very least seven kinds of expertise which comprise the anatomy of ITSs for designing, developing, deploying, and evaluating machine tutors. Because of space limitations, their conceptual model will not be explicated here further save for a listing of the ITS's anatomy (Burns and Capps 1988: 18):

1. content expertise in the expert module,
2. diagnostic expertise (determining what learners know and need to learn),
3. instructional and curriculum expertise in the instructor module,
4. expertise in creating instructional environments,
5. human-computer interface expertise,
6. implementation expertise, and
7. evaluation expertise.

Anyone attempting to achieve these 'expert' capabilities within ITSs for second and foreign language learning in general, and idiom learning in particular, will soon realize that, as the authors correctly stated in their concluding paragraph, it is "not easy to integrate all of this knowledge in a single delivery system" (Burns & Capps 1988: 18). The move toward dynamic knowledge-based educational system designs will no doubt continue to puzzle our intellect and test our capabilities in the years ahead (Furnes & Barfield 1995; Laurel 1990; Norman 1987; Park & Hannafin 1993; Shneiderman 1993; Wallace & Anderson 1993).

However, if AI computer technology is ultimately to prove useful for teaching and learning second and foreign languages, computer-based natural language processing (NLP) systems must be designed to take into account, for example, the processing of idiomatic phrases and sentences in contexts; the relationship among semantics, pragmatics, parsing, and understanding; knowledge representation; and other multi-knowledge sources, including human memory, thinking, learning, and perception. In short, the future use of these systems lies in their programming and processing capabilities to respond accurately to a wide variety of correct and incorrect answers and to learn from the procedural skills of their users. (A helpful comparison of artificial intelligence and information retrieval paradigms for natural language understanding is provided in Teodorescu 1987. See also Sheremetov & Nunez 1999; Ziems & Neumann 1997.)

Notwithstanding the need for such NLP systems, it is equally important to design AI knowledge systems that can arrange and rearrange the nature of learning; that is, systems that can tap into learners' multiple intelligences and personal learning or cognitive styles to deliver learning that is richer in content, more varied in the sensory pathways (visual, auditory, and kinesthetic/tactile), more engaging in the learning options and experiences, and, above all, more personalized and imaginative. According to the multiple intelligences (MI) theory (Gardner 1983, 1993), there are at least eight distinct forms of intelligence (ways of learning) that each individual possesses in varying degrees—*logical/mathematical, visual/spatial, body/kinesthetic, musical/rhythmic, interpersonal, intrapersonal, verbal/linguistic,* and *naturalist*—with a ninth fast emerging: *digital intelligence*; that is, the ability to interact with digital technologies (Adams 2004). Learning to program a computer, for example, involves, according to Gardner (1983: 390), multiple intelligences:

> Logical-mathematical intelligence seems central, because programming depends upon the deployment of strict procedures to solve a problem or attain a goal in a finite number of steps. Linguistic intelligence is also relevant, at least as long as manual and computer languages make use of ordinary language... an individual with a strong musical bent might best be introduced to programming by attempting to program a simple musical piece (or to master a program that composes). An individual with strong spatial abilities might be initiated through some form of computer graphics—and might be aided in the task of programming through the use of a flowchart or some other spatial diagram. Personal intelligences can play important roles. The extensive planning of steps and goals carried out by the individual engaged in programming relies on intrapersonal forms of thinking, even as the cooperation needed for carrying a complex task or for learning new computational skills may rely on an individual's ability to work with a team. Kinesthetic intelligence may play a role in working with the computer itself, by facilitating skill at the terminal...

By extension, combining and blending these distinctive MI with the learners' preferred mode and ways of learning through which they acquire linguistic and sociocultural information can result in a powerful medium of learning that is truly *user-centered.* Put another way, visual learners can learn by *seeing*, auditory learners by *hearing*, and kinesthetic/tactile learners by *doing* and, more specifically, by *movement* or *touch*. In turn, the built-in 'modules of learning' can be as varied as the individual learning styles and sensory modality preferences, personalities (field-dependent/independent, extroverts/introverts), and cultural backgrounds of the learners themselves. Table 2 below presents a helpful summary of learners' preferences based on their learning/cognitive style or multiple intelligences (see also Armstrong 1993, 1994; Christison 1996; Hatch 1974; Jung 1933; Gardner 1995, 1999; Kolb 1984; Smith & Kolb 1986; Lach, Little & Nazzaro 2003; Weiss 2000).

Table 2. Learning Styles and Multiple Intelligences

	Styles			Multiple Intelligences								
Prefer…	Visual	Auditory	Kinesthetic / Tactile	Logical / Mathematical	Visual / Spatial	Body / Kinesthetic	Musical / Rhythmic	Interpersonal	Intrapersonal	Verbal / Linguistic	Naturalist	Digital
3-D worlds/computer simulations	X				X							X
advanced organizers	X				X							
animations/illustrations/clipart	X				X							X
audio texts (all genres and types)		X										
auditory feedback		X										
categorizations/classifications/hierarchies	X			X	X						X	
charts/flipcharts/flowcharts	X				X							
concept maps/diagrams/outlines	X				X				X			
debates/discussions/forums/group presentations								X		X		
demonstrations	X				X							
digital images/photographs/drawings/sketches	X				X							X
e-mail exchanges/real-time chat /listservs/ teleconferencing								X		X		X
games, including computer-generated board games			X	X	X	X		X				X
graphics/graphic representations	X				X							
grids/tables/figures/lists	X				X							
hands-on activities			X			X						
in-built speech technologies		X										X
instructional activities/tasks	X	X	X		X	X						
interactive environments	X				X							X
interactive exercises/lessons	X	X	X		X							X
interactive/virtual stories	X	X	X		X							X
jigsaw puzzles	X			X	X							
kinesthetic/tactile feedback			X			X						
maps/mazes	X				X							X
music/songs/jazz chants		X					X					
note taking/researching/word processing	X				X					X	X	
note taking while listening to oral texts			X									
oral transcriptions/voice overs		X										
pair-/group-work								X				
pantomime/gestures						X						
problem-solving activities	X	X	X	X	X	X						
project/problem-solving work				X				X				
reading/writing tasks	X				X							X
sequential presentations				X								
simulation/role-playing activities	X	X	X		X			X				
sounds/spoken words/music files		X					X					X
task-based activities	X	X	X		X			X				
texts (all genres and types) and e-books	X				X					X		X
textual annotations/definitions/paraphrases	X				X					X		
tongue twisters/word games/anagrams										X		
translations	X				X					X		
videos	X	X			X							X
visual feedback	X				X							
visual organizers	X				X							
visual pronunciation guides	X				X							

Table 2 continued…

		Styles			Multiple Intelligences								
		Visual	Auditory	Kinesthetic / Tactile	Logical / Mathematical	Visual / Spatial	Body / Kinesthetic	Musical / Rhythmic	Interpersonal	Intrapersonal	Verbal / Linguistic	Naturalist	Digital
Benefit from…	access to 3-D/animation/imaging/morphing software	X		X		X	X						X
	access to audio glossary database		X										
	access to concept mapping tools and diagrams	X				X							X
	access to draw/paint programs	X		X		X	X						X
	access to electronic reference tools	X		X		X	X		X		X		X
	access to interactive communication tools								X		X		X
	access to music generation/composition software	X	X	X		X	X	X					X
	access to multimedia authoring languages and tools	X		X	X		X				X		X
	access to organizational/calculation tools				X								X
	access to problem solving software				X					X			
	access to publishing software and tools			X									X
	access to puzzle building and map making tools	X		X		X	X						X
	access to recording/painting tools			X			X				X		X
	access to spreadsheets/statistics/search tools				X								
	access to story-creation software										X		
	access to text-based software										X		
	access to text/video/glossary database	X				X							
	access to web development tools	X		X		X	X		X		X		X
	constructing models			X			X						
	engaging in cataloguing/classifying/organizing				X							X	
	engaging in image manipulation			X		X	X						X
	engaging in inductive/deductive reasoning				X			X					
	engaging in linguistic analysis										X		
	engaging in metalinguistic analysis										X		
	interacting with digital technologies	X	X	X		X	X	X	X		X		X
	journal keeping/diaries									X		X	
	locating, accessing, transferring, manipulating, and integrating digital information												X
	manipulating, controlling, moving objects around			X			X						X
	observing patterns				X							X	
	receiving auditory feedback		X										
	receiving kinesthetic/tactile feedback			X			X						
	receiving visual feedback	X				X							
	reflecting/thinking/meditating									X			
	singing/playing music							X					
	sketching/drawing			X									X
	socializing/collaborating								X				X
	story telling										X		
	writing/drawing onto a computer (e.g., digital drawing pad) using a pen, a mouse, or a joystick			X			X						X

Table 2 continued…

	Styles			Multiple Intelligences								
Attributes / Characteristics	Visual	Auditory	Kinesthetic / Tactile	Logical / Mathematical	Visual / Spatial	Body / Kinesthetic	Musical / Rhythmic	Interpersonal	Intrapersonal	Verbal / Linguistic	Naturalist	Digital
can create/form mental images					X							
can discern relationships and connections in data				X			X					
can explain, convince, and express thoughts and ideas orally and in writing										X		
can practice self-discipline/self-assessment									X			
can put things together in novel ways				X								
can recognize tonal patterns							X					
can see abstract patterns				X								
can solve complex problems quickly				X								
enjoy data collection and problem solving				X								
enjoy illustrating/color-coding and visualization					X							
enjoy setting and pursuing goals									X			
enjoy 'thinking about their thinking'									X			
enjoy working independently									X		X	
enjoy writing and creating with words										X		
exhibit scientific reasoning				X								
have active imagination/perception					X							
have bird's-eye view visualization					X							
have sensitivity to rhythm, pitch, melody							X					
like to observe and record 'nature'											X	
like to search for patterns, regularities, or logical sequences				X								
like to solve brainteasers requiring logical thinking				X								
like to weigh, measure, calculate, and organize data				X								
prefer to exercise self-evaluation									X			
prefer to use language effectively and creatively										X		
prefer to use numbers				X								
prefer to use their bodies for self-expression and problem solving						X						
prefer transferring information from one medium to another			X			X						X
value another person's temperaments, moods, feelings, motivations, intentions, and behavior								X				

Much of that 'computing' promise could be realized by teaching computers to simulate the same mental activities involved in human knowledge processing and cognition as discussed earlier. Indeed, if "computers can model—retrospectively, prospectively, or simultaneously—the cognitive and physical processes required for linguistic perception and production," a view echoed in Pennington's (1996: 7) work, it is only logical that we continue to expedite and support the computer's evolving relationship with the user. In the words of Pennington (1996: 12-13),

> [t]he more the computer and the user work as a team, the more the computer can be said to be partnering the user's cognitive processing, 'shadowing' and enabling the user's

> processing of information. At an even higher level of effects, the computer's simulation of a human process or system becomes a virtual process or system, which through modeling and training the process or system can actually bring it into being.

In idiom learning specifically, these 'becoming-a-being' multi-sensory, multi-intelligent capabilities could be realized by storing large numbers of diverse classes of idioms that can all be interconnected, along with instructional and authentic texts supporting their uses, in these AI knowledge systems. Doing so would lead to accurate pattern recognition and problem-solving by learners. Problem-solving could be further enhanced through the use of artificial neural networks (ANN), which, after being fed sample idiom training and test cases, could learn from the input and recognize idiomatic patterns in the stored data and, more importantly, could use this information systematically to screen and diagnose such patterns in new sets of data (Carlson 1991).

AI knowledge systems design could also aid idiom learning through context-based diagnosis and user modules, embedded into process-oriented learning programs that interact meaningfully with language learners, thus making the human/computer interaction more personalized. For example, high-frequency idioms (based on corpus linguistics data) could be presented in the cultural context of an amusing soap-opera-like storyline designed to give language learners exposure to the idioms while encouraging them along the way to actively determine their meanings, the functions they perform, and the communicative situations in which they arise (e.g., evaluation of people and situations; conveyance of representations of the world in imagery; signaling of congeniality and conflict; recognition of disagreement/agreement between interlocutors; appraisals of manners, morals, behavior, and actions; display of affective states, i.e., anger, happiness, joy, and grief; use of logic to make for coherence in topic and theme).

An additional corpus of variant idioms (i.e., conceptually related idioms with similar or associated meaning) could offer systematic support for the learning of those main idioms. To reinforce and further explain each idiom, a series of carefully-planned learning steps could be included in the organizational content of the program, ranging from entertaining visual images to 'real-life' interactive exercises. Such programs could also include, for example, simulation activities and interactive exercise/stories within virtual reality 3-D worlds (from entertaining cartoon-like environments to elaborate science fiction worlds). With such a design, language learners would interact with virtual characters (i.e., intelligent agents that function as improvisational actors in virtual microworlds) in a contextually meaningful fashion while developing their idiomatic competence via reliable, high-quality tactile, visual, and auditory feedback on performance. (For examples of pedagogical microworlds that build knowledge of language through listening comprehension, see Douglas 1995; Johns 1997. See also Reeder, Heift, Roche, Tabyanian, Schlickau & Gölz 2004.) More importantly, language learners would…

- Become active players in an interactive virtual reality 3-D world.
- Become exposed to large numbers of diverse classes of idioms including polysemous phrasal units that combine powerful literal visual imagery (literal, referential meaning) with a memorable, striking expression (institutionalized, figurative meaning) occurring above word level and often, but not always, in the length of a sentence.

- Explore the power of idiomatic expressions in everyday discourse by distinguishing nuances in meaning and appropriateness.
- Learn how best to understand idioms in the cultural context of an amusing soap-opera-like storyline.
- Actively determine the meaning of idioms in natural conversations.
- Discover how well they have deciphered the figurative meaning of the main idioms used in the program and how well they have retained their emerging knowledge of idiomaticity.
- Be asked to produce and use their own idioms in real-time and real-life situations.

Accordingly, the resulting 'personalized' human/computer interaction could be maximized even further by incorporating into the design of the program a rich variety of multimedia presentation modes and learning formats. Each mode and format, in turn, could be presented within a contextual framework for ease of learning and recall so that language learners with differing abilities, interests, aptitudes, experiences, and learning preferences will employ them in the most beneficial ways possible. In addition, idiom-learning test practice samples, training and test cases, and real-life tests (e.g., 'search high and low and leave no stone unturned,' 'idiom soup,' 'idiom parts missing in action,' 'draw an idiom,' 'mix-and-match idioms,' 'scrambled idioms,' 'idiomatic jigsaw dialogues,' 'choose the correct word that completes the idiom,' 'find-a-word cube,' 'choose the definition that goes with the idiom,' 'match idioms with images and texts,' 'match the idiom/variant columns,' 'complete a crossword puzzle, i.e., fill in the blanks in the sentences, and use the answers to fill in the crossword puzzle,' 'complete sentences and short paragraphs [taken from authentic texts, songs, movies, Internet, and the like] with the appropriate idiom,' 'write an advertisement/headline using idiomatic speech,' 'respond to real-life encounters using the appropriate cultural norms and practices') need to be made available to language learners at the click of a button if they are to truly develop idiomatic competence. (For a more complete account of idiomatic learning formats, see Liontas 1999; concerning the design and use of multimedia digital technology for improving comprehension of culturally authentic texts, see Liontas 2002b.) Allowing language learners to employ a variety of multimedia digital elements (e.g., music, sound, text, audio, video, continuous speech recognition) that they could play and replay as needed, using a variety of media aides and (navigational, application, and intelligent) tools, would only enhance the instructional utility of such an intelligent system that is broader, more flexible and adaptive, and more responsive to the needs of the individual learner. (For a description of the theoretical and pedagogical issues involved in the programming of multimedia reading software for multilevel computer-managed instruction, see Liontas 2001a. See also Chun & Plass 1996a, 1996b, 1997.)

An 'intelligent' user-centered interface design system like this has the potential to provide a highly effective level of interaction with the user, limited only by the quality of the sources of (comprehensible) input made available, the multimedia aides facilitating comprehension and manipulation of input, the presentation modes enabling controlled and automatic modes of information processing, and, finally, the learning formats generating and guiding representational change and restructuring of idiomatic knowledge through integrative practice and performance monitoring of comprehensible output.

To further increase the system's instructional utility, it would be necessary to include an automated scoring program, diagnostic analyses of learner responses, personal tutors, progress tracking capabilities via intelligent memory, time-sharing, telecommunications, and networking capabilities, including publishing capabilities, an information management database (for locating, organizing, applying, storing, updating, and evaluating diverse sets of data), and a (text, audio, video, glossary) feedback database (for remembering favorable user behavior). Building these characteristics into the system would not only increase the potential for learning idioms, but would also give the system the capability to provide valuable information for scholarly idiom research. In addition, both formative and summative evaluations will be needed to evaluate the effectiveness and overall quality of these AI knowledge systems for idiom learning. (For considerations in developing computer-adaptive tests, see Dunkel 1999. For an outline of the development of AI in (second language) education, see Cumming 1998; Underwood 1994; Lian 1992; McLaughlin 1980; Paramskas 1986; Plaut & Gonnerman 2000; Renie & Chanier 1995.)

Finally, the user interface in its application to SLA has to support the user's cognitive and metacognitive processing of idiomatic knowledge. From *comprehensible input* (the amount and quality of the target language the learner is exposed to) to *comprehensible output* (the development of the linguistic knowledge the learner is producing)—the basic components in the SLA process—the user interface must be 'intelligent' enough to be able to address successfully nonlinear modules of perception, cognition, and performance believed to be involved in the learning of idioms (Arnaud & Savignon 1997; Irujo 1986, 1993; Kellerman 1978, 1979, 1983; Levorato & Cacciari 1992, 1995; Liontas 2001b, 2002c, 2002d, 2002e, 2002f, 2003). Accordingly, procedures for selecting appropriate linguistic and pragmatic skills/competencies, tasks, and activities governing idiom use must be presented meaningfully in the architecture and engineering of AI knowledge systems for idiom learning. (For an excellent introduction to SOAR, a symbolic cognitive architecture for AI, visit: http://sitemaker.umich.edu/soar > *Gentle Introduction to Soar: 2006 Update*. Visit also http://act-r.psy.cmu.edu/ for an introduction to ACT-R, yet another promising cognitive architecture theory about how human cognition works.)

Meaningful presentation encompasses a high degree of flexibility in the ways in which learners should use the available linguistic input to affect the production of comprehensible idiomatic output that is amenable to interactional modifications. Along the way, they should be afforded ample opportunities to direct their focus on the form, meaning, and function of idioms; notice and (self-)correct errors in their idiomatic output in real-life discourse; engage in goal-oriented interaction and communication generating representational change and restructuring of organizational structures and cognitive processes; employ diverse sets of skills, competencies, and domain knowledge within authentic tasks and interactional activities; and, finally, monitor, assess, and evaluate their performance and overall knowledge base of idiomaticity.

Naturally, the science and engineering of designing dynamic, nonlinear AI knowledge systems capable of emulating human intelligence in all its forms and behaviors will no doubt remain a formidable challenge for AI researchers and language educators alike (see Anderson, Bothell, Byrne, Douglass, Lebiere & Qin 2004; Budiu & Anderson 2000, 2001, 2002, 2003, 2004). And while we await the development, deployment, and evaluation of such promising systems, the SLA profession should direct its efforts at modeling within the user interface design of such systems the conditions that are believed to be ideal for idiom learning. Pennington (1996: 14) states this point most eloquently:

> Under favorable conditions, the computer model becomes equivalent to the process or capacity that is modeled, or supplants it in a new form of skilled behavior that achieves a high quality outcome. It is at this point, that the full power of CALL is realized.

Whether or not the SLA profession will be able to exploit the full power of CALL for idiom learning will depend largely upon the expertise, time, and effort put into the development of such multi-dimensional, multi-level, multi-measure 'intelligent' systems. Anecdotal evidence aside, less than a handful of CALL software to date have even attempted to address in a systematic way the development of idiomatic competence in second and foreign languages. Though an exposition of their design features lie outside the scope of this discussion, it bears repeating that relevant theories of SLA need to inform the design, development, deployment, and evaluation of future AI knowledge systems for idiom learning. Only then can it be said in earnest that such dynamic systems achieve their maximum effectiveness. Table 3 below presents a comprehensive summary of the theoretical and instructional considerations impacting the future of AI technologies and knowledge systems for idiom learning. The anatomy of such systems is presented graphically in Figure 2, whereas Figures 3-6 present a preliminary sample of the user-centered interface design features of the new multimedia CALL software *It's All Greek to Me! Learning Idioms in Context* (still under development by this author). For ease of presentation, all captured screen shots are presented along with a short descriptive explanation.

Table 3. AI Technologies and Knowledge Systems for Idiom Learning

Future AI technologies for idiom learning will require…	***Future AI knowledge systems design will need to include…***
▪ Expert systems. ▪ Artificial neural networks. ▪ Virtual reality environments. ▪ Interactive learning environments. ▪ Intelligent agents (or 'virtual humans'). ▪ Intelligent tutoring systems. ▪ Intelligent memory. ▪ Computer-based natural language processing systems. ▪ Computer-assisted instruction authoring languages. ▪ Advanced programming and processing capabilities. ▪ Advanced computer-mediated simulation and communication. ▪ Rich variety of multimedia presentation modes. ▪ High-quality graphics, navigational tools and transitional effects, and animation and 3-D modeling of the virtual reality. ▪ Authentic texts containing diverse classes of idioms. ▪ A 'personalized' human/computer interaction.	▪ Personal intelligent tutors. ▪ Automated scoring programs. ▪ Diagnostic analyses of learner responses. ▪ Progress tracking capabilities via intelligent memory. ▪ Time-sharing, telecommunications, and networking capabilities. ▪ Information management database (for locating, organizing, applying, storing, updating, and evaluating diverse sets of data). ▪ Feedback database (for remembering favorable user behavior). ▪ Glossary database (for defining unknown vocabulary). ▪ Simulation activities and interactive exercises/ stories within virtual reality 3-D worlds (from entertaining cartoon-like environments to elaborate science fiction worlds). ▪ Lessons that encompass a variety of multimedia digital elements allowing access to still and animated images, sounds, and audio/video sequences (from movies, songs, advertisements, horoscopes, literature, native-speaker conversations, and the like).

Table 3 continued…

Future AI knowledge systems design will need to be able to…	***Future AI knowledge systems design will need to allow language learners to…***
▪ Interact meaningfully with language learners to personalize the human/computer interaction. ▪ Simulate the same mental activities involved in human knowledge processing and cognition. ▪ Distinguish among semantics, pragmatics, parsing, and understanding; knowledge representation; and other multi-knowledge sources. ▪ Store large numbers of diverse classes of idioms, along with texts supporting their uses. ▪ Use artificial neural networks to learn from the input and recognize idiomatic patterns in the stored data. ▪ Use input information to screen and diagnose idiomatic patterns in new sets of data through context-based diagnosis and user modules. ▪ Include sample idiom training and test cases to discover accurate pattern recognition and problem-solving by language learners. ▪ Learn from the procedural skills of their users. ▪ Process idiomatic phrases and sentences within culturally authentic contexts. ▪ Expose language learners to large numbers of diverse classes of idioms while encouraging them to actively determine their meanings. ▪ Present idioms within appropriate cultural contexts. ▪ Respond accurately to a wide variety of correct and incorrect answers. ▪ Present multimedia presentation modes within contextual frameworks for ease of learning and recall. ▪ Reinforce idiomatic vocabulary items and phrases (with listening, reading, writing, and pronunciation features) via digital audio/video repetition and animated images/characters.	▪ Become active players in interactive virtual reality 3-D worlds. ▪ Interact with virtual characters in a contextually meaningful fashion. ▪ Employ a variety of multimedia digital elements that they could play and replay as needed, using a variety of controls and tools. ▪ Use definitions, animated images, video, music, sound, text, or all of the above and in any contribution according to their own learning style, speed, and choice of different media links. ▪ Explore the power of idiomatic expressions in everyday discourse by distinguishing nuances in meaning and appropriateness. ▪ Hear the word, phrase, or entire text spoken, by different speakers of the target language, as often as they wish and thus have absolute choice over the kind of media help they prefer. ▪ Hear selected parts or all of the entire authentic text read and acted out by native speakers. ▪ Actively determine the meaning of idioms in natural conversations. ▪ Discover how well they have deciphered the figurative meaning of an idiom and how well they have retained their emerging knowledge of idiomaticity. ▪ Test their gained knowledge of idioms at their convenience and at their own pace of learning and style. ▪ Create and write their own paragraph or dialog using previously learned idioms or their variants. ▪ Produce and use their own idioms in real-life situations. ▪ Publish their ‘text idioms’ in a digital format, which are then shared with the other classmates and the instructor for immediate feedback and subsequent treatment.

Figure 2. Anatomy of AI Knowledge System for Idiom Learning

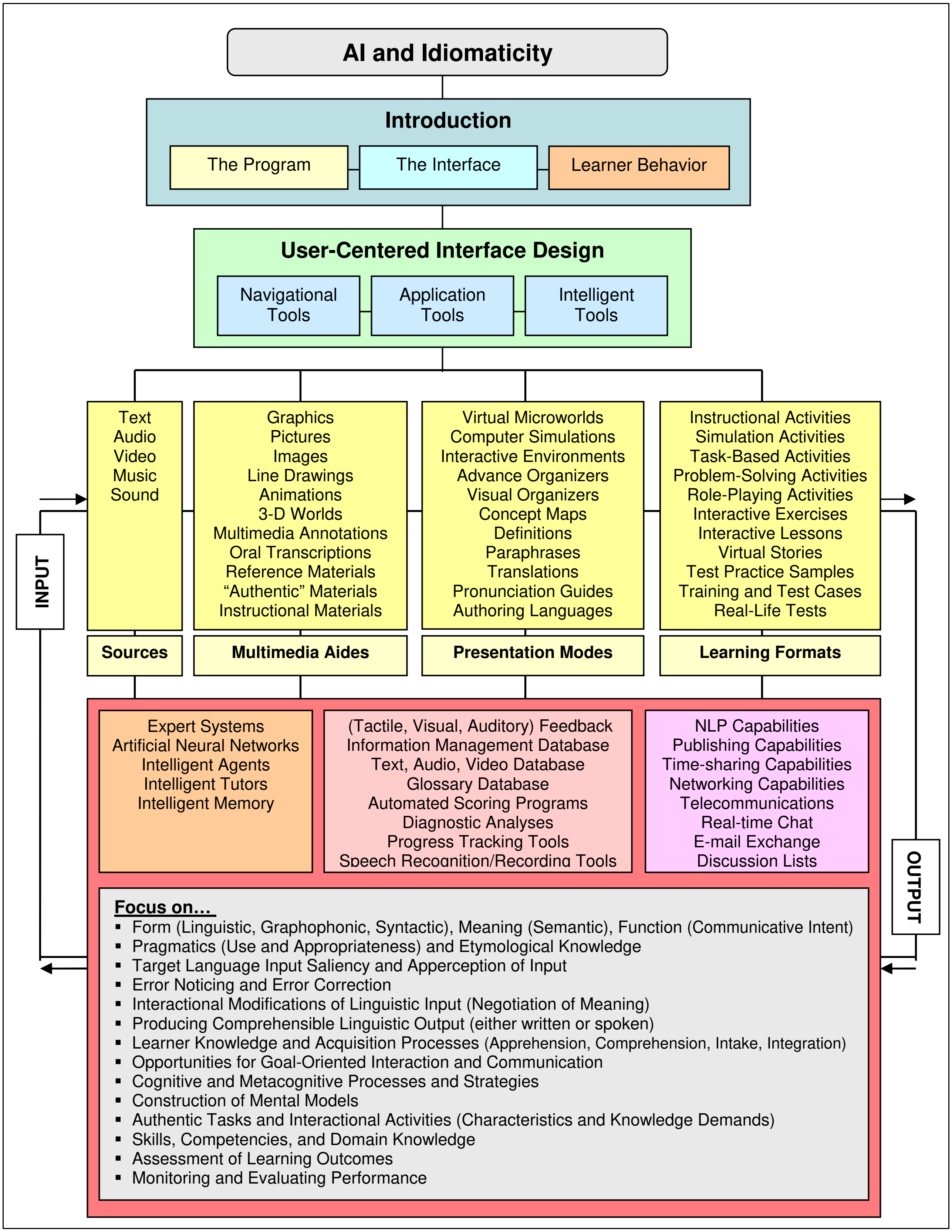


Figure 3. Program, Interface, Learner Behavior

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It's All Greek to Me! Following the loading of the program, the user enters the virtual interactive world of the designer and creator of *It's All Greek to Me! Learning Idioms in Context*. The 3-page long **Letter** ( ) on the desk introduces the program, the interface, and the expected learner behavior to the user. The user can bypass the reading of the letter by dragging and dropping it into the trash can (right of the table) or double click to read its contents. Either decision takes the user to the program's **Home Page**. Alternatively, the user can turn on the TV on the wall and have **Professor Lexis** (an intelligent agent) introduce the program's contents and multimedia capabilities

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Letter. The **Letter** (left behind by the designer and creator of the program) sets the tone for the user's idiom-learning process. In succinct and direct language the user is invited to make full use of the program's interactive multimedia capabilities. Following a brief 'clearing of the air' explanation of the expected user behavior, the user is introduced to the program's learning goals and objectives culminating into one final piece of advice:

> *To ensure success, keep your shirt on, your nose to the grindstone, and your ear to the ground. Do that, my friend, and you will soon find yourself understanding and using idioms at the drop of a hat. That's a promise!*

Clicking the **Special Invitation Card** ( ) calls the program's **Home Page.**

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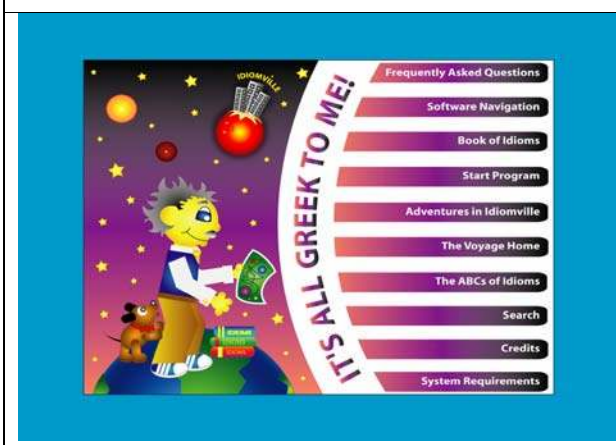
<td>
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Home. The **Home Page** displays the table of contents. Resting the cursor ( ) for a few seconds on any one of the ten content buttons on the right of that page displays the function of the individual button. Double clicking on a highlighted content button takes the user directly to the selected page (see Figure 4). Available pages for selection include:

- **Frequently Asked Questions**
- **Software Navigation**
- **Book of Idioms**
- **Start Program**
- **Adventures in Idiomville**
- **The Voyage Home**
- **The ABCs of Idioms**
- **Search**
- **Credits**
- **System Requirements**

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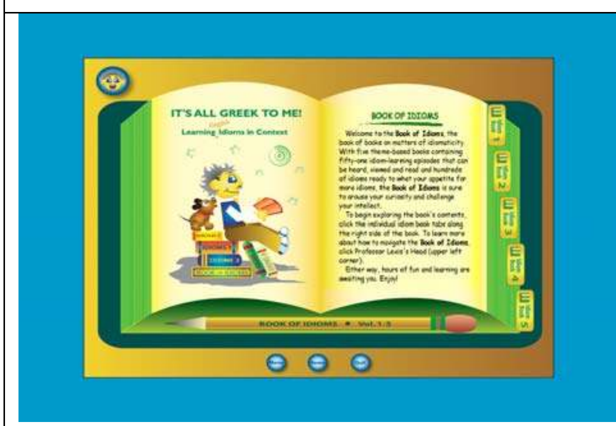
Figure 4. Table of Contents

	**Frequently Asked Questions.** Provides answers to the following questions: ▪ *What are idioms?* ▪ *Where do idioms come from?* ▪ *How many idioms are there?* ▪ *Why study idioms?* ▪ *Which idioms will I learn?* ▪ *What is the best way to learn the idioms in It's All Greek to Me! Learning Idioms in Context?* ▪ *What are some of the most common mistakes learners do in learning idioms?* ▪ *What else can I do to continue to develop my knowledge of idiomaticity?* ▪ *For whom is It's All Greek to Me! Learning Idioms in Context intended?*
	**Software Navigation.** Offers step-by-step instructions on how to navigate this interactive software most efficiently.
	**Book of Idioms.** Presents the organization of the program in Idiom Books, along with titles, idioms, and variant idioms. All selections follow the **Fixed Order View** (see *Start Program* below, as well as *Book of Idioms* in Figure 5).

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Start Program. Displays the order of screen activation: Fixed Order View and Random Order View.

➢ Fixed Order View launches the program in the default mode as its creator and designer intended it to be used. The order of screen activation is as follows:

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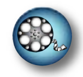
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Show Graphic</td><td>Hear Audio</td><td>Watch Video</td><td>Read Text</td><td>Do Exercise</td></tr>
</table>

Clicking Professor Lexis's car activates this order.

➢ Random Order View lets user select the order of screen activation that best suits his/her cognitive style and learning preferences. Clicking the Ferrari car activates this order.
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<td>Adventures in Idiomville. Provides background information on Professor Lexis, his family, life, and work on Planet Idiomville (see also Figure 6).</td>
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The Voyage Home. Assesses and evaluates learning and retention of idiomatic knowledge within a fantasy-filled cosmic voyage.

A cosmic explosion near Planet Idiomville has caused the planet's center of gravity to shift. As a result, the once perfect 'beam of light' alignment between Planet Idiomville and Earth is no more. Planet Earth is no longer a mouse click away causing all flights to Planet Earth to be canceled until further notice. To realign Planet Idiomville with Earth again, you must subject yourself to a series of interactive trials that will no doubt test your metal and knowledge of idiomaticity. The higher your success rate, the sooner the realignment will be completed.

Do you accept the challenge?
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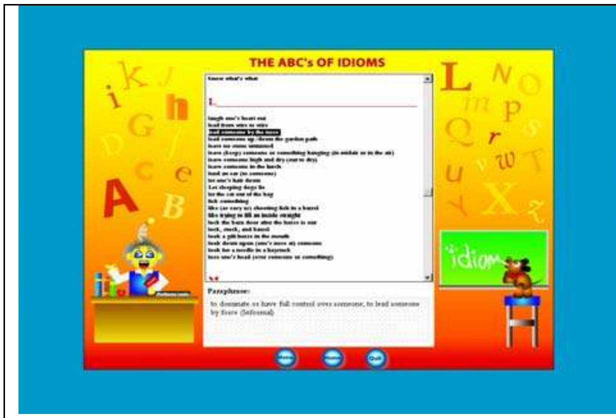
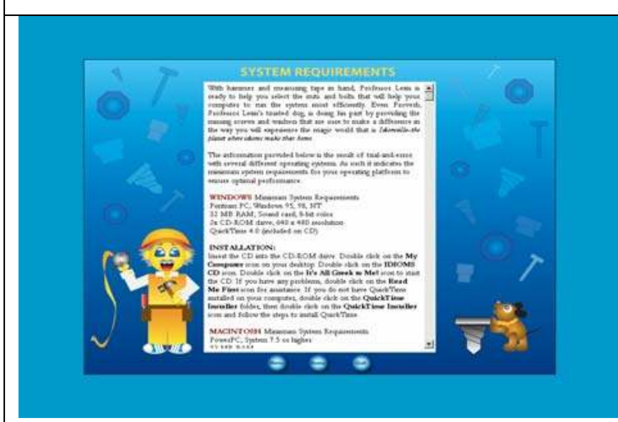
	**The ABCs of Idioms.** Lists all idioms in alphabetical order. From A to Z, the user can scroll up or down the list by clicking ▲ or ▼ or click and drag the scroll box (□) along the scroll bar for a quicker scroll through the list. The location of the scroll box (□) indicates which part of the idiom list is being viewed. To quickly locate all the idioms listed under a particular letter, the user can click any one of the interactive alphabet letters on this ABC page. Clicking the desired **Idiom** launches the **Paraphrase** window at the bottom of the screen. Double clicking the **Idiom** takes the user directly to the location where the idiom is used in the program. The idioms that are hyperlinked appear in blue within the idiom list.
	**Search.** Allows the user to search for any idiom by word or phrase. If the user cannot recall all or part of an idiom, he/she can have Professor Lexis and his trusted dog Proverb search the program's database. Finding a needle in a haystack has never been easier. To search for idioms that contain specific words or phrases, the user types the word or phrase (example: ball) in the **Search Window** and then clicks **Search** to start the search. When the search is complete, all the idioms containing the text specified are displayed in the **Eureka Window**. Clicking the desired idiom displays its corresponding paraphrase in the **Idiom Window**.
	**Credits.** Recognizes all the people involved in the creation of *It's All Greek To Me! Learning Idioms in Context.* *In designing and creating the multimedia computer assisted idiom-learning (CAIL) program It's All Greek to Me! Learning Idioms in Context many players have supplied the nuts and bolts of this work. People say that too many cooks spoil the broth. I say, the proof is in the pudding. This is my story about them from soup to nuts. And here the story goes…idiomatically that is!* All of them are bright eyed and down to earth, full of beans and all ears. And that's only the tip of the iceberg…
	**System Requirements.** Displays the operating system technical requirements for optimal performance.

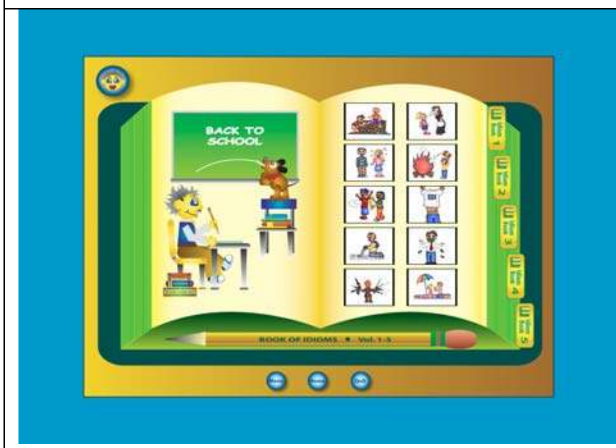
Figure 5. The Book of Idioms

Book of Idioms. Presents the organization of the program in Idiom Books, along with titles, idioms, and variant idioms. All selections follow the **Fixed Order View.**

The **Book of Idioms** (also known as the **Main Menu** page) includes five theme-based **Idiom Books** (🕮):

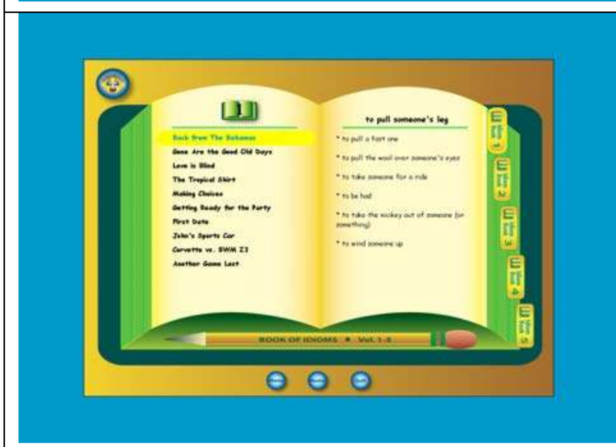
Idiom Book 1 — *Back to School*
Idiom Book 2 — *One Day at a Time*
Idiom Book 3 — *Much Ado About Nothing*
Idiom Book 4 — *Keeping Up Appearances*
Idiom Book 5 — *Light at the End of the Tunnel*

Clicking the individual idiom book tabs along the right side of the book starts the exploration of the book's contents. **Professor Lexis's Head** (upper left corner) offers additional navigational information.



Each **Idiom Book** (🕮) contains 10 idiom-learning episodes, each devoted to a single idiom, except **Idiom Book 3**, which has 11 episodes. Combined, the 51 episodes cover a wide range of speech acts, feelings, and emotions, and are illustrative of real-life situations. Both the individual idiom books and the idiom-learning episodes need not be studied sequentially, but such an approach might be considered here because as a whole they represent a connected soap-opera-like storyline that is sure to amuse the user and challenge his/her intellect.

Resting the cursor (🖰) over the individual **Idiom Books** displays the book's overall **Theme** (left page) and **Still Photographs**/**Graphic Art**/**Animation** (right page). To select a particular book, the user must click his/her choice of **Idiom Book 1-5** (🕮).



Following the selection of a particular idiom book, for example, **Idiom Book 1**, the left page now lists all the available **Titles** included in this book.

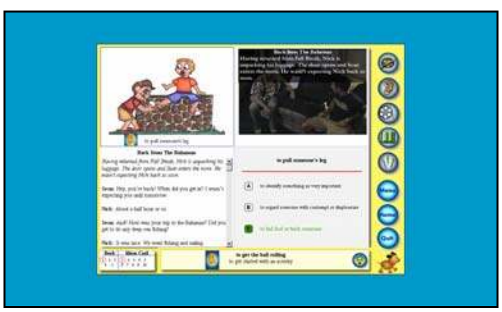
Resting the cursor (🖰) over the individual titles displays the **Idiom** used in each idiom-learning episode along with other idioms of similar or associated meaning (right page). The yellow **Selector Bar** (▭) indicates which title the user is currently viewing. Double clicking on a highlighted **Title** takes the user directly to the selected **Idiom Card** (▭).

The **Pencil** *(Book of Idioms Vol. 1-5)* keeps track of the user's navigational/application footprints. Clicking the body of the Pencil takes the user to the **User Profile Database** page (i.e., a personalized account of the user's idiom-learning and look-up behavior). Clicking the **Eraser** part of the pencil (✎) erases all footprints.

Idiom Card. Each **Idiom Card** (▭) is subdivided into 4 display screens and 2 sidebars (one vertical, one horizontal). Each sidebar contains a series of buttons that let the user quickly select commands.

Control Buttons				
Show Graphic	Hear Audio	Watch Video	Read Text	Do Exercise

Navigational Buttons		
Menu	Home	Quit



❖ <u>**SIDE TOOLBAR**</u>

The **Side Toolbar** (vertical sidebar) contains 5 control buttons and 3 navigational buttons. All buttons are visually represented for easy and focused learning. Resting the cursor (🖰) for a few seconds on any one of the 5 control buttons displays the name and function of the individual button.

<u>**Navigational Buttons**</u>

The **Menu** calls the five theme-based **Book of Idioms**.

The **Home** displays the table of contents.

The **Quit** terminates the user's idiom-learning session and shuts down the program *It's All Greek to Me! Learning Idioms in Context.* Once the **Quit** button is activated, the program automatically generates a **Progress Report** displayed in the **Results** page which includes both descriptive quantitative and qualitative data (**Professor Lexis's Two Cents**). A paper copy of the **Progress Report** can be instantly produced by clicking the **Print Results** button.

<u>**Control Buttons**</u>

Show Graphic. Launches <u>Image</u> <u>Screen</u> (upper left quadrant), displaying graphic illustration of idiom.

Hear Audio. Launches <u>Media</u> <u>Screen</u> (upper right quadrant), playing audio of idiom's text.

Watch Video. Launches <u>Media</u> <u>Screen</u> (upper right quadrant), playing video of idiom's text.

Read Text. Launches <u>Text</u> <u>Screen</u> (lower left quadrant), displaying the text heard or seen previously.

Do Exercise. Launches <u>Exercise</u> <u>Screen</u> (lower right quadrant), displaying idiom with three paraphrases.

Selector Window	
Book	**Card**
1 ② 3 4 5	1 2 3 4 ⑤ 6 7 8 9 10
Location	

Feedback Window			
	**Close but no cigar** to nearly achieve success, but not quite		
Hear Audio	**Feedback**	**Displays Variant Idioms**	**Calls Next Card**

❖ STATUS BAR

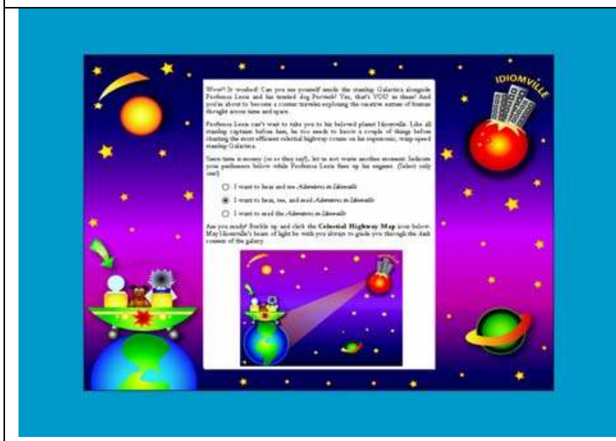
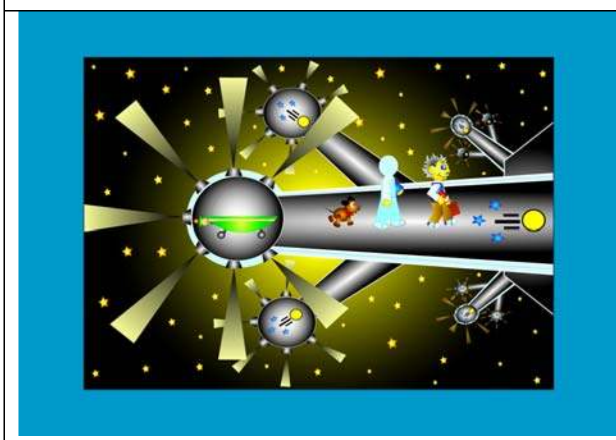
The **Status Bar** (horizontal sidebar) is composed of two side-by-side windows and an animated icon.

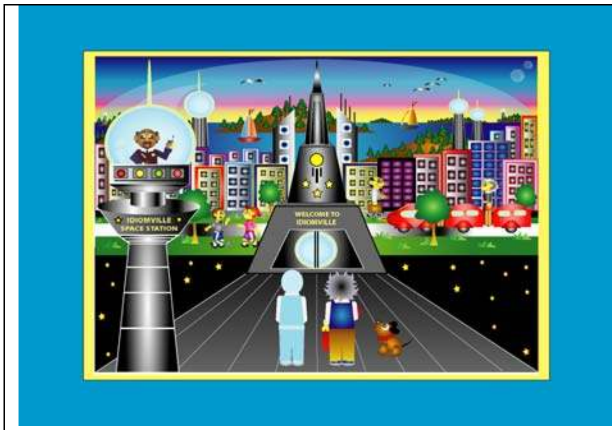
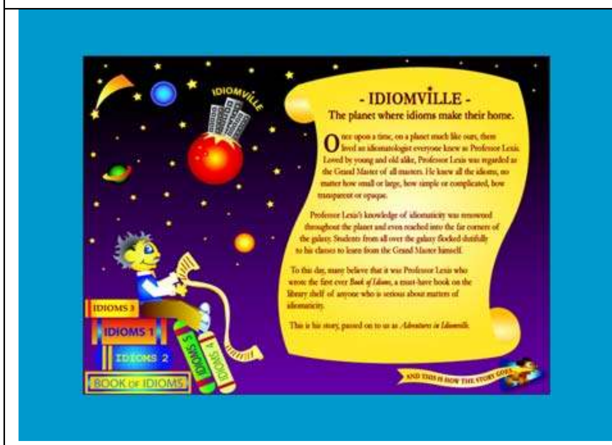
The **Selector Window** (left portion of the **Status Bar)** shows which **Idiom Book** and **Idiom Card** is currently open. By clicking on the desired book or card number, the user can quickly open any **Idiom Book** or **Idiom Card** he/she desires.

The **Feedback Window** (center portion of the **Status Bar)** displays the feedback received (both positive and motivational). Clicking the **Ear** allows the user to hear the feedback again. A flashing **Professor Lexis's Head** appearing within the **Feedback Window** indicates that there are other idioms of similar or associated meaning to the one displayed in bold in the **Text Screen** (lower left quadrant) of the **Idiom Card**. Clicking **Professor Lexis's Head** displays the **Variant Idioms** with their accompanying (audio) texts.

Clicking **Proverb** (the animated dog icon) advances the next **Idiom Card** in sequence or the user can select a new card or book from the **Selector Window** (left portion of the **Status Bar**) or the **Menu**, thus taking full advantage of the system's built-in flexible design capabilities.

Figure 6. Interactive Simulation, Animation, and Virtual Reality 3-D Worlds

	**Adventures in Idiomville.** Provides background information on Professor Lexis, his family, life, and work on Planet Idiomville. The user is invited to become a cosmic traveler exploring the creative nature of human thought across time and space. To catch Idiomville's 'beam of light' the user must be wiling to teleport himself/ herself into the Starship Galactica where Professor Lexis and his trusted dog Proverb are waiting.
	Following the successful teleportation into the Starship Galactica, the user is now asked by Professor Lexis to indicate his/her preferential mode of experiencing the *Adventures in Idiomville* while he charts the most efficient celestial highway course on his supersonic, warp-speed starship Galactica. The user's choice below determines the extent of the interactive simulation, animation, and virtual reality 3-D worlds he/she will be experiencing: O I want to hear and see the *Adventures in Idiomville* ⊙ I want to hear, see, and read the *Adventures in Idiomville* O I want to read the *Adventures in Idiomville* Following the selection, clicking the **Celestial Highway Map** (center icon) takes the user on a wild virtual reality 3-D ride through the dark corners of the galaxy.
	Arrival at Planet Idiomville.

	Entering Idiomville's Space Station.
	A fairytale-like introduction to *Idiomville.* **— IDIOMVILLE —** **The planet where idioms make their home.** *Once upon a time, on a planet much like ours, there lived an idiomatologist everyone knew as Professor Lexis. Loved by young and old alike, Professor Lexis was regarded as the Grand Master of all masters. He knew all the idioms, no matter how small or large, how simple or complicated, how transparent or opaque.* *…* *This is his story, passed on to us as Adventures in Idiomville.* **AND THIS IS HOW THE STORY GOES…**
	The first of more than two dozen screen shots from the fairytale-like story of *Adventures in Idiomville* allowing the user to fully immerse himself/herself into this interactive simulation, animation, and virtual reality 3-D world. *It was that time of year again, the first day of school. Professor Lexis looked at the aged clock on the wall. It was 7:30 in the morning. "I'd better get going," he said to himself. "There's bound to be a lot of traffic today." He took a last sip of his coffee and went down the narrow hallway, catching a glimpse of himself in the mirror on the wall … For a moment his mind wondered back to his first day of teaching, now some forty years ago … A lonely tear ran down his right cheek. He took a deep breath. "This is not the moment to become sentimental," he reminded himself. He straightened the tie that his late wife of thirty-five years had given him on their fifth anniversary, took another deep breath, and with renewed energy said goodbye to his likeness in the mirror. With briefcase in hand and the Book of Idioms under his right arm, he closed the door behind him.*

Conclusion

This article has highlighted the deployment of AI knowledge systems for idiom learning. Language learners, whether the language is their first or second (or even third, fourth, etc.), can become successful idiom users if idiomatic knowledge is properly cultivated during language instruction and presented meaningfully in AI knowledge systems. Future AI knowledge systems will only reach their maximum effectiveness in the classroom, if they are part of a systematic long-term exposure to idioms, for such exposure is what allows learners to develop idiomatic competence in the target language. Further research on AI knowledge systems will be required in order to identify both the short-term and long-term needs of such systems for idiom learning, and to forecast future user interface and evaluation design needs. Those applications that appear most promising will then need to be critically evaluated in light of up-to-date psychological and sociolinguistic studies regarding idiom learning, and language learning processes in general, in order to make explicit the complex mechanisms used in natural language processing and idiom learning. The study of natural language processing and idiom learning at both the micro and macro levels should, in turn, guide the use of AI in curriculum development and research efforts. The future possibilities for artificial language study and idiom learning can only be made more concrete by pondering the sources of knowledge, conjecturing about the various vehicles of knowledge, reflecting on language, and speculating on the nature of the activity of knowing.

In sum, the potential for the use of AI in first and second/foreign language programs in general, and idiom learning in particular, will largely depend on how ‘intelligent’ and ‘real’ the human/computer interface interactions can be made for users in the classroom and beyond.

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Appendix A. Questionnaire II, Part Three

III. Regarding *It's All Greek to Me!* Program

The following statements deal with your *It's All Greek to Me!* program experience. Please indicate your agreement with each of the following statements. (Mark one for each item)

Presentation

1. ① ② ③ ④ ⑤ The program *It's All Greek to Me!* is free of technical problems or programming errors.
2. ① ② ③ ④ ⑤ Screen displays are clear and easy to read.
3. ① ② ③ ④ ⑤ The color, print size, and spacing of text is appropriate.
4. ① ② ③ ④ ⑤ The program *It's All Greek to Me!* contains appropriate linking from text to text and from idiom to idiom.

Content

5. ① ② ③ ④ ⑤ The content of the program *It's All Greek to Me!* is appropriate for my level of learning.
6. ① ② ③ ④ ⑤ The content is presented clearly and logically.

Instructional Quality

7. ① ② ③ ④ ⑤ The program *It's All Greek to Me!* can be operated easily.
8. ① ② ③ ④ ⑤ The program *It's All Greek to Me!* is organized in a clear way.
9. ① ② ③ ④ ⑤ Directions on the screen are easy to follow.
10. ① ② ③ ④ ⑤ The examples are helpful to understanding the instructions for each task.

Learner Interaction

11. ① ② ③ ④ ⑤ I am motivated to finish the program *It's All Greek to Me!*
12. ① ② ③ ④ ⑤ I could control the rate of presentation.

Idiomatic Tasks

13. ① ② ③ ④ ⑤ The *Idiom Detection Task* challenged my reading skills.
14. ① ② ③ ④ ⑤ The *Zero Context Task* challenged my knowledge of equivalent expressions in English.
15. ① ② ③ ④ ⑤ The *Zero Context Task* made me want to read the accompanying supporting texts.
16. ① ② ③ ④ ⑤ The *Full Context Task* made a difference in my understanding of the idiomatic meaning.
17. ① ② ③ ④ ⑤ The *Full Context Task* gave me the contextual support I needed to understand the idioms.

Attitude

18. ① ② ③ ④ ⑤ The program *It's All Greek to Me!* challenged my knowledge of idioms.
19. ① ② ③ ④ ⑤ The program *It's All Greek to Me!* used my time efficiently.
20. ① ② ③ ④ ⑤ The program *It's All Greek to Me!* is easy to navigate.
21. ① ② ③ ④ ⑤ I am given the opportunity to learn the idioms used in the *It's All Greek to Me!* program.
22. ① ② ③ ④ ⑤ I am satisfied with what I learned.
23. ① ② ③ ④ ⑤ Answers to specific idioms is satisfactory.
24. ① ② ③ ④ ⑤ I could work at my own pace.

Additional Comments: *If you feel that this questionnaire has failed to discuss certain issues of importance to your idiom learning experience, please take some time to write comments or suggestions you may have. Any additional input is greatly appreciated!* ***(Please use reverse side for further comments)***

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