P. G. Michaelides, "Special Education with the use of Computers" στο Learning in Mathematics and Science and Educational Technology, University of Cyprus July 2001, Volume II pp. 107 - 127.

Special Education with the Use of Computers[1]

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Summary

In many cases, some of them referred here, the education of persons with alternate abilities is based on the continuous repetition of tasks and drills. For these cases, the use of Computers is possible and useful, in principle at least.

The problem however is that every case of special education requires a separate treatment with its own requirements in equipment (Hardware) and programs (Software). This fact limits the finances and makes difficult the development of programs and equipment to be used in Special Education.

For small countries like Greece, where the necessity for the 'Hellenization' of the relevant products is an additional demand, at least for the man-machine interface, these problems exist, to a significant extent also for the 'normal' education with the use of computers.

In this work, after a short introduction where an expose of the very basics of Informatics is given, we present the possibilities of the use of computers in education and in special education and we propose the use of general-purpose software in a way to meet demands of the special Education and of the education in general. This proposal, if appropriate to be implemented, has the advantage to bypass the otherwise unaffordable cost of the development of software specific to every case of Special Education

1.- Introduction to Informatics. Informatics include the acquisition, the codification, the store and the retrieval, the transfer, the interrelation and, in general, the process of Information. It incorporates the (electronic) Computers and the Telecommunications. It was based on Physics, the base for every technology, especially its branch of (micro)-electronics, and on Mathematics, especially in relation to the representation of Information and processes (algorithms). It uses findings from Cognitive Psychology (artificial Intelligence). The coding of Information produces data that are processed by (electronic) computers. Information and data are distinct notions although they are often confused. The coding of information may be represented in the form of speech, in the form of nods and signs, in the form of musical notes, in the form of an alphabet, etc. Data processed by computers are represented in **bi**nary digi**ts** or bits for brevity. Bits are usually combined in groups, the most widely used one is the byte, a series of 8 bits. With one bit two values may be represented. The most commonly used two values are the value 0 and the value 1. That is why we say that computers use binary arithmetic. With one byte we may represent up to 2^8 = 256 values. In the ASCII code[2] these values represent the letters of the (english) alphabet (e.g. 65 for A, 66 for B, 96 for a, etc) including the space (with value 32), the numbers from 0 to 9, the punctuation marks and special symbols, letters from another alphabet (values from 128 and up). Note that the English letter A and the Greek letter A, although they have the same appearance, they are distinct letters within the ASCII code, a point for frequent confusion. The

values from 0 up to 31 represent various ‘control characters’, for example, start of transmission of a message, end of transmission, break, change of line etc. In Table

Table1. ASCII code with the Greek alphabet

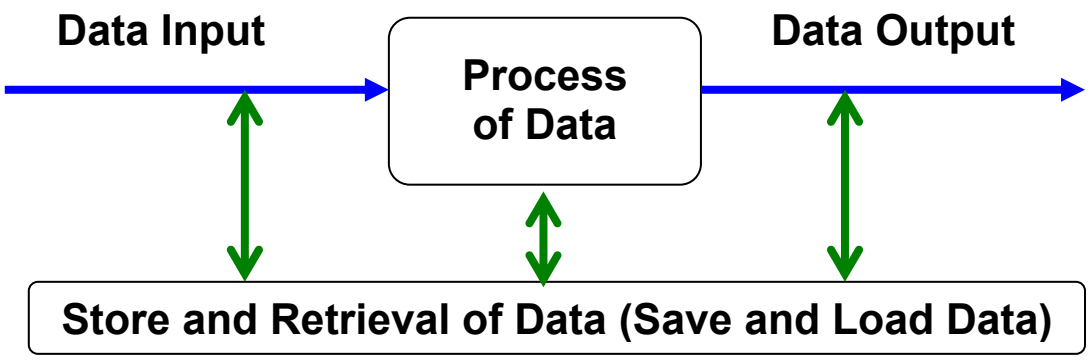
0		32		64	@	96	`	128	€	160		192	Ï	224	ΰ
1		33	!	65	A	97	a	129	□	161	¨	193	A	225	α
2		34	"	66	B	98	b	130	,	162	Ά	194	B	226	β
3		35	#	67	C	99	c	131	*ƒ*	163	£	195	Γ	227	γ
4	Break	36	$	68	D	100	d	132	„	164	¤	196	Δ	228	δ
5		37	%	69	E	101	e	133	…	165	¥	197	E	229	ε
6		38	&	70	F	102	f	134	†	166	¦	198	Z	230	ζ
7		39	'	71	G	103	g	135	‡	167	§	199	H	231	η
8		40	(	72	H	104	h	136	□	168	¨	200	Θ	232	θ
9		41	)	73	I	105	i	137	‰	169	©	201	I	233	ι
10	LineBreak	42	*	74	J	106	j	138	□	170	□	202	K	234	κ
11		43	+	75	K	107	k	139	‹	171	«	203	Λ	235	λ
12		44	,	76	L	108	l	140	□	172	¬	204	M	236	μ
13	CR- Return	45	-	77	M	109	m	141	□	173		205	N	237	ν
14		46	.	78	N	110	n	142	□	174	®	206	Ξ	238	ξ
15		47	/	79	O	111	o	143	□	175	—	207	O	239	ο
16		48	0	80	P	112	p	144	□	176	°	208	Π	240	π
17		49	1	81	Q	113	q	145	‘	177	±	209	P	241	ρ
18		50	2	82	R	114	r	146	’	178	²	210	□	242	ς
19		51	3	83	S	115	s	147	“	179	³	211	Σ	243	σ
20		52	4	84	T	116	t	148	”	180	΄	212	T	244	τ
21		53	5	85	U	117	u	149	•	181	µ	213	Y	245	υ
22		54	6	86	V	118	v	150	–	182	¶	214	Φ	246	φ
23		55	7	87	W	119	w	151	—	183	·	215	X	247	χ
24		56	8	88	X	120	x	152	□	184	Έ	216	Ψ	248	ψ
25		57	9	89	Y	121	y	153	™	185	Ή	217	Ω	249	ω
26		58	:	90	Z	122	z	154	□	186	Ί	218	Ϊ	250	ϊ
27	Escape	59	;	91	[	123	{	155	›	187	»	219	Ÿ	251	ϋ
28		60	<	92	\	124	|	156	□	188	Ό	220	ά	252	ό
29		61	=	93	]	125	}	157	□	189	½	221	έ	253	ύ
30		62	>	94	^	126	~	158	□	190	΄Υ	222	ή	254	ώ
31		63	?	95	_	127		159	□	191	Ώ	223	ί	255	

1, the ASCII code with the Greek alphabet is shown. Because of the ASCII code, the one byte is often called a character, a term used mainly to denote values from similar coding using a more restricted set of 5, 6 or 7 bits. The symbol KB represents 1 kilobyte i.e. one thousand bytes. Sometimes, because of the binary

arithmetic used in the computers, 1 KB represents 2^{10} = 1024 bytes. Correspondingly, 1MB (one megabyte) may denote either one million bytes or 1024 X 1024 = 1 048 576 bytes.

1-1.- The operation of a computer may be depicted from Scheme 2. The computer

Scheme 2. Operation of a Computer



(Von Neumann's Architecture)

may 'read' data (Data Input), may process them (Process of Data), may store them (Save data) and may present the same or other data (Data output). This simple scheme is known as Von Neumann's architecture and is the basis for all of the personal computers used and for most of the other computers. Other architectures include the parallel processing architecture and computers with multiple processors while computer networks (local, interconnected, world wide web, etc) are now widespread.

1-2.- A computer includes the Hardware, which includes the physical (material) components of the computer, the Software, which includes all the programs of the computer and the Firmware, by which we denote software of the computer that cannot be changed without changing the component (chip) on which it resides. A change in the Hardware implies replacement of an accessory of the device and it is not always possible. In contrast, the programs may be replaced more easily without any change in the Hardware. Table 3. Parts of a Computer presents some of the jargon used in relation to computer components. The high process speed, the capability of programming to perform different tasks, the possibility to choose between different (known) paths depending of the previous course taken and the possibility of inventing new actions not known beforehand (artificial intelligence) distinguish Computers from other automat machines. They are useful tools, necessary for a more efficient work in production, in services, in office, in administration, in entertainment, in the house, in school, etc. They are used everywhere affecting work and leisure time, the organization and operation of the society, causing a redefinition of most of the vocations. It is a real intrusion called the 'Informatics revolution'. Because of these rapid changes, there are many illiterate persons in all countries. These non-literates in Informatics are a problem in every country. The countries that will adapt to the new forms of economic relations resulting from the Information Technologies will export poverty to the countries keeping with the previous relations, exactly as it has happened with the previous technological revolutions.

2.- Informatics and Education. Informatics and Education may be considered along

three main trends. The first trend is as an Administrative Tool, for reports, files, class register, etc. It is being introduced with many problems, similar to those in other sectors. The main problem is due to the fact that even the relatively simple and

Table 3.- Parts of a Computer

A.-H/W, Hardware, Συσκευή

(central) Processing Unit	•Central Processing Unit, CPU •Intel 80486DX2/66, P5, 386 .... Cyrix 486, .. PI, PII, PIII •Motorola 6800, ... AMD K5, 486, ...
	(Peripherals)
Communication Units	•Keyboard, Display, Mouse, Joystick, •Speech recognition and synthesis, •Image processors, OCR, •Serial, parallel, USB, SCSI, etc.
Store Units (to save and /or retrieve data)	•Temporary and permanent memory, ROM, RAM, •Central and peripheral memory, Cache, ... •Hard Disks, •Diskettes •CD, magneto optical Disks, etc. •(cards, paper, paper tape, magnetic tape, ...)

B.-S/W, Software, (Computer Programs)

Operating Systems	•DOS, Windows, OS/2, ... •System 7, •VMS, UNIX, LINUX, ...
Applications	•Programming Languages, •Word processors (Text Writers), •Drawing, •Spreadsheets, •Data Bases •etc.

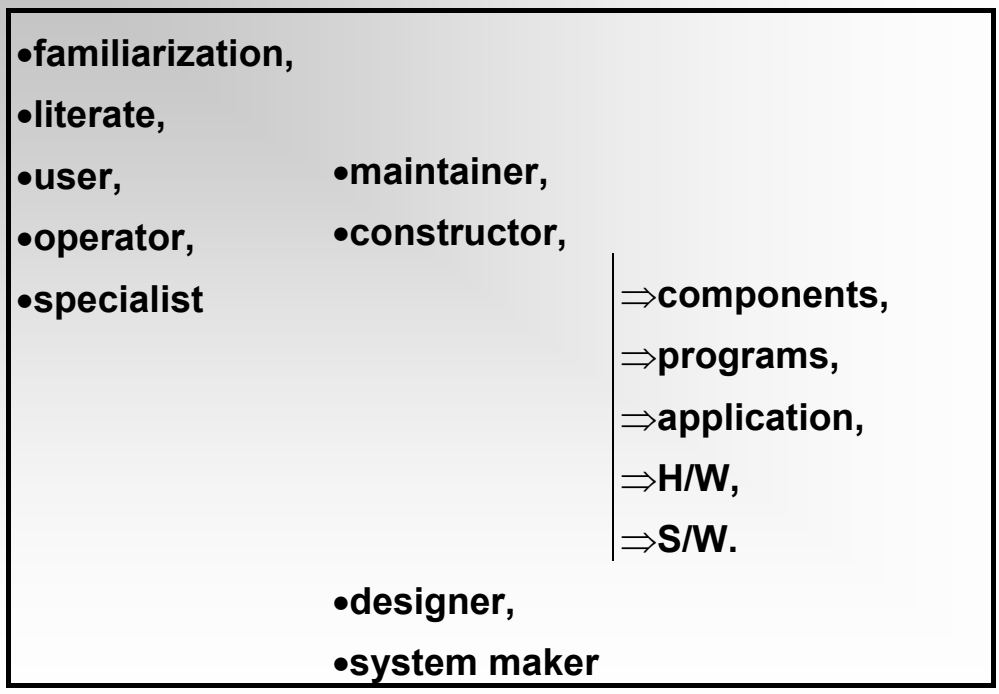
C.-FirmWare (e.g. the BIOS)

common tasks require a tailored construction by a programmer who is not the end user. The recent massive appointment of teachers trained as informaticiens may solve, at least partially, this problem.

2-1.- Education in Informatics. This term denotes Informatics as a teaching subject. It has been introduced in the schools in Greece since 1985 with many problems, including vague objectives without a clear syllabus. It has not been considered in an integrated way and usually it is restricted in the training of a specific subject, for example learning the basics of an operating system or a programming language

etc[3]. Practice work, whenever it occurred, was usually in an abstract way, e.g. numerical solution of a 2nd degree equation. An approach in conjunction with the use of Informatics as a teaching tool only recently, with the 1997 education reform, has been taken, although remnants of the previous situation are still observed. With the new curriculum, Informatics is taught in an integrated way from the primary education (Demotiko) to the upper secondary education (Lyceum), in upgrading levels as depicted in Figure 4. To understand these levels an analogy with automobiles (cars) may be useful where the corresponding levels may be the user (e.g. for transportation), to the driver, to the repair technician, to the car designer and maker. Its implementation is still depending on the appropriate training of teachers to teach effectively the corresponding subjects. This problem is further enhanced by the rapid developments in the subject[4].

Figure 4. Education levels in Informatics.



2-2.- Informatics in Education. This term denotes the use of Informatics as a Teaching – Learning Tool. The proliferation of computers by now has made obsolete the past worries, if we need Informatics as a Teaching – Learning tool. Rather, the new worry has to be 'on what conditions Informatics is a more effective tool in teaching and learning'. In general, there is a delayed and questionable introduction of Informatics as a teaching – learning tool because:

- Economically affordable products became available only recently,
- The educational systems, suffer from a 'bureaucratic inertia',
- There is a prevailing feeling of the need for specialized knowledge,
- There is ignorance on the possibilities and capabilities of Informatics,
- Its implications are unknown,
- There is vagueness of objectives,
- There is a shortage of trained personnel and lack of infrastructure,
- There is a trend to use in education the outdated elsewhere equipment,

- Lack of specialists (in teaching theme, education and informatics combined)
- The high cost for the development of specialized programs.

A combined approach in which Informatics is used in Education as a teaching subject and as a teaching – learning tool concurrently is a more efficient choice, especially for the primary education[5].

2-3.- Why Informatics in Schools. Informatics must be included in the school curricula, especially in the compulsory education, because it is a cultural characteristic of our society so it has a place together with the other school subjects. It influences the social organization and behaviour, for example the notion of legal and illegal[6] or the ethics of communication[7]. Informatics constitutes a vocational skill useful in all the vocations. As a new subject it requires special teaching to acquire a basic knowledge on its possibilities, a necessary condition for participation in the society's decision-making processes. Its inclusion in the school curricula raises the point of competent teachers. This point may seem similar to the problem of lack of trained personnel whenever a new technology is introduced. However in education the lack of trained personnel is more problematic because, in a national level, it enhances alienation[8] and within a society it may broaden social inequalities[9]. The fact that an 'Informatics dependent society' is a new culture together with its rapid evolution adds a unique peculiarity for which special actions are required. In this action, the intensive training of teachers is fundamental.

2-4.- Features of Informatics in Education. The use of Informatics in Education shows endless features. It can be used as a tool for teaching and for learning, for example as a substitute for the more expensive tools, for the (static) Audio Visual tools or for the Libraries. It may also be a relief for routine tasks, e.g. administration, organization and class register. It helps with the individualization of teaching, which is considered as a general improvement of teaching, but it is necessary in Special Education where every case has to be treated separately according to its specific problems. It may make teaching more effective, a disputable point, depending on the objectives of teaching and the education philosophy[10]. In general education Informatics may foster the development of cognitive skills. In technical and vocational education it is by now a prerequisite for an effective technical – vocational education. In Special Education it may help to reduce inequalities and compensate for the deficiencies. It may lead to short- and long- term economic development[11]. It may lead to a better exploitation of school time. Extensive use of Informatics in school may lead to educational change (see for example the case for open and distant education). However, due to the lack of a previous relevant culture, it may lead to a topple of the normal class[12], a case which puts heavy demands on the teacher in order to preserve his/her authority. For small ages, the use of Informatics in teaching requires calls for special action because of a capability of abstraction required on the children's' part. This requirement may be compensated, at least partly, by organizing teaching in projects (learning by doing). Contrary to a widespread opinion, Informatics cannot replace the teacher totally, at least for the foreseen future.

3.- Informatics and Special Education. If fit to be used[13], Informatics may help considerably in Special Education. Especially for the (difficult) cases where the Attention or the Continuous Interest and Concentration from the child is a problem, Computers may be an advantage to use compensating to some extent for the small numbers of trained personnel. It may help immensely towards the adaptation of the general methods of teaching to the specific and different needs of every child

(individualization of teaching). The richness of graphics and animation provide an easy alternative way of communication, with easiness of implementation (and reuse). The computer, if properly used may help in the socialization of handicapped children and may facilitate their social acceptance. Also it may help in boosting their self-esteem by achieving similar goals in doing tasks similar to those of their classmates but adapted to their own abilities.

3-1.- If the previous statements are true, Informatics should have conquest all schools, especially the schools for Special Education, and indeed it has whenever its inherent constraints do not prevail[14]. Such constraints include the fact that it is still a new tool with features unknown to the majority of the potential users. Its use requires concerted actions from specialists on different areas. It addresses a small number of potential users for every separate case while the development cost is high. This constraint makes the development of software (and in some cases and of hardware) appropriate to be used in special education a non-profitable adventure and limits the number of potential developers mainly to research institutes. The rapid changes in this field makes this constraint more prominent because it shortens considerably the time (see note 4) to recover any investment made for the development of specific products to be used in Special Education. Consequently, although the development of products specifically adapted to the requirements of every case is a preferable solution, it is economically unaffordable and cannot be applied in practice. A way out of this constraint is to use existing general-purpose software (e.g. the 'utility software' or, simply, 'utilities' as it is termed) and adapt it to the specific needs of every case. This is feasible because modern operating systems (especially these with a graphic interface) are accompanied with utilities providing almost all the tools necessary for the development or, more appropriately, the adaptation of general-purpose software to meet needs in teaching. This adaptation has an affordable very low cost, if any at all. However, it demands specialized but easily accessible computer knowledge and skills from the teacher[15]. Some general examples on the use of general-purpose software in teaching are given later on.

4.- Subjects of Special Education. In need of special education are persons (usually children) with abilities substantially different from the mean[16]. Included are the 'handicapped' persons (persons with body or mental deficiencies) and the 'gifted' persons. However, the values of our society impose to care more for the 'handicapped' persons to whom, usually, the term special education refers. According to the World Health Organization (WHO) the mental deficiencies are classified as 'grave', 'medium' and 'light'. From a social point of view the 'totally dependable socially' and the 'self-sustained socially' classes are differentiated. From an education point of view we may differentiate between the 'unfit' (persons that are impossible or very difficult to be educated), 'trainable' (persons that are able to be trained and develop special skills) and 'educable' (persons that can be educated). In the rest of this work we refer to some cases from these later classes (trainable, educable). They refer to persons with light mental deficiencies or to persons with body deficiencies that affect lightly or non at all their mental abilities. In many cases these persons have developed well above the mean other of their abilities and the term 'persons with alternate abilities' is used as a more appropriate one. It is estimated that as many as 0.4% of births relate to children with medium or heavy mental deficiency and another 3% relate to children with light mental deficiency. In Greece, it is estimated that as many as 250.000 children need Special Education and only 1 out of 10 receives it. Some cases for special education include[17]:

- physical disabilities in general that may lead to emotional disturbances and behavioral problems,
- kinetic disabilities (spasticity, ataxia, amputation, etc)[18]
- various kinds of mental deficiencies that lead in learning disabilities as the dyslexia (exhibited as aphonia, stuttering, aphasia, problems with the order – sequence of letters and/or of numbers, etc),
- deafness and hearing problems that may result in aphasia,
- blindness (and vision problems) that may result in mental retardation.

5.- Some Aspects of Special Education. Special education aims to the full development and utilization of alternate abilities with continuous practice and intensive teaching and guidance so that the subjects will be able to compensate for their deficiency in order to achieve a smooth social placement (feeling of belongingness, boost of self-esteem, etc). It includes Psycho-motive skills (orientation, movement, coordination, communication, etc), Mental skills, Vocational education and training, etc. Also Special Education aims at the emotional development and the development of social skills. It requires a teaching strategy trail on a case-by-case basis, extensive repetition, great effort, passion and patience from the teacher and, sometimes, recourse to alternative means of communication. Foreign products cannot always be used (see also the remark in section 2-3.- and note 9). Although the lack of necessary equipment may be remedied easily, only a modern and intensive training of the existing personnel may cope with the lack of competent specialists. The necessary equipment is:

- General. A sufficient number of PC with appropriate operating systems, components and peripherals, software for the development of graphics, animation, sound, etc. The utilities of an operating system like the Windows are, in general, sufficient for most of the cases.
- Specific to the case, for example special keyboards or other input devices, LCD displays instead of the commonly used cathode ray ones, hardware and software for alternative means of communication, etc.

5-1.- Some cases in need of Special Education are[19]:

- Speech disorders. Here the aim is the perfection of oral and written communication, a task where repetition is useful. Because of the usually accompanying concentration problems, alternate forms of teaching may help, a point, which, together with the need for repetition calls for the use of computers. Speech recognition, speech synthesizers and, possibly, special pointing devices are rather necessary.
- Learning disabilities. Again a repetitive task requiring teaching organized in multiple levels with increasing difficulty and special techniques to cope with concentration problems. The adaptation of the teaching to the specificity of every case (individualization of teaching) is rather a necessity.
- Mental deficiencies. Training and education is based, in general, on the continuous repetition of (rather simple) tasks and on techniques to preserve (mental) concentration and attention. On all these tasks, the use of computers is helpful.
- Deafness. Here there is a need for speech stimulants, alternative means of communication and equipment for speech recognition. Graphics are also helpful, e.g. to demonstrate the produce of speech.
- Blindness. Here the teaching and the training are based on the (exceptionally high) development of the other senses, especially hearing. The use of

computers using general-purpose hardware and software only recently has been made possible. Navigation instruments and substitutes for the normal writing (e.g. Braille) are helpful.

- Infirmities for which see note 18

5.- Educational aspects in General purpose Software. The inquiring teacher with knowledge of Informatics may invent some educational use for almost any kind of software. Some of the most widespread categories of Software include: Drawing and Painting programs, Games, Word (and text) processors, Spreadsheets, Databases and Communication Programs while for the more experienced user, the Animation programs, the Presentation programs, Programming languages, even the Operating Systems themselves are within his/her reach[20]. In almost all of these programs, editing tools like cut, copy, paste, erase (or delete) are present. These tools are very useful and may be used to teach basic programming skills (or the core notion of forming an algorithm), subjects believed to be difficult because of the mental abstraction involved. These programming skills may be developed along the following guidelines:

- The basic steps of programming are:
  1.-problem definition,
  2-analysis to a series of (interdependent) steps, a repetitive task until an adequate level of detail is reached,
  3.-choice of appropriate actions from the tools available, and
  4.-implementation of the solution chosen[21],
- We ask the students to use one of the programs they know (e.g. a drawing program or a word processor program) and produce something (a 'work') of their own (e.g. a drawing or a story text).
- We suggest to them a somewhat different work (drawing or text) and ask them to describe (or write down) what they should do in order to modify their work accordingly, i.e. to make a plan in order to achieve the necessary modifications.
- We call them to actually implement their plan using the editing tools of the program they use and check the result.

The aware teacher may deduce the cognitive skills that may be developed by such a procedure, which in fact incorporates common teaching practices with more conventional means. The same objectives may be accomplished if the students engage in the planning and implementation of producing a specific work.

In the rest of this work some of the main characteristics of the most commonly used programs together with their possible educational use are presented in short[22].

5-1. Drawing – Painting programs are used for the drawing of figures, shapes, images, etc or the manipulation of pictures. Most are restricted to 2 dimensions (2d-programs) although more advanced programs may show different plane cuts of the same 3 dimensional object (2.5-programs) or show a 3 dimensional object in a perspective view (3d-programs). Many allow free hand drawing and retouching effects. Almost all have the possibility of creating simple shapes (cycles, squares, triangles, lines, etc), and provide the facility of (simple or more complex) geometrical transformations such as inversion, mirroring, rotation, scaling (up or down), stretching, etc by the use of which more complex shapes may be formed and stored for reuse. The user interface (that is the way the user 'communicates' his – her commands to the program) is usually simple and graphic, facilitating the task. This

interface may easily be adapted to meet specific deficiencies (e.g. adaptation to respond to finger or eyelid movement) and they are suitable to keep prolonged (mental) concentration. They may be used to develop the notions of analogy and similarity, of (simple) symmetries and transformations and also to develop analysis and synthesis skills. They may also help to cases where non-verbal communication is used. They are restricted in two dimensions only.

5-2. Games. The significance of Games in Education is well known[23]. Computer games may be classified as[24], video, adventure, strategy, simulation, etc. The graphics, the animation and sound used put them in the forefront of the field. Their variations, even within the same game seem endless[25] a feature convenient for cases where there is a need for many repetitions of similar drills. They may be useful as drills for the development of proper reactions to visual or acoustic stimuli (video and adventure) or for more complex cognitive skills (simulation, strategy, adventure). Their difficulty level may be adapted to the user a possibly useful feature in boosting self-esteem. However, their use in Special Education in particular, must be well studied. Apart from possible physical harms (see note 13) in most of them, mainly in the categories of video and adventure, the prevailing values are destruction, humiliation, racism and nihilism, especially with respect to human life, a negative feature for the emotional development[26]. Another negative outcome is the possibility of addiction and seclusion that may be developed, a fact known also from other electronic games. If these negative features are screened out, computer games may be useful in the development of cognitive, psycho-motive and (conditionally) social skills.

5-3. Word-Processors. The purpose of these well known programs is to create, edit and present a document[27]. They have been used very early in Language courses especially in Composition. Most modern word processors (Microsoft Word is the more widely known one) apart from their very advanced editing and formatting tools, provide also spell checker and grammar – synonyms and antonyms, thesaurus (for some languages) a feature useful in cases of dyslexia. Although they may improve the appearance of written text, handwriting may turn into scribbling.

5-4.- Spreadsheets. Their purpose is to easy the manipulation of (2-dimensional) tables. They are also well known programs from the pioneer Lotus1-2-3 to Microsoft Excel. Their value lies to the fact that the content of a cell may be dependent on the contents of one or more other cells and is updated automatically whenever there is a change. The powerful arithmetic, statistical, graphical, etc tools (functions) these programs come with constitute another advantage. They are valuable teaching tools especially for Mathematics[28]. They are useful for cases with learning disabilities where extensive drill and practice is used.

5-5.- Databases. They may be considered as 'hyper-spreadsheets' or as the computerized equivalent of an office filing system. Modern databases may store Information data in any form of a computer object (data values, files, links, program files, etc). Their value lies in the powerful tools they are accompanied, which facilitate 'query retrieval' of the stored Information data. They may be used in schools as notebooks, as filing systems, etc. Using a database from 'scratch' requires a data organization scheme i.e. data description, a classification scheme, relations between data, etc, tasks that involve complex cognitive skills. These programs are very useful in relation to teaching by the assignment of projects.

5-6.- Communication programs. The purpose of these programs is to facilitate the (electronic) communication. They function in layers, lower layers making possible the (physical) interconnection of the Hardware used and the exchange of electric

signals, other layers permit the exchange of data organized in structures for error correction and validation of the exchanged data and the higher levels being application specific. Widely known are the programs for e-mail communication, for 'surfing the web', the chat programs (permitting written and/or oral conversation between the users) and the teleconferencing programs permitting the transmission of text, graphics, animation, sound, etc. Their significance for Education at a Distance is well known. Their use enhances the possibilities for group work and socialization, if good communication lines are available at affordable prices.

6.- Epilogue. Informatics is useful in a number of cases for General and for Special Education. Simultaneous accomplishments may be achieved by its use like the individualization of teaching, the literacy in Informatics, the reduction in costs, etc, resulting in a more efficient education. However, these achievements depend heavily on the existence of competent teachers knowing the possibilities and the limitations of this new technology

I would like to thank Dr. Eleni Papadaki-Mihailidi, Assistant Professor in the Department for Primary Education of the University of Crete for her help in translating some terms from Special Education

Notes and References

1.-parts of this work have been presented in: a/ P. G. Michaelides, 'Computers in Special Education', proceedings of the International Conference titled 'Informatics in Primary and Secondary Education', Athens 27-28 November 1989 and in the E' Pan Hellenic Physics Conference by the Greek Physics Society, Athens, December 1989. (in Greek), b/ P. G. Michaelides, Problems from the Introduction of Informatics in Schools, proceedings of the International Conference titled 'Informatics in Primary and Secondary Education', Athens 27-28 November 1989 (in Greek), c/ P. G. Michaelides, 'Education and Special Education with Computers', proceedings of the International Conference on 'Computers in Special Education' School of Philosophy of the University of Athens, Athens 21-22 September 1991, organized by the Greek Informatics Society, the University of Athens and the (Greek) Ministry for Education.

2.-American Standard Code for Information Interchange.

3.-See for example, a/ P. G. Michaelides, Informatics in the Greek Multibranch Lyceum, 2nd Pan Hellenic Conference on the Didactics of Mathematics and Informatics in Education, Nicosia 26-28 April 1995, pp. 403-412 (in Greek), b/ Introduction to Informatics: a course for students in Departments of Education, 1st Pan Hellenic Conference on the Didactics of Mathematics and Informatics in Education, Nicosia 26-28 April 1995, pp. 403-412 (in Greek), c/ Problems from the Introduction of Informatics in Schools, proceedings of the International Conference titled 'Informatics in Primary and Secondary Education', Athens 27-28 November 1989 (in Greek).

4.- The mean life of a Hardware or Software product is around 2-3 years as compared with the 10 or more years in other sectors.

5.- see also the following (in Greek): a/ A. Raptis and A. Rapti 'Informatics and Education', A. Raptis editor, Athens 1988, b/ B. Makrakis, 'Hypermedia in Education', Metaihmio, Athens 2000, c/ P. G. Michaelides, 'Informatics in Primary Education: Problems', invited speech in the Pan Hellenic Conference titled 'Informatics in Education', Ioannina 14-15 May 1999, organized by the union of

Informatics Teachers in Epirus, the pedagogical Institute and the Department for Primary Education of the University of Ioannina (A. Tzimogiannis editor).

6.- see for example the new legislation on copyright or the 'fight' against hacking.

7.- see for example the dispute about the e-mail privacy and communication or the information spreading via the internet.

8.- e.g. by the use of software prepared for other societies with, possibly, different values. See also, the point with the use of the Greek alphabet is still not completely solved. The jargon used by programmers not only in Greece but almost everywhere is also a characteristic point.

9.- upper classes can pay and find the necessary trained personnel to have education outside the common schools.

10.- Studies on the use of Informatics in schools have lead to contradictory conclusions regarding the effectiveness of teaching. Although most of this contradiction may be levied if all relevant parameters will be taken into account, it must be noted that most of these studies are done with the use of previous generation computers a fact that imposed many restrictions on its use in teaching. Also, when comparing the outcomes of independent researchers, we must keep in mind the difference on the equipment and software used, a significant parameter because of the rapid development in the field. In general we may state that in education as in all other tasks, Informatics may enhance the outcomes of the task. If a job is done well without the use of Informatics it may be done better and more effectively with its use. If a task is done badly, the use of Informatics in it will probably make things worse.

11.- Education is a big consumer. A specially organized introduction of Informatics in Education may boost local industry (the case of BBC micro in England is very Characteristic). Also, a society literate in Informatics may use this knowledge for a more effective production in all sectors.

12.- Quite often, the students may be better skilled or trained in the use of a specific computer accessory or program than their teacher.

13.- Sometimes the use computers and computer accessories by persons with disabilities is not advisable. For example the usual cathode ray displays may bring forward epilepsy symptoms to persons with a relevant predisposition.

14.- Most of modern research for a more effective special education is done using Informatics in ever expanding areas (private communication from the personnel in 'Laboratory for Non Verbal Speech Development University of Mons, 20 Place du Parc, 7000 MONS, Belgique.

15.- More on this theme may be found in the following postgraduate dissertations, which were made within the Laboratory for Science Teaching, University of Crete, Rethymno-Crete, Greece (they are in Greek): a/Plevrakis A., 'Educational Application Development Systems for Computer Assisted Learning', 1993. It refers to methods for the development of education software with a predetermined learning content, b/Goumenakis Giannis, 'Programs and programming of Computers in Education: the case of LOGO', 1993. It refers in the educational use of some computer systems environment and their learning outcomes, c/Kollias A., 'Computers in Teaching and learning: a critical approach', Athens 1993. It has been

published as a book from the 'ΕΛΛΗΝ' publishers. It is a systematic and commented presentation of the different methodologies for introducing Informatics in Teaching.

16.- The aim of this summary is only to orientate the reader in order to make clear the following parts on the use of general-purpose software in education. For this reason we did not stick strictly to the right terminology. In any case, this subject has to do with human beings worth of our respect and the interested reader must resort to appropriate professional resources.

17.- It must be stressed that although the synoptic term 'Special Education' is used and some general, mostly methodological principles may exist, almost every case is unique and requires its own treatment (special education). This diversity is one of the main reasons for which the use of Informatics in Special Education seems advantageous.

18.- The development of artificial limbs and other organs, sense organs etc. is a separate interdisciplinary area of informatics (and Medicine and Psychology).

19.- The purpose of this section is only to demonstrate the diversity of every case of special education and the relative advantages that the use of computers may exhibit and not to provide a complete and rigorous description.

20.- See also in Makrakis, V. (1991), 'Computer resource teachers: a study and a derived strategy for their use in in-service training', Computers and Education, Vol. 16, No1 (43-49.

21.- Traditionally steps 1.- and 2.- are termed analysis and steps 3.- and 4.- are called (computer) programming. This was imposed because the end user (usually illiterate on computers) gave the specifications of the work to be done and a (computer) specialist (the programmer) undertook the task to form the necessary computer program. In most cases another very important person intervened, the (computer) analyst. He was the mediator (interpreter) between the end user who stated his needs in the terms (jargon) of his profession and the programmer who new only the data types, the commands, the possibilities and the limitations of the computer system he was going to use. Although a detailed knowledge of techniques was not necessary, in order for the analyst to be effective, he had to know a combined broad knowledge on computers and on the workings of the end user's profession. The significance of the analyst may be judged from the fact that they were the only persons always accepted as immigrants in the USA.

22.- The 'authoring tools' are programs specifically designed to help the inexperienced user to create works useful to his profession. They constitute a special case of software tools termed CASE (Computer Aided Software Engineering). Those interested may consult the relevant literature. Many of the utilities accompanying Windows (e.g. the Help system) exhibit characteristics of CASE tools. See more details in the first reference given at note 15.

23.- See for Example, Bertrand Russell "On Education", chapter 5 Play and Fanny.

24.- see more in : KOMIS (V.), "Les nouvelles technologies de l'information et de la communication dans le processus d'apprentissage et application par l'étude de leurs représentations chez les élèves de 9 à 12 ans", Phd Thesis, University Paris 7, December 1993.

25.- Although this features help to keep the interest and attention of the user, it has been found that they are rather disadvantageous in the acquirement of knowledge.

See more in "L’ influence des divers facteurs et particulièrement des divers médias de logiciel multimédia éducatif expérimental sur le processus de l’ apprentissage de l’ informatique initial" chez des étudiants de niveau d’ IUT", Thèse de doctorat de l´Université, présentée par Panagiotis Politis à l' Université PARIS VII, UFR Didactique des Disciplines, (spécialité: Didactique de l' Informatique).

26.- trigger – happy, survival, destruction, rivalries, … describe some of the situations that may evolve.

27.- The term ‘document’ must be taken in the broader possible meaning. It may include text, simple or formatted, drawing, figures and pictures, even sound animation and links to other documents (the terms hypermedia and hypertext are also used then).

28.- See more in M. Kourkoulos, ’Numbers: an interactive software for the learning of arithmetic and algebra’, ed. Savalas 1996 (in Greek).