The ICT at Elementary School and Kindergarten: reasons and factors for their integration

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Abstract:
In this text we will try to indicate the reasons that justify the integration of the ICT in schools and kindergartens, based on the contributions provided by the available research and most particularly by an action-research project[1] we have developed and monitored in a kindergarten throughout the school year aimed at integrating the new technologies in classroom context. We will also try to highlight the factors we believe are essential to enhance the integration and use of the ICT in these contexts in a way to effectively contribute to the promotion of educational quality.

Keywords:
Information and Communication Technologies, Elementary school/Kindergarten, Development, Learning.

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CONTRIBUTIONS OF THE ICT TO LEARNING DURING CHILDHOOD

The discussion on the use of the ICT by very young children has given rise to some controversy between those who defend, more or less warmly, the educational benefits of technology and those who object to it for various reasons. However, in recent years, this controversy, which was particularly intense during the 1980's (Haugland & Wright, 1997), has become less evident. In fact, the potential of these new technologies, both with regard to the nature of the programmes used and to the possibilities in accessing information and communication available via the Internet, in addition to their increasingly influential presence in our daily lives, makes it difficult to ignore the contribution of these new means to enriching the learning contexts for childhood (Amante, 2003; NAEYC, 1996; Ramos *et al.*, 2001).

Language development

The development of language and literacy are the most studied curricular areas when it comes to their relationship with the use of technology in the preschool years (Laboo *et al.*, 1999; Mioiduser *et al.*, 2000; Moxeley *et al.*, 1997).

With regard to verbal skills and contrarily to the opinion of the critics (Cordes & Miller, 1999; Healy, 1998), the computer does not inhibit the development of language. In fact, research has shown that:

- Computer games encourage more complex and fluent speech (Davidson & Wright, 1994);
- Children are encouraged to use language, especially when they use open programs that encourage exploration and fantasy, such as art programs, with which they make descriptions whilst drawing, moving objects, or "writing" (Clements & Nastasi, 2002);
- Children tell more elaborate stories about the drawings made on the computer (Clements & Nastasi, 2002);
- Interaction with computers encourages verbal communication and collaboration between children (Crook, 1998a, 1998b; Drogas, 2007) and provides situations of socio-cognitive conflict which lead to learning (Amante, 2003, 2004a);
- The stimulation of vocalizations by children with speech problems has also been evidenced (McCormick, 1987, cit. by Van Scoter *et al.*, 2001).

With regard to written language, research has shown that the ICT, namely the use of text processors, provide children with the opportunity to become involved in the exploration and co-building of knowledge on symbolic representation and development of literacy and related concepts, such as the direction of the written language, sequence, etc. (Amante, 2004a; Laboo & Ash, 1998). The use of electronic story books, as well as their creation by the children and educators themselves (Laboo *et al.*, 1999; Lefever-Davis & Pearman, 2005; Trushell, Maitland & Burrel, 2003) has also revealed important gains. In fact, interactive books seem to contribute towards the development of vocabulary,

syntax and recognition of words (Uchikoshi, 2005), as well as the understanding of the narrative structure of the stories (Verhallen, Bus & De Jong, 2006). In turn, Lewin (2000) states that interactive multimedia programs complement the development of literacy because its audio component can help to work on pronunciation, and provide syllabic reading, or centred on phonemic segments, thus developing phonologic awareness, as has been shown by many studies (*cf.* Chera & Wood, 2003; Wise *et al.*, 2006).

In addition to programs that work specific skills, the importance has also been verified of children using the ICT to develop their reading and writing learning skills in a more global and functionally significant manner, integrated in other activities and serving real needs, such as writing a recipe, a warning, a shopping list, etc. A reference to the many possibilities made evident by the use of e-mail is inevitable here (Amante, 2003, 2004a; Siraj-Blatchford & Withebread, 2003) the ease of which, together with the instant exchange of messages, stories, drawings, etc., is highly motivating for children and stimulates communication and the discovery of the written language.

Mathematical thinking

In this area of educational development, the use of computers has also shown to encourage the emergence of some mathematical concepts such the recognition of shapes, counting and classifying. Clements and Nastasi (2002) refer that children who can associate direct manipulative experiences to the use of a computer program have shown greater skill in classification operations and logical thinking than those that only had access to the concrete manipulative experience.

However, the computer's main contribution seems to be at the level of the development of geometrical and spatial thinking, favouring the development of concepts of symmetry, patterns, and spatial organization, among others (Clements & Swaminthan, 1995). Children can use the graphic programs to create objects and act on them, enlarge or reduce them in size, add shapes that lead to other new shapes, colour closed areas, and reflect on the topological characteristics of those areas (Amante, 2004c; Clements & Nastasi, 2002). All of this is obtained as a consequence of their action, and not so much due to the characteristics of the static shapes, which makes one consider that "the power of such tools resides in the possibility of children later interiorizing the processes, thus building new mental tools" (Clements & Nastasi, 2002, p. 580).

LOGO programming may also contribute to the development of geometrical and spatial concepts. According to the Piagetian theory (Piaget, 1971), children apprehend the notions of geometrical shapes not through perception, but through the physical and then mental actions they have on those objects. LOGO programming (which has the Piagetian learning perspective subjacent) helps children relate their intuitive knowledge of movement and drawing with mathematical ideas. Although research outcomes do not enable a conclusion on the influence of the LOGO programming on mathematical skills in general, and are even controversial, namely with regard to the transfer of such skills to other situations (Crook, 1998a; Underwood & Underwood, 1990), it undoubtedly seems to be a field for problem solving, which contributes to the development of spatial and numeric notions, creative thinking and metacognitive knowledge (Amante, 2004c; Clements & Nastasi, 2002; Underwood & Underwood, 1990).

Anyway, it is important to stress the need for the educator to provide assistance in terms of relating the work carried out on the computer with mathematical knowledge, be it by LOGO or any other application. This mediation is fundamental because of its active encouragement, because it encourages children to verbalize the strategies followed, making them reflect on their own thought and making them aware of their problem-solving strategies (Amante, 2004b; Clements, 1999; Clements & Nastasi, 2002).

Knowledge of the world

Pre-school education is concerned with providing children with knowledge of the world: be it their direct world encompassing the very context of their activity room, the world outside their physical and community kindergarten, be it a more distant world encompassing the knowledge and awareness of different scientific fields, the knowledge of other realities, whether natural, social or cultural. In this

sense, and as highlighted by Haugland and Wright (1997), Grácio (2002) and Rada (2004), among others, information technology (namely the possibilities made available by the Internet) can provide educators and children with unique opportunities to access extremely diversified and otherwise inaccessible information, which can most certainly become powerful educational resources. Thus, from carrying out research on whales and their habitats, to 'visiting' the faraway country where their new colleague came from, to using an interactive encyclopaedia to find out what rockets are, or simply to see the work carried out by children in another school or kindergarten, the ICT enable a quick response to children's inexhaustible curiosity and open the door of their classroom to a whole range of knowledge which being rooted in the work they are developing can contribute to a broader view and a better understanding of the world.

But, as well as accessing information, technology may also be used to transform and produce new information (Ponte, 2002). So, for example, through the Internet, children can edit their work on paper or online, whether it is a school journal, a research project undertaken, or a story. The experiences lived by children within their community or in other contexts can easily be registered with a digital camera and edited in the school journal, the class's blog or in the school's site. In addition to establishing a relationship with the world outside their school by making their own work public, they can also represent and share their experience with other people, such as family members and friends. Being exposed to other people who are important for them gives value and added sense to their work (Amante, 2003; Cotrim, 2007; Drogas, 2007).

Parallel to these possibilities, computers enable children to easily communicate with other people, family, friends, other schools, or institutions in their community. Although research at this level is still very limited, interpersonal communication made available by technology seems to be another advantage to be considered (Shiels & Behrman, 2000). In fact, reports of experiences using such resources (Amante, 2003; Van Scoter & Boss, 2002) show that both by using webcams - which allow online forums and enable children to be in contact with scientists, clowns, actors, or simply other children and other schools - or by the simple use of email – which enables the exchange of messages, animated cards, texts, stories, photographs, and scanned drawings, with friends, family, community members and correspondents - we are stimulating their communicative skills, developing their disposition to write, and favouring the understanding of its functionality. And we do this by using a form of communication which is itself an indissoluble part of the world we want them to know and discover.

Educate for Diversity

The ICT can be used to help contribute to children's learning and acceptance of diversity (Haugland & Wright, 1997). In fact, children not only develop the awareness of social, cultural, racial and ethnic differences, but also interiorize the dominating values in accordance with the social status given to these groups. In this sense, the multicultural education of young children is of utmost relevance and should be a concern of kindergarten and elementary school, aimed at developing positive cross-cultural attitudes, perceptions and behaviours that contribute towards the civic education of future citizens in a fairer and more tolerant society.

As with other materials, new technologies and their contribution to this multicultural education also depend largely on the attitude and choices of the educator. However, it should be stressed that there is educational software that values social and cultural diversity at various levels. Anyway, more than any educational software, we believe that the real potential of new technologies within this scope does effectively reside on the use of the Internet to access knowledge on other realities and cultures, as well as the communication opportunities available on such level. This set of opportunities enables them to expand their view of the world, to get to know, question and understand their diversity.

FACTORS TO BE CONSIDERED FOR AN EFFICIENT ICT INTEGRATION

Integrating new technologies in learning contexts is not enough to ensure an improvement in quality. In fact, a suitable integration and use of the ICT must be considered if we want to effectively create richer educational contexts that promote a constructivist

learning. According to the general characteristics of this perspective (Coll, 1992) technology must:

• serve the active construction of knowledge, without giving way to a simple piling up of knowledge, but to a continuous transformation of the knowledge schemes that integrate the new experiences and continuously reconstruct them (Coll, 1992);

• offer "meaningful learning" (Jonassen *et al.*, 2003) capable of relating the new experiences with former knowledge and the pupils' interests, namely valuing functional learning;

• consider the importance of the interactive social contexts because learning is not an isolated and compartmentalized process, but an eminently social one (Coll, 1992; Crook, 1998a, 1998b).

In this sense, it is important to consider a set of factors which could contribute towards an adequate integration of technology in the educational contexts. Thus, from several writers (Haugland & Wright, 1997; Stables, 1997; Sutherland, Robertson & John, 2004) and from the reports of successful experiments of integrating computers into kindergarten and elementary schools (Amante 2003; Ramos, 2005; Van Scoter & Boss, 2002; Van Scoter *et al.*, 2001) we gathered some principles we would like to broach here.

Location and Access to Equipment

Placing computers in the classroom is a basic principle for a true integration (Davis & Shade, 1994; Haugland & Wright, 1997). Papert (2001) considers the placing of computers in special rooms – a "computer laboratory" – to be an "immunological" answer for the school to "neutralize" this "foreign body". In fact, the adoption of this procedure, so often seen in our schools, is the first step to consigning it outside the learning context. With regard to kindergarten, research carried out by Susan Haugland (2002) showed that when computers are placed out of the classroom where activities are taking place, the children do not experience the same developmental rewards as when the computers are accessible in their classroom, like any other material. On the other hand, as the author reports, this procedure creates two groups of children, one outside the classroom using the computer and one inside the classroom with no possibility whatsoever of seeing what their colleagues are doing. Thus the computer immediately assumes a special status, not the status of any other resource that the children integrate into their activities. It is important, therefore, that computer work is an integral part of classroom activities and two chairs should be placed in front of the screen to suggest from the beginning the possibility of sharing that equipment (Haugland & Wright, 1997). If there are few computers, it is preferable for the equipment to rotate among classrooms for a determined period (Haugland, 2000). Accessibility is important for various reasons: it allows the children to know when the equipment is available; it favours interaction between the children who are using the computer and those involved in other activities; it encourages children to learn from each other, creates opportunities for peer tutoring and, at the same time, facilitates the integration of the activities developed into the whole curricular work.

Educational Applications

Besides the utilitarian programs more commonly used by adults (Word, Paint, Power-Point) and which are equally useful and adequate for children, it is up to the educator to select more specific educational programs which can be used by children.

In effect, the selection of educational programs is of utmost importance. Several writers (Davis & Shade, 1994; Haugland & Wright, 1997; Ramos, 2005) have shown that the quality of software is a determining factor in the development of adequate learning experiences. However, selection is a particularly difficult task as the market is inundated with graphically attractive programs claiming to be educational but which, when explored, are shown to be deceptive. Taking the present research into consideration, children seem to benefit from the applications that:

• have open-ended characteristics which encourage exploration and imagination as opposed to very structured programs of the drill and practice type;

• are friendly and intuitive, easy to use, showing menus and figurative icons easily associated with their function;

• are flexible, responding to various educational needs and objectives, success-oriented through positive feedback and clues which, if necessary, guide the child;

• give the child an active role by requiring reactions, choices, exploration, decision making, carrying out of activities;

• are multisensorial, attractive, interactive, but not so as to deteriorate into a show of sound, music, colour and movement with no relevance to the whole;

• are directed to problem-solving, meeting real needs and the child's interests;

• facilitate and encourage cooperation among children – instead of competition – and consequently communication;

• establish a link with real life without relinquishing fantasy;

• give value to diversity, ethnic, cultural or other, so that the children establish identification points with the contents, independent of their background;

• make information available to adults regarding syllabus aims, suitable ages, suggestions for accompanying the activity and also indications regarding installation and resolution of any problems that may crop up.

To sum up, at stake is research-based use of the new technologies, concerning the way children learn. These principles are as valid for software as they are for other types of activities and experiences. Thus, exploration, discovery, self-motivated activity, control and flexibility inherent in the open-ended programs are appropriate for the development of an active learning specially suited to children of this age group.

Integration in Curricular Activities

It is important to remember that the use of technology in elementary school and kindergarten is not an aim in itself: "Learning to use the computer should only be a secondary objective. Learning to communicate, to draw, to color, to share and take turns-those preschool goals should be primary and one way of learning them is to use the computer" (Pierce, 1994, pp. 15-16). In effect, we are not dealing with teaching children to use ICT, rather to make it available for their educational development. In this sense, an appropriate use of the new technologies is what makes it possible to expand, to enrich, to differentiate, to individualize and to implement the curricular objectives. Therefore, the activities developed around technology should be considered as new educational opportunities, though integrated in a whole which will give them sense. This view, shared by several authors (Crook, 1998a; Haugland & Wright, 1997; Jonassen *et al.*, 2003; Ramos, 2005), is also supported by various experiments using ICT in educational contexts (Amante, 2004b; Van Scoter *et al.*, 2001) and by NAYEC (1996). In fact, this integration is not only fundamental to effectively take advantage of the potentials of technology but also for educators to be able to see it as a real contribution to the work they are developing, being integrated in the work routines and activities in their classroom, but giving also place to new projects and new ways of accessing and building knowledge. In other words, ICT in the school should be understood as a cultural instrument at the service of educationally relevant experiences and learning.

Mediation by the Educator and Social Dynamics of Collaboration

The role of educator is fundamental in various ways. Besides the initial role of any educator/teacher in familiarizing the child with technology, continuous backup is always fundamental even though assuming other aspects. If, on the one hand, it is important for the child to be given the liberty to experiment and carry out his/her work autonomously, on the other hand, it is important to be alert to his needs, above all with younger children. These tend to benefit from a more systematic attention from the adult, the intervention of the educator being to encourage and at the same time answer his needs and avoid the child feeling frustrated when difficulties arise (Clements & Nastasi, 2002); with older children who have developed more skills, it is possible to implement more autonomous forms of work and less controlled by the educator, who assumes a role of supervisor, intervening only when necessary, directing and asking questions to encourage the child to think about the activity and the procedures (Van Scoter *et al.*, 2001).

Work developed around computers stimulates interaction, motivating the children to communicate both among themselves and with the adult. So, apart from the adult attending to immediate backup needs, it is also important that the educator knows

how to stimulate a productive interaction, either during the activity itself, or in the exploration *a posteriori*, in the sense of taking advantage of these important moments of learning. In effect, the literature regarding education and technology highlights the importance of the role of the teacher in guiding (De Corte, 1992), establishing adequate contexts (Crook, 1998a, 1998b), as well as in the development of strategic and meaning-making models which lead to meaningful learning (Jonassen *et al.*, 2003; Salomon & Perkins, 1996). In this sense, several studies developed on the interactions arising from work with computers (Amante, 2004d; Fisher, 1997; Wegerif & Mercer, 1997) having Vigotsky (1991) and his followers as their theoretic framework, showed how some of the activities in which the pupils were involved using this medium (especially writing activities) became opportunities for a child's confrontation with emerging learning, that is to say, situations in which the child operates in the Zone of Proximal Development (Vigotsky, 1991) and as such, needs the aid of an adult (or a peer) to allow the developmental leap needed to reach a new phase of learning. The ability of the educator to be alert to, and recognize these moments and intervene, adopting *scaffolding*[2] behaviour (Wood, Bruner & Ross, 1976) so that the child gives this leap, is extremely important for learning to take place.

On the other hand, within the role of mediator undertaken by the educator, s/he should encourage the interaction and cooperation among the children and make efforts to improve the quality of these interactions (Dawes, 1997; Drogas, 2007; Pierce, 1994); namely, stimulating them to adopt patterns of collaboration which contribute to widen shared construction of learning, to diversify points of view and, in this way, promote the quality of educational practice.

Training of Educators/Teachers

The training of educators is naturally crucial in all and every process which aims at the adequate integration of technologies into the educational context (Clements, 1999; Haugland, 2000; Kosakowsky, 1998). In effect, one of the main reasons stated for the resistance to the integration of technologies in the school is based on the inadequate or limited preparation of the educators and teachers for their use (Ponte, 2002; Stables, 1997). When teachers/educators learn to use technology in the context of their school, their classroom, with real children and according to equally real objectives, they have a greater possibility of benefiting from this training and so improve the quality of the learning contexts to develop their activity. In this perspective, it is worthwhile to highlight some aspects which may constitute key areas in the development of this training:

- develop the understanding of teachers/educators regarding educational technology; there is a dearth of knowledge about the possibilities and aims in the use of ICT in the educational context;
- help them to see how the work they usually do with their pupils and the experience they already have can be adapted and reinforced by the development of activities which resort to the use of technology;
- develop their confidence in the use of ICT; lack of self-assurance and the resulting anxiety is one of the main factors inhibiting teachers/educators using the new technologies (Crook, 1998a; Stables, 1997);
- pinpoint various activities that might introduce the teachers to the use of ICT, providing opportunities for experiencing on their own before trying it out with the children;
- provide opportunities for the exchange of ideas and the sharing of experiences and record "good practices" from these exchanges.

It is also important that educators/teachers feel that the new technologies, besides being tools for encouraging educational experiments with the children, are also the means of communication and collaboration among professionals, being powerful devices in their own professional development. Besides giving an opportunity to achieve a set of backup activities for the development of work with children and for the organisation of tasks, they also facilitate, via online communication, easy interaction between peers and specialists, thus opening up to a vast range of opportunities for cooperative training. Actually, these new "learning communities" could become a new and stimulating pedagogic field for teacher training, as well.

The new technologies and the Internet offer opportunities for professional development, which

until recently had no equivalent. While educators/teachers become more competent and confident users of technology in their professional sphere, they also become more apt to use them adequately with their pupils (Jonassen *et al.*, 2003).

Administration of the School/Leadership

Just as in the case with innovative procedures in general, the interest of the school leaders, their favourable attitude towards change shown in a continuous support to educators /teachers involved (Perrenoud, 1994) is also essential for the specific case of the integration of technology (Han, 2002; Haugland, 2000; Kosakowsky, 1998). So, and in agreement with the reports on various experiments (Van Scoter *et al.*, 2001) it is crucial to have a school leader which, besides providing any necessary resources, adopts an attitude open to suggestions, concedes independence to educators/teachers so that they can experiment and implement their ideas and encourage their efforts, offering collaboration whether in the eventual reorganisation of space, or in the restructuring of timetables, which may need to be adjusted to the needs of the training. In effect, a school leadership which is concerned with the creation of conditions favourable to the improvement of the learning context, which is concerned with the professional development of their teachers, which adopts democratic leadership in which everyone feels involved, in a working atmosphere where respect and dialogue prevail, will tend to set up an organisational context which is promoter of successful integration processes. It is worth mentioning that teachers/educators need to feel that their work and investment is recognized and reassured at the highest level, this attitude being a reinforcement of change by valuing and making it legitimate (Thurler, 1994).

Contact with Families

The participation of families in the school life of their children is, naturally, desirable. Regarding the technologies, it is essential that their integration does not neglect the importance of this connection, which is relevant at various levels. Therefore, according to some experiments (Cotrim, 2007; Thouvenelle, 2002; Van Scoter & Boss, 2002; Van Scoter *et al.*, 2001), giving parents the opportunity of visiting their children's activities room/classroom, using the computer together with them to accomplish activities relevant to both, giving them access not only to the children's productions, but the way they were achieved, are important contributions for the families and the school to become closer, to give more value to the school and to develop positive attitudes regarding the role of ICT in this context. This type of initiative allows the parents to develop their knowledge of the educational possibilities that technologies offer, being equally alert for the need of their acceptable use. Actually, today many children have access to a computer and other electronic equipment at home. The use of these is generally valued by parents; however, it may require guidance in order to become educationally relevant. It is important that educators/teachers give parents information about adequate use of technology and that together they can, as consumers, exercise pressure for the development of educational programs appropriate for children of this age. On the other hand, and especially in the case of families who do not have access to these means, contact and possibilities of exploring ICT in elementary school and kindergarten assume a very particular relevance not only because they contribute to correcting the inequality of access and to fight against info-exclusion, but also because they create learning situations for parents and children together where the children can show their skills and get their parents' recognition of their performance (Cotrim, 2007; Computer Family Night Program[3]).

Backup Technical Assistance

Finally, but also essential for the success of the integration of ICT, it is important that schools and kindergarten provide backup which provides assistance also at the technical level, ensuring maintenance of the equipment and the resolution to any functional problems that may arise (NÓNIO, 2002). Without this backup there is a risk of a small technical problem obstructing the use of the equipment for months and consequently causing the whole undertaking to regress or miscarry; this demoralizes the educators and creates insecurity in its use.

TO SUMMARISE

To summarise, we would like to reflect on some questions arising from this text. On the one hand, we would say that the research points to very favourable results in the use of technology in elementary schools and kindergartens. On the other hand, as Becker (2000) stated, it is a fact that few teachers and educators use computers in their schools for the constructive and creative purposes that technology seems to offer, which have largely emerged from the studies carried out as the responsible for most of the positive results obtained. Indeed, research sometimes creates specific and well-defined contexts and provides technical and training backup which do not exactly correspond to the conditions of the majority of the educational contexts experienced in the schools, where ICT are under-explored or even used to reproduce antiquated practices. In this sense, there could be a hiatus between the possibilities of ICT and what actually happens in the majority of schools when they are available. But this hiatus, although undoubtedly a reality, could, however, be reduced if research and training were to be centred on the schools and their concrete and specific realities, considering them as strategic units of innovation (Canário, 1996; Oliveira-Formosinho & Formosinho, 2001).

There is capacity and knowledge to develop an adequate technology favourable to learning-rich environments which prepare the children to learn how to learn and to live in a world of new demands which increasingly requires lifelong learning. The quality of education depends, among many other things, on knowing how to make the most of such technology, by putting it at the service of a renewed educational project in which learning to learn is an important part of what must be learnt. Thus, once more, the possible answer is not in technology, but in people and institutions. For this educational project to be renewed throughout the schools, an effort is needed by all those who, in one way or another, are responsible for building the school we would like, from political decision-makers to teachers, teacher training institutions (which play a determining role here), parents and the educational community in general. If the technological developments that have changed our world deeply act as a mirror reflecting the image of an "inadequate" school, if through that image we are confronted with the urgent and inevitable need to renew it, then it is particularly important to make use of technological developments as catalysers of that change, aimed at a School that builds knowledge and forms citizens who are capable of facing the challenges of this new era.

Endnotes

1. The said project, "New Technologies: A Pre-School Integration Experiment", was funded by the Instituto de Inovação Educacional (Institute of Educational Innovation) within the scope of the 12th edition of the competition "Innovate by Educating/ Educate by Innovating", which is part of the System of Incentives for Quality in Education (SIQE), without which it would not have been possible.

2. This concept refers to the steps taken by an adult in the sense of delimiting a given task to enable the child to centre on the skills in question in a given process of acquisition. This deals with anticipating the development of the understanding of the task by the child and acting in harmony with this anticipation through "strategic interventions".

3. This initiative and the reactions of parents can be found on: http://www.mcps.k12.md.us/curriculum/littlekids/archive/computer_family_night.htm (visited in June 2007).

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