# KidSmart: an essential tool for mathematical education in nursery schools

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**Abstract**. This paper is part of a wide debate and critical reflection on the use of ICT in nursery schools, and focuses on the use of station KidSmart in the classroom to enhance scientific learning within the logical-mathematic field. The study is organized as follows: after presenting the institutional setting within which ICT has been introduced in Italian nursery schools, some considerations are made on the essential characteristics of mathematical education and on the relationship with physical reality through the mediation of ICT, highlighting in particular the pedagogic-educational value of ludic-experiental activities in an early learning context. After that, the characteristics of the KidSmart station are introduced, and some interesting results of the action-research experience aimed at scientifically controlling the conditions and introductory procedures of KidSmart in the field of experience '*exploring, knowing and planning*' are given. Related conclusions round off this work.

## 1 Introduction

The enhancement of scientific knowledge at all levels is essential to shape a society able to cope harmoniously with today's remarkable scientific progress and rapid technological advancement. A scientific-mathematic education, that is the acquisition of a scientific way of thinking, should form an integral part of any learning programme today, and should make a critical and conscious use of information and communication technology (ICT). On the basis of this, technology has been introduced in Italian schools, with the object of providing innovations and improving the process of teaching and learning. In Italy the introduction of technology in education has mainly concerned secondary schools, while nursery schools, except for a few pioneering experiences, have been totally excluded, despite the regulations introduced in 1991 [1] which recognized the value of multi-media education through the field of experience '*Messages, forms and media*'. In 1995-96 the Programme for the Development of Didactic Technologies (PSTD) was started, which for the first time included infant schools. The real turning-point in the

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relationship between technology and infant schools is the 'Act for the re-organization of school cycles' [2], together with a review of the curricula for compulsory education [3], where the use of new technology is strongly recommended.
No specific 'items' or objectives are set out, but reference is made to the field of experience '*Fruition and production of messages*'. In this institutional context the project KidSmart Early Learning was introduced in the scholastic year 2000/01, promoted by the IBM Foundation Italy in collaboration with the Ministry of Education, University and Research, with the object of facilitating the introduction of ICT in the first phase of infant learning. The project, highly innovative in the Italian school context, made use of a model already available internationally, which was then discussed and re-designed around the needs and specificities of the Italian school system [4]. Such a project in Italy involved numerous infant schools located in difficult socio-economic contexts and/or areas geographically isolated, which benefited from the donation of multi-media stations and didactic software programmes [5].
Further details can be found on: http://www.fondazioneibm.it/scuola/kidsmart.htm.

### 1.1 Mathematical education and utilization of ICTs in nursery schools

In nursery schools, mathematical education represents an important part of the syllabus as the particular field of experience for the development of logical skills, no longer an isolated subject of an abstract nature, but a language useful for the mastering of a scientific way of thinking and reasoning. From this educational perspective, Mathematics becomes not just a system of knowledge organized as a discrete discipline, but a symbolic system which helps the young learners in the processes of decoding real life, in the solution of problems, in the revision and integration of hypotheses, and in the attribution of meaning. Thus, Mathematics provides a powerful conceptual tool which leads children to form general ideas on logical concepts, shaping in them a mental attitude which will later assimilate Mathematics in a way of acting, thinking and doing. From the perspective of didactic methodology, only a suitable approach can provide an effective variable which can promote intrinsic motivation, such as curiosity, lucidity and the pleasure of discovery, all essential factors for the understanding and interpretation of reality. Mathematical education in Italian nursery schools is part of the various fields of experience, in particular of the field of experience '*Exploring, knowing and planning*', where the following skills are given special relevance: the ability to group, order, quantify and measure, localize, put into relation, plan and invent. This is the field which first helps to organise the child's first knowledge of the world of natural and artificial reality, with special emphasis on exploring and learning through discovery. Such a field of experience, given its special nature, requires dynamic-constructive methodological pathways, able to encourage cooperative activities that can sustain the interest and curiosity of the children, as well as stimulate organization, planning, research and discovery. The evolution of pedagogical practices allow for a diversification of learning situations, so that traditional activities in situ can be supported by technological instruments which make daily education more effective. The introduction of physical instruments (educational

technology, media) cannot do without a methodological rationalization (a conceptual scaffolding that supports the organization of the educational process) which should offer stimulating learning environments that contribute to social and cognitive development. As regards the age of the children, the introduction of technological tools should be gradual, privileging the ludic-experiential sphere, and offering elements of continuity with everyday reality. Such a step, to paraphrase Seymour Papert's [6] authoritative thinking, should not be linear and 'sequential' but should gradually be integrated into the different stages of development. Integration of a non-linear nature between experience coming from play and reflexive and metacognitive activities, according to Donald Norman [7-8] should combine experimental learning and reflexive learning. Consequently, the guide lines and theoretical references can only be found in post-Piaget pedagogy, in theoretical reflections inspired by Vigotskij [9] which have been defined as the 'pedagogy of complexity' by Howard Gardner [10-12] or the 'cultural psychology' of Jerome Bruner [13-15]. Thus, the question to be addressed is that of the four sides of a tetrahedron concerning the relationship between age, development and introduction to technology. First of all, the familiar and social context in which children are born and grow up cannot be ignored, an environment which becomes progressively more technologically based. Also, multimedia education should take into consideration the harmonization with different stages of the child's psychological and sensory-motor development, as well as respect for individual maturity and subjectivity [16]. Moreover, the multi code structure of ICTs should be fully exploited through the planning of didactic pathways and Mind Tools [17] so as to enhance, develop and evaluate critically all the possible skills and forms of intelligence that can be taught through multimedia tools, especially relational and communicative intelligence. Last but not least, the introduction of ICTs should be accessible in three relevant aspects: finalization, character based, co-planning [16].

## 2 'First Mathematics' with KidSmart: an action-research experience

### 2.1 The KidSmart station [18]

The KidSmart station (Fig.1) contains a state-of-the-art personal computer and a 17 inch screen. It is equipped with big keys sensitive to the touch, a small mouse. Loud speakers are found on the wings of the station, so as to contain sounds which may otherwise disturb other children engaged in different activities nearby. The station also has a microphone and printer, a scanner, video camera and Internet connection facilities, all important aids for didactic activities. It is also equipped with a double seat to encourage cooperation between children. KidSmart uses the much acclaimed software package for children Young Explorer by Riverdeep, which offers a series of different types of educational activities ranging across various fields of experience centred around play and creativity. As an example, in Fig.2 we show the cover of the software package '*IMPARO GIOCANDO'* (Learn through Play) where a jolly group of four animals are each linked to a particular field of experience: the

mouse relates to the '*Fruition and production of messages*', the cat is linked to '*I, the self and others*'. Lastly, the rabbit and the hippopotamus to the fields '*Exploring, knowing and planning*'. This package is made up of 3 blocks, each one with 30 CD-ROMs.


**Fig. 1.** The KidSmart station


**Fig. 2.** The software Learn through Play

All the games in the Learn through Play software package use a problem solving methodology as the privileged modality to expand knowledge. Furthermore, the games ensure the synergic and continuous activation of different representational planes (iconic, symbolic, etc.) which ignites the 'sensory machine', making the children a protagonist of their learning.

### 2.2 The action-research experience

Action-research originated from the need to investigate whether the use of computers and specific didactic software programmes in nursery schools would enhance learning in the ambit of logic and Mathematics. Thus the proposed objectives were:

- experimenting and scientific control of procedures for new methodological approaches and learning situations relating to the use in the classroom of KidSmart and related software in the field of experience '*exploring, knowing and planning'*;
- promoting opportunities for global and immediate learning which connect the use of computers to direct multi-sensory experience.

The action-research experience, given its specific characteristics, has required a continuous synergy between University and schools, with the direct involvement of a nursery school in the Didactic Circle 'Vittorio Morello' in Bagnara Calabra, in the province of Reggio Calabria, which had already taken part in the KidSmart Early Learning Project. A systematic report of the whole experience has been the subject of a degree Dissertation in the Science of Primary Education at the University of Calabria. Here, in brief, the stages of the experiment and a number of the findings are reported. From a technical point of view, the action-research was carried out in three phases: planning, operation, evaluation and feedback. It lasted two years (2005/07). The planning phase, which followed in-depth studies relating to the use of KidSmart and the research regarding the best practices in the logic-mathematical ambit available in the literature, was organized on the basis of the territorial data and an analysis of the related scholastic context. After that, the scaffolding of the methodological-didactic process was set up, in full respect of the specific biopsychic,

social and cultural characteristics of the young learners, as well as of their style and pace of learning. During the operational phase, didactic activities were carried out in order to develop lateral thinking, the perception of shapes and colours, chronological order, the use and interpretation of codes, symbols and signs, knowledge of numbers and figures. All the activities were carried out first in the traditional way (without the use of technology), and subsequently with the use of KidSmart in the classroom using software programmes from the package Learn through Play selected according to the context and to didactic aims. In fact, the software programmes where the adventures of the happy group (a birthday party, at the fairground, etc.) were chosen with regard to the following specific aspects: spatial relations, perceptive discrimination, associations, logical sequences, primary numbers, counting, geometrical figures. The selected software programmes were analysed and evaluated before use for their educational value, and for their potential to stimulate and encourage active learning. As an example one of the activities carried out relating to the concept of quantity, which plays an important role within the field of learning arithmetic will be briefly reported. There are basically two approaches to numbers: non arithmetic (the number is object of reading and writing) or arithmetic (counting as correspondence of numerals to the objects and with cardinal and ordinal meaning). For this purpose, the CD-ROM 'Happy birthday Biff' (Fig.3) was selected. The analogical dimension of the software programme introduces the children to Biff's birthday celebration organized by his friends, who have decorated the room and have put a cake on the table, in full wiew. (Fig.4).


**Fig. 3.** Home page: 'Happy birthday Biff'

**Fig. 4.** Output: Biff coming home

Tom the mouse invites children to click on his icon to help them prepare the food. The heuristics dimension of the software programme offers the children the chance to take decisions on the following questions: which plate has more sandwiches than the yellow plate? - which plate has fewer sandwiches than the green plate? (Fig.5). Which plate has the same number of cakes as the green plate? (Fig.6) Some children gave the correct answers straightaway, while others had some difficulty, and were helped through further logical stages by the button with the question mark available on the control bar (Fig.5 and 6).

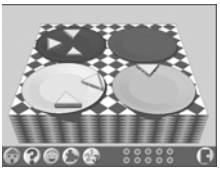

**Fig. 5.** Output: sandwiches plate

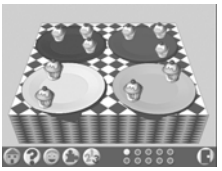

**Fig. 6.** Output: cakes plate

The button with numbers, on the other hand, reminds the child that numbers are used in this game and not the letters of the alphabet, while the series of dots arranged on two parallel rows represent the number of correct answers. For example, in the case of the first question formulated, by pressing the Help button the following situation was recorded:
*Help*: count how many sandwiches there are on the yellow plate! *Child*: one, two! *Help*: then we must find a plate that has more. How many sandwiches does the green plate have? *Child*: one. *Help*: are there more on the yellow plate? *Child*: yes.
*Help*: let's count those on the red plate. *Child*: there aren't any.
*Help*: how many on the blue one? *Child*: one, two, three.
*Help*: count again the sandwiches on the yellow plate. *Child*: one, two.
*Help*: so are there more on the blue one than on the yellow one? *Child*: yes!

In order to monitor the activities in the innovation process and their effect on the learning environmen, some protocol observation tables were devised:

- definition of the field and object of observation;
- definition of the categories of the object of observation (description and evaluation function);
- formulation of observation items;
- construction of recording tools (chart, schemes);
- definition of the plan of observation (to establish where, how many, for how long this operation will be carried out).

It should be stressed that all activities with KidSmart were carried out in groups of between 3 and 4 young learners of mixed abilities, as far as starting level, cognitive style, emotional and socio-affective conditions and general skills were concerned. This mode of operation enabled every child to contribute to the group 'whatever their abilities' by playing a role and having a task, while keeping to the agreed rules. For reasons of space, only the synoptic table of the registered results obtained by the young learners during the mathematical activity relating to the concept of quantity is given, leaving any comments to the reader.

The operative and evaluation phases represent, in many ways, the core of the action-research experience. In short, the aim was to 'measure' on a small sample of children any possible improvement and cognitive development in the logical-mathematic field by comparing the results obtained with the use of KidSmart in the classroom with those obtained through traditional learning activities, that is without the use of technology. Below some overall data relating to the KidSmart approach taken from the chart of the activities are shown.

**Table 1.** Results in the mathematical activity relating to the concept of quantity

| Evaluation Educational Objectives | Traditional Activities | | | Activities with Kidsmart | | |
|---|---|---|---|---|---|---|
| | Inadequate | Adequate | Good | Inadequate | Adequate | Good |
| Comparing Quantities: *many-few* | 15 | 23% | 62% | / | 21% | 79% |
| Understanding the equipotent sets: *as many as* | 34% | 7% | 59% | 13% | 34% | 53% |
| Comparing Quantities: *one-many-few* | 14% | 22% | 64% | 7% | 14% | 79% |
| Quantifying and Counting objects up to number six (6) | 23% | 14% | 63% | 23% | 21% | 56% |

**Table 2.** Some data relating to the KidSmart approach

| | never | sometimes | always |
|---|---|---|---|
| Has raised the curiosity of the young learners | / | | 100% |
| Has led the young learners to discoveries | / | 14% | 86% |
| Has made easy the use of the keyboard and mouse | 10% | 7% | 83% |
| Has encouraged flexibility of adaptation | 7% | 5% | 88% |
| Has promoted the acquisition of The skills of: | | | |
| - eye-hand coordination; | 5% | 10% | 85% |
| - Speed of perception; | 10% | 20% | 70% |
| - Interest in the IT tool; | / | 8% | 92% |
| - Peer cooperation and Turn taking | / | 38% | 62% |

## 3 Conclusions

After analysing the results of our action-research we can state that:

- the introduction of technology into the nursery school curriculum offers young learners the opportunity to cultivate interests and curiosity by taking part in activities within a learning environment organized around the principles of doing and reflecting on doing;
- the teacher, by planning the introduction of KidSmart in the classroom activities and by considering the different opportunities it can offer, is able to extend the experiences available to the children and the educational and cognitive processes activated by the didactic activities on a daily basis;
- the play element in an interactive context has had positive effects on motivation, has effectively increased interest in the technological tool, thereby also improving participation in the search for solutions to problems and increasing peer interaction;
- the use of the software programme has greatly facilitated learning by doing, allowing the children to behave naturally and spontaneously during activities which provided direct experience, with the effect of encouraging feelings of

confidence, shared responsibility, and consolidating skills while, at the same time, decreasing performance anxiety.

KidSmart, therefore, makes for a new approach to mathematics, more stimulating than the traditional one as it encourages a polyhedric development of mental abilities and a mode of learning that refers not only to Mathematics but has also socio-cultural connotations. In this way the old prejudice that by sitting in front of a computer screen one must be passive is refuted. Therefore, in the nursery school, by making children aware of these aspects we discourage false expectations regarding technology, and encourage a more realistic and critical use of computers. As Gardner says (April 10, 1997), computers can be used to manipulate people or to liberate them, they can be used to teach people in the same boring rigorous ways as was done for ages, or they can be used to teach in very new ways [19].

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