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Teachers' beliefs about learning from multimedia

Alessandro Antonietti *, Marisa Giorgetti

*Cognitive Psychology Laboratory, Department of Psychology,
Catholic University of the Sacred Heart, Largo Gemelli 1, 20123 Milano, Italy*

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Abstract

Opinions about the psychological correlates of multimedia computer-supported instructional tools were analyzed by means of a questionnaire concerning the motivational and emotional aspects of multimedia learning, the strategies to be followed during the learning process, the mental abilities and the style of thinking required, the cognitive benefits and outcomes. The questionnaire was distributed to 272 teachers working in kindergarten, primary, and secondary schools. Gender and previous experience with multimedia, as well as the disciplinary fields taught by secondary school teachers, were taken into account. Respondents identified a large number of non-trivial instructional opportunities from multimedia and showed well-defined and internally articulated beliefs. No significant gender effect was found. Differences of school level, disciplinary field, and direct experience with multimedia tools affected a part of the teachers' representation. Implications for instruction were discussed.

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1. Introduction

Multimedia learning is proposed as an active, student-centered approach in which learners can select relevant words and images, organizing them into coherent verbal

* Corresponding author. Tel.: +39-2-72342909; fax: +39-2-72342280.
E-mail address: antoniet@mi.unicatt.it (A. Antonietti).

and visual models, and integrating them into whole conceptual structures (Mayer, 2001). Such an approach can enhance students' learning when appropriate principles are taken into account (Moreno & Mayer, 2000; Mayer & Moreno, 2003). Animations and virtual simulations that require technological supports provide the most recent and sophisticated implementations of multimedia learning. Therefore, nowadays multimedia learning is obtained by suggesting that teachers should use computers.

According to Mackie and Wylie (1988), a user's acceptance of technology is affected by different factors such as: the extent to which the features of the technology are consistent with the user's needs, the user's experience with the technology, the user's awareness of technology and of purpose. If these suggestions are applied to school settings, we can predict that the use of multimedia tools – stressed both by institutional incentives and by socio-cultural trends – should be accepted only if teachers are aware of the purposes and advantages deriving from such instruments (Fullan, 1991). Teachers who decide to use computer-supported multimedia tools should develop personal beliefs about the goals that such tools allow students to reach, the expected outcomes, the skills which are required, the strategies to be followed, the relevant attitudes and behaviors (Demetriadis et al., 2003). Also teachers who are not inclined to introduce new multimedia devices in school activities should develop, the same kind of opinions, but in the opposite direction, to justify why they are reluctant to use these tools (Fleener, 1995). Since nowadays almost all teachers are exposed to multimedia instructional instruments – even through short demonstrations and trials or incidental observations and experiences – we can assume that whether they make use or not of multimedia tools in school activities, teachers have construed in their mind, explicitly or implicitly, some ideas about the potentialities and the dangers of these tools in learning.

Therefore, it is interesting to know what teachers think about possible advantages produced by multimedia tools and their limits. Since teachers are in charge of managing students' learning processes, these benefits and weaknesses should concern learning. Knowing teachers' opinions about these issues might help us to understand both what teachers expect to obtain by using multimedia tools and comprehend why teachers choose particular kinds of multimedia and why they tend to use them in particular ways, and why some teachers are reluctant to do so. Knowing teachers' beliefs might also be useful to design pre-service and in-service training which take into account their stereotypes and resistances. However, as yet little is known about what teachers think with respect to the role that multimedia can play in order to support and to improve or, by contrast, to obstacle learning processes.

As well as other categories of professionals (Zoltan & Chapanis, 1982), teachers seem to share consistent opinions about the impact of technology on learning (Galanouli & McNair, 2001; Wishart, 2000). For instance, Hammond and Mumtaz (2001) interviewed ten teachers who attended a post-graduate course on information technologies and realized that they preferred an approach aimed at using computers to motivate students, to face pupils with authentic problems, and to enhance learners' higher order skills (e.g., interpreting and analyzing); however, teachers, though committed to reach these goals, were also aware of the possible limits of information

technologies in education. Windschitl and Sahl (2002) investigated the concept of three teachers about the introduction of computers in their school and found both positive and negative reactions. A teacher who was interviewed in this case-study perceived that computers meet students' needs; consequently she modified her ideas about the role of teachers and students within the learning process and changed her teaching behavior. Another teacher, on the contrary, thought that computers served only to facilitate classroom activities and to motivate students; he was skeptical about possible deep influences on teaching and maintained that computers can distract a class. More sophisticated views of the relationships between information technologies and learning were identified by Kynäslähti (2002) by interviewing university teachers who reported that they can teach according to their own pedagogical beliefs thanks to the use of computers during their classes.

Other studies showed that teachers have opinions about specific kinds of computer-based tools. Poole (2000) described the experience of five teachers who found that email exchanges constitute an exploratory environment where children can develop problem-solving skills. Hippisley and Houghton (1999) reported teachers' appreciation of the positive aspects of a computerized system devised to test school skills. On the contrary, Knight, Pedersen, and Peters (2004) interviewed pre-service teachers about the role that a video session can play in biology education and found that respondents identified above all limitations due to the reduced interaction that the tool allowed. Greenberg, Raphael, Keller, and Tobias (1998) investigated high school teachers' reactions toward a digital image-processing technology that permits pictures or photographs to be manipulated and analyzed through a computer so to highlight features and properties that previously were difficult or impossible to perceive. By means of such technology students can follow an inquiry-based approach that can lead them to extract meaning and to see things that no one had seen before. In fact, this instructional tool was devised to facilitate the process of exploration, discovery, and interpretation in research since it guided students to apply previously acquired knowledge to new realistic, open-ended inquiry situations and fostered discussions and follow-up activities. Interviews showed that teachers expressed strong support and enthusiasm in using this technology and realized changes in their teaching styles as a consequence, although refusals and needs for further training emerged. Similarly, Sandberg (2002) reported that some preschool teachers believed that playing with the computer stimulates children's ability to seek knowledge and forces pupils to rely on visual forms of thinking; moreover, the computer is helpful to children with attention difficulties since it gets preschoolers interested in the task to be carried out. Tharp, James, Fitzsimmons, and Ayers (1997) and Gningue (2003) studied teachers' positive attitudes toward graphic calculators, perceived as thinking tools useful to enhance conceptual understanding. Teachers realized that a Web-based science learning environment can be used to access up-to-date information and real-world data and that it made students more interested in understanding phenomena (Mouza & Bell, 2001).

An overall consideration of these findings suggests that teachers react to the introduction of new technologies in school activities either by accepting them or by refusing them (Greenberg et al., 1998; Windschitl & Sahl, 2002). These reactions seem to

be grounded on the strengths and weaknesses that teachers identify in the use of such tools (Hammond & Mumtaz, 2001; Hippiisley & Houghton, 1999; Knight et al., 2004; Windschitl & Sahl, 2002). In teachers' opinion both benefits and limits make reference to three main issues:

- (i) The motivating and/or involving power of computer-supported instructional instruments (Hammond & Mumtaz, 2001; Hippiisley & Houghton, 1999; Mouza & Bell, 2001; Sandberg, 2002);
- (ii) The facilitating and/or optimizing effects that such instruments can produce in learning processes (Knight et al., 2004; Windschitl & Sahl, 2002);
- (iii) The fostering of high-level cognitive activity (Hammond & Mumtaz, 2001; Poole, 2000; Sandberg, 2002; Tharp et al., 1997).

It can be interesting to analyze deeply the structure of teachers' beliefs about such issues and to study possible relationships among them.

Unfortunately, studies investigating specifically teachers' ideas about the relationships between information technology and learning tend to be single-case studies concerning idiosyncratic opinions of single individuals, lacking in statistical analyses, so that the representations identified cannot be assumed to be shared by the majority of teachers. Conclusions supported by the analysis of data collected in wide samples of respondents were drawn in studies carried out about the so-called *attitude towards the computer* (Yaghi, 1997) which includes different dimensions that can be classified into the following main categories:

1. Emotional reactions towards the computer (anxiety, frustration, tension, nervousness or stress, fatigue or boredom; being intimidated by computers; feeling helpless or isolated; enjoying the computer or perceiving computer as a entertaining or exciting activity).
2. Curiosity, interest, and motivation toward computer.
3. Opinions about the importance of the computer (being glad that computers are becoming widely used, recognizing the role of computers in the society, appreciating the usefulness of the computer, or claiming that computers are dehumanizing, etc.).
4. Opinions about computer users (folk ideas about the alleged features of persons who like computers and gender stereotypes associated with computer use).
5. Personal skills (wanting to be appreciated as a computer proficient person), efficacy (self-confidence, feeling in control of the computer, evaluation of personal aptitudes and abilities or skills), and strategies in computer using (for example, developing shortcuts).

Research about the attitudes towards the computer informs us about teachers' general reactions towards technological tools but fails to inform us about teachers' specific ideas about what such tools may introduce into the learning process. In fact, questionnaires on attitudes toward computers do not consider issues such as the mental activities that computers foster, the cognitive and interpersonal

skills that they enhance, and the kind of learning results that they produce. It is worth noticing that in the Bath Country Computer Attitude Scale (Bear, Richards, & Lancaster, 1987) only one item (“Computers help people to think”) can be related to these topics. The same is true for a more recent instrument: in the Computer Attitude Scale employed by Liaw (2002) only a general item (“I believe that computers can serve as tools for learning”) is relevant to the issues mentioned above.

Altogether, case-studies, mostly based on interviews, can highlight the personal opinions of some teachers about the instructional opportunities and limits of computer-supported instructional tools, but do not allow us to know to what extent such opinions are shared by their colleagues; surveys carried out by means of questionnaires highlight general opinions but fail to include specific topics related to these opportunities and limits. What do teachers think of what happens in the learners’ mind while using computers, the students’ skills required to benefit from such a tool, the cognitive styles most suitable for employing computers, the most productive strategies? Up to now we have no answers to these questions. The present paper was aimed at investigating one of these topics on a large sample of teachers in order to permit us to draw an overall view of what teachers think. It considered a specific feature of the computer-supported instructional tools, namely “multimedia”, and a specific aspect of such feature, that is, the psychological correlates of using multimedia for instructional aims.

Theorists themselves developed contrasting claims about such issues. For instance, Clark (1983, 2001) maintained that multimedia yield only superficial, optimising effects; on the contrary, De Kerchove (1991) argued that multimedia deeply modify the learner’s mind. Thus, we considered both kinds of effects, namely, superficial and structural. Furthermore, we considered both positive and negative effects. Our aim, in fact, was not to identify a shared representation (it is difficult to assume that all teachers possess the same beliefs) but to identify possible different patterns of opinions.

Finally, possible influences of some variables on teachers’ representation were investigated: (a) the gender of the participants, (b) the school level, (c) the disciplinary field taught, and (d) the direct experience with multimedia instructional tools.

2. Method

2.1. Participants

A total of 272 teachers participated in the study. Seventy-one teachers (68 women and 3 men) taught in kindergarten, 131 (114 women and 17 men) in primary, and 70 (57 women and 13 men) in secondary schools (some teachers failed to provide this kind of data). Secondary school teachers were divided according to their disciplinary field (when reported) in the following subgroups: humanities ($N=18$), sciences ($N=12$), other fields ($N=26$). Participants had been in service from 3 to 11 years and their age ranged from 27 to 41 years.

Participants worked in schools belonging to the same district and attended by students of average social status. These schools were contacted by random extraction. Schools were asked to get involved in a short educational program concerning new media and learning. At the beginning of the program, before training activities started, all teachers were given the questionnaire described below. The aims of that instrument were explained. Although teachers were given a choice, they all agreed to fill out the questionnaire.

2.2. *Materials*

Since there was no previous instrument designed to analyse such an issue, a questionnaire was devised to study what people think about the psychological correlates in the use of multimedia, computer-supported instructional tools. It consisted of 30 items concerning various psychological aspects of multimedia educational software. Items were construed as follows. Ten experts in the field of educational technologies were asked to list features of computer-supported multimedia that can affect (positively or negatively) student's learning. Experts were academics working in the field of psychology or pedagogy who had already done previously theoretical or empirical researches about the roles of new media in educational settings and taught in training programs for school teachers. Experts filled out a sheet reporting the instructions and ten empty lines: on each of them they were asked to write down a characteristic/feature of multimedia that influences the learning process. No time limit was given.

Protocols were analysed as follows. Firstly, all features mentioned by the experts were transcribed so to devise a unique list. Such a list was given to two independent judges who were asked:

- To delete synonyms;
- To collapse responses describing similar features into a single description;
- To delete responses which were not focused on psychological features of using multimedia tools in instruction. A feature was considered psychological if it matched two criteria: (i) it referred to a mental state, process, strategy or function; (ii) it referred to individual, but not social, effects.

After the last step, the judges compared their lists. Eighty-two percent of the features were found mentioned in both lists; judges discussed cases of disagreement in order to reach an agreement. The resulting features concerned these issues: motivational and emotional aspects of learning (e.g., attraction, involvement, boredom, tiredness), activation state during the learning process (participation, effort), mental abilities required (attention, language, logical reasoning), style of thinking preferred (intuition, visualization, reflection), cognitive benefits and learning results (better understanding, memorization, application, overall view), metacognition (planning).

Features were arranged in the form of short sentences that constituted the items of the questionnaire. The items of the questionnaire are listed in [Table 1](#) (in the table items are listed in an order which corresponds to the decreasing values of the means recorded, whereas in the questionnaire they were listed in a different, random order,

Table 1
Mean values and SDs recorded in each item of the questionnaire in the whole sample

Item	<i>M</i>	<i>SD</i>
29. Are attractive and/or arouse people's curiosity	4.16	0.98
6. Facilitate persons who have a visual thinking style	3.75	1.13
23. Require concentration	3.74	1.12
25. Induce and/or facilitate making comparisons and links	3.72	1.08
30. Facilitate persons who tend to think schematically	3.65	1.15
17. Make notion memorization easier	3.63	1.08
16. Allow to learn fast	3.58	1.10
12. Help persons to have a global overview	3.57	1.20
8. Are useful to schematize concepts	3.50	1.19
19. Make the comprehension easier	3.48	1.04
28. Require to keep in mind the overall picture	3.48	1.17
18. Require to plan actions	3.46	1.14
10. Help people to re-elaborate notions and to reason about them	3.39	1.19
1. Induce persons to be active	3.38	1.09
15. Make notion application easier	3.38	1.08
11. Facilitate persons lacking of linguistic abilities	3.33	1.23
13. Make notions convincing	3.28	1.25
20. Require creativity	3.16	1.20
26. Facilitate persons who have an intuitive thinking style	3.14	1.14
14. Allow people to learn with no effort and/or in an implicit way	3.10	1.22
24. Are suitable for logic persons	3.01	1.18
7. Are suitable for persons who are bored in a short time	2.90	1.46
27. May be too involving	2.89	1.36
5. Require to think simultaneously to various things	2.85	1.35
3. Are tiring	2.84	1.33
21. Are appreciated by people who like adventures	2.72	1.34
2. Are suitable for thoughtful persons	2.67	1.19
9. Facilitate people who have much imagination	2.65	1.23
22. May be confusing	2.21	1.19
4. Are not suitable for precise persons	2.00	1.21

corresponding to the numbers preceding the items). In each item of the questionnaire a statement was reported. The respondent was asked to rate on a 5-point scale (1 = minimum; 5 = maximum) his/her agreement about what was expressed in each statement. The subject of the sentence reported in each item was always "Multimedia computer-supported instructional tools ...".

In the questionnaire the list of the statements to be endorsed was preceded by a brief introduction explaining the aim of the instrument and what multimedia computer-supported instructional tools are; the simultaneous presentation of texts, pictures, movies, and sounds in such tools was stressed. The introduction reported also the instructions to fill out the questionnaire and the request to list examples of multimedia educational computer-supported tools that the respondent had employed in school activities.

The inspection of the list of the items shows that the three main issues that we realised to be present in the literature lie under the questionnaire: (i) motivation and involvement (items 1, 3, 7, 13, 14, 21, 27, 29); (ii) facilitation and optimisation

(items 4, 6, 9, 11, 15, 16, 17, 19, 26, 28, 30); (iii) cognitive activity (items 2, 5, 8, 10, 12, 18, 20, 22, 23, 23, 24, 25). Thus, we are induced to maintain that the experts' opinions mirrored the core topics which were taken into account by studies carried out previously and that, in turn, the questionnaire – based on the experts' beliefs – considered such topics.

2.3. Procedure

The questionnaire was administered in the schools where the teachers worked during the rest period. The questionnaire was anonymous. They were not given a time limit to fill it out.

3. Results

To test the internal consistency of the questionnaire Cronach's alpha coefficient was computed by considering all the items of the questionnaire: it resulted as being equal to 0.82; Guttman's split-half reliability coefficient was found to be equal to 0.74.

Mean scores in each item, computed on the whole sample, are listed in Table 1. Teachers appreciated not only trivial features of the multimedia tools (attraction, facilitative effects on comprehension and memorization, quick learning), but also more sophisticated properties (association with visual and schematic styles of thinking, hint at comparing and linking, global view). Negative aspects such as imprecision, confusion, boredom, tiredness, excessive involvement were rated low. In general, apart from cognitive styles, the use of multimedia was not associated with structural personal characteristics (to be a precise, imaginative, "adventurous", thoughtful, logic individual).

Factor analysis led to extract, as suggested by the Scree-test, five factors. The resulting rotated matrix is reported in Table 2. Factor 1 concerns *thinking processes*: multimedia is related to logical (item 24), schematic (items 30 and 8), holistic (item 28), associative (item 25), strategic (item 18) reasoning (item 10). Factor 2 is loaded by items about *creativity* and intuition (items 20, 21, 26, and 9) and about activation (item 1) and *attraction* (item 29); reflection (item 2) is moderately linked to these aspects. Factors 3 can be labeled as *facilitating effects*: multimedia are perceived to make application (item 15), memorization (item 17), and comprehension (item 19) easier, thanks also to the reduction of time (item 16), of effort (item 14), of simultaneous thoughts (item 5), and of verbal load (item 11). Factor 4 concerns the *impact effects* of multimedia, that is, visual (item 6) and global (item 12) understanding and arousing (item 7) and a convincing (item 13) presentation of the contents. Factor 5 includes the *negative effects* of multimedia: confusion (item 22), excessive involvement (item 27), tiredness (item 3), and imprecision (item 4). Thus, teachers' representation appeared to be highly articulated and internally coherent.

It is worth noticing that the factors, which were found, can be reported to the experts' opinions. In fact, by reconsidering the lists of the properties attributed by the

Table 2
Factorial structure of the questionnaire after varimax rotation

Item	Factor				
	1	2	3	4	5
30. Facilitate persons who tend to think schematically	0.645				
24. Are suitable for logic persons	0.636				
23. Require concentration	0.602				
18. Require to plan actions	0.590				
28. Require to keep in mind the overall picture	0.544				
25. Induce and/or facilitate making comparisons and links	0.506				
8. Are useful to schematize concepts	0.414				
10. Help people to re-elaborate notions and to reason about them	0.334				
20. Require creativity		0.702			
9. Facilitate people who have much imagination		0.647			
21. Are appreciated by people who like adventures		0.614			
29. Are attractive and/or arouse people's curiosity		0.600			
26. Facilitate persons who have an intuitive thinking style		0.455			
1. Induce persons to be active		0.417			
2. Are suitable for thoughtful persons		0.325			
15. Make notion application easier			0.702		
14. Allow people to learn with no effort and/or in an implicit way			0.667		
17. Make notion memorization easier			0.614		
16. Allow to learn fast			0.531		
5. Require to think simultaneously to various things			–0.483		
19. Make the comprehension easier			0.433		
11. Facilitate persons lacking of linguistic abilities			0.388		
6. Facilitate persons who have a visual thinking style				0.689	
7. Are suitable for persons who are bored in a short time				0.621	
12. Help persons to have a global overview				0.566	
13. Make notions convincing				0.509	
4. Are not suitable for precise persons					0.613
3. Are tiring					0.529
22. May be confusing					0.699
27. May be too involving					0.521
Eigenvalue	5.84	2.36	2.14	1.83	1.49
Explained variance (%)	19.5	7.9	7.1	6.1	5.0

ten experts to multimedia instructional tools, we realized that each expert tended to report mainly features which resulted to be included in only one (or at least two) of the factors extracted.

T-tests carried out by considering both the factorial scores and the scores recorded in each item of the questionnaire failed to show significant differences due to gender.

The effects of the school level on the teachers' representation were assessed by computing one-way ANOVAs on factorial scores, by assuming school level (kindergarten school vs. primary school vs. secondary school) as an independent variable; Newman–Keuls post-hoc tests were computed when significant effects occurred.

Analyses showed that kindergarten schoolteachers tended to share opinions that were significantly different from those developed by the other teachers (Table 3). Other significant differences depending on the school level emerged by considering scores in each item (Table 3). Generalized effects failed to emerge: the school level affected only few aspects of teacher's conception of instructional multimedia. Moreover, no common trend was identifiable: in some cases kindergarten teachers scored higher than other teachers, in other cases the highest scores were recorded by either primary or secondary school teachers. Kindergarten teachers underestimated the impact features of multimedia (Factor 4; items 1, 7, 13, and 29), presumably because most activities, not only the ones involving the use of multimedia, carried out in their schools are aimed at activating and attracting children's attention and at arousing their curiosity. By contrast, these teachers overestimated the role of thinking and concentration in multimedia use (Factor 1; items 3, 23, and 30), probably because of the cognitive load required by educational software which, for preschoolers, is higher than that required by usual activities carried out with other instruments (paper, pencils, scissors, and so on). The involvement of conceptual thought in multimedia usage was less appreciated by secondary school teachers (Factor 1): it may be that they assumed that schematic, non visual reasoning (items 5 and 6) is fostered by verbal-abstract, not multimedia supported, tasks such as those commonly proposed in the traditional disciplines. Primary school teachers did not appear to have distinct opinions: in some cases their responses were approximately the same as those of the former and in other cases as those of the latter.

Table 3

Significant differences in mean values (SDs in parentheses) according to the school level

Measure	School level			$F_{2,269}$	Post hoc ^a
	Kindergarten	Primary	Secondary		
Factor 1 (thinking processes)	0.12 (1.00)	0.14 (1.00)	-0.51 (0.83)	7.02***	S KP
Factor 3 (facilitating effects)	0.38 (1.16)	-0.18 (0.91)	-0.08 (0.87)	5.81**	PS K
Factor 4 (impact effects)	-0.44 (1.11)	0.10 (0.92)	0.29 (0.88)	7.93***	K PS
Item 1 (activation)	3.09 (1.07)	3.46 (1.14)	3.52 (0.95)	3.17*	K PS
Item 7 (bored persons)	2.48 (1.59)	3.69 (1.09)	3.34 (1.24)	5.53**	K SP
Item 13 (convincing)	2.83 (1.39)	3.47 (1.14)	3.37 (0.50)	6.04**	K SP
Item 29 (attraction)	3.87 (1.17)	4.28 (0.94)	4.22 (0.76)	3.91*	K SP
Item 6 (visual style)	3.47 (1.33)	3.69 (1.09)	4.17 (0.87)	6.44**	KP S
Item 5 (simultaneous thinking)	2.34 (1.29)	3.15 (1.33)	2.80 (1.29)	8.16***	KS SP
Item 3 (tiring)	2.88 (1.39)	3.00 (1.28)	2.45 (1.32)	3.58*	SK KP
Item 23 (concentration)	3.76 (1.38)	3.87 (0.98)	3.44 (1.05)	3.02*	SK KP
Item 14 (without effort)	3.41 (1.26)	2.89 (1.17)	3.19 (1.19)	4.35*	PS K
Item 4 (not precise persons)	2.32 (1.33)	1.91 (1.14)	1.85 (1.16)	3.17*	SP K
Item 30 (schematic thinking)	3.78 (1.30)	3.73 (1.04)	3.33 (1.13)	3.11*	S PK

^a Subgroups which did not result to be significant different according to the post-hoc test are indicated by adjacent letters (K = kindergarten school; P = primary school; S = secondary school); subgroups which resulted to be significant different are separated by a blank space.

* $p < 0.05$.** $p < 0.005$.*** $p < 0.001$.

Table 4
Significant differences in mean values (SDs in parentheses) according to the disciplinary field taught

Measure	Disciplinary field			$F_{2,53}$	Post hoc ^a
	Humanities	Science	Other		
Factor 1 (thinking processes)	−0.44 (0.59)	−1.32 (0.71)	−0.18 (0.91)	4.92*	S HO
Factor 3 (facilitating effects)	−0.51 (0.71)	−0.21 (0.76)	0.46 (0.84)	6.47**	HS O
Item 29 (attraction)	3.78 (0.81)	4.50 (0.67)	4.38 (0.69)	4.84*	H OS
Item 19 (comprehension)	3.11 (0.76)	3.33 (1.23)	3.92 (0.89)	3.40*	HS O
Item 2 (thoughtful persons)	2.67 (1.08)	1.91 (0.79)	2.96 (1.31)	3.40*	S HO
Item 18 (planning)	3.39 (0.89)	2.58 (1.31)	3.65 (1.09)	3.86*	S HO
Item 12 (global view)	3.33 (1.24)	3.00 (1.73)	4.19 (0.89)	4.81*	SH O

^a Subgroups which did not result to be significant different according to the post-hoc test are indicated by adjacent letters (K=kindergarten school; P=primary school; S=secondary school); subgroups which resulted to be significant different are separated by a blank space.

* $p < 0.05$.

** $p < 0.005$.

In order to assess the influence exerted by the cultural aspects involved in a secondary school teachers' education and work, one-way ANOVAs were carried out by assuming factorial scores and scores in each item of the questionnaire as dependent variables and the disciplinary field (humanities vs. science vs. other fields) as independent variable. In few cases significant differences were found (Table 4). Science and humanities teachers often shared similar conceptions. Only the following trend can be identified: science teachers tended to attribute a lower role to thinking processes in multimedia (Factor 1; items 2, 12, and 18), presumably because their expectation is that multimedia tools foster an intuitive acquisition of the contents to be learned, allowing students to overcome the cognitive boundaries that they encounter when concepts are presented through words and abstract symbols.

Finally, experience with multimedia tools was taken into account. Teachers who have used at least one multimedia tool in school activities were classified as teachers *with* direct experience; the other teachers were classified as teachers *without* direct experience. The analyses of the examples of computer-supported multimedia tools that teachers reported to use gave us the assurance that they all were thinking of computer-supported multimedia such as CDs, educational software, and so on. Factorial scores were not affected by this classification and only in few items did teacher with direct experience obtain mean scores that were significantly different from teachers without that experience (Table 5). It is worth noticing that participants who had directly experienced multimedia did not develop a sense of "saturation": they continued to appreciate to a great extent the activating, attractive, and involving power of multimedia.

4. Discussion and conclusions

Literature has suggested that teachers perceive a computer-supported instructional tool as a mean which can either match or mismatch their pedagogical ideas

Table 5

Significant differences in mean values (SDs in parentheses) between teachers with and without direct experience of multimedia instructional tools

Measure	Experience		
	With	Without	
Item 1 (activation)	3.57 (0.98)	2.96 (1.16)	3.23***
Item 27 (too involving)	2.95 (1.31)	2.41 (1.14)	2.19*
Item 29 (attraction)	4.24 (0.90)	3.69 (1.28)	2.48**

* $p < 0.05$.

** $p < 0.005$.

*** $p < 0.001$.

(Greenberg et al., 1998; Kynäslähti, 2002), being prone to accept and to use it (even by modifying their professional practices) if it allows them to pursue the educational goals that they have in mind. Therefore, the crucial aspect of the acceptance of technology by teachers is recognizing that a new tool induces students to achieve the desired outcomes through learning paths that are consistent with such outcomes. In order to establish whether a tool can do so, such features as the cognitive operations, strategies, and styles which are involved, the mental skills required, the emotional-motivational variables (in short, what we called the “psychological correlates” of the tool) should be taken into consideration.

What do teachers think about these topics? Previous case-studies have provided us with the descriptions of some teachers’ opinions, but have failed to inform us to what extent those opinions are shared, how they are internally articulated, whether they are influenced by gender, school level, disciplinary field taught, and direct experience with the tool. The present investigation was carried out to acquire preliminary data about these topics.

Since computer-supported instructional instruments constitute a wide and heterogeneous category of tools, we decided to focus our attention on a specific instrument of this kind, that is, multimedia. We asked a sample of teachers working in different school levels to assess their agreement about a series of statements concerning what multimedia instructional tools could elicit in the learner’s mind.

Teachers’ responses showed that they share reliable opinions about how students can learn through multimedia. They identified a large number of opportunities stressed by theorists and researchers in the field of technology and instruction. It can be noticed that not only obvious qualities of multimedia were recognized but also less evident issues were appreciated. The overall picture that emerged was that teachers had well-defined and deep-rooted conceptions about what multimedia tools can introduce into a learning process. Teachers’ representation appeared to be internally articulated: items saturated consistent factors, suggesting that the opinions investigated were coherent and were organized in specific dimensions.

It is interesting to note that different patterns of opinions emerged. Above all, some teachers acknowledged the optimizing effects of multimedia, according to Clark’s (1983, 2001) position. Other teachers prevalently appreciated the deep mental changes that multimedia can induce, according to De Kerchove’s (1991) view. Some

teachers appreciated the positive features of multimedia, whereas other teachers seized the possible negative outcomes. Furthermore, possible parallelisms between respondents' beliefs and the three main issues emerging from literature can be identified. Previous case studies showed that teachers' opinions concerned mainly (i) motivation and involvement, (ii) facilitation and optimization, and (iii) cognitive activity. Factors 4 and 5 can be related to the first issue; Factor 3 to the second one; Factors 1 and 2 to the third one. Thus, some links between the literature and the results of the present investigation can be drawn. However, this study allowed us to assess the extent to which each feature of multimedia educational instruments is shared by teachers and to describe in more detail the internal structure of their beliefs about such issues, and to test the possible aspects influencing their beliefs.

The representation of multimedia tools was not affected by gender. Male/female differences in attitudes towards the computer have often been reported (e.g., Colley, Gale, & Harris, 1994; Oosterwegel, Littleton, & Light, 2004; Shashaani, 1993; Volman & Van Eck, 2001), although they have tended to diminish in the last years (Schumacher & Morahan-Martin, 2001). It might be that gender affects only the overall attitude towards the computer – which includes the frequency of computer use, enjoying computer use, self-evaluation of computer using skills, and so forth – but not opinions about specific issues related to the role of multimedia in instruction. Also Shapka and Ferrari (2003) failed to find gender differences in computer attitudes within a sample of teachers. It is likely that attitudinal differences between males and females are overwhelmed by common professional interests and competences: teachers working in the same socio-cultural environment are faced, irrespectively of their gender, with the same educational problems, are involved in the same practices, are trained according to the same pedagogical principles, and so on; this leads them to develop more or less the same conceptions about the instructional tools that can be employed. These remarks might also explain why the school level and the disciplinary field played a minor role in modulating the kind of representation investigated by the questionnaire.

As far as the direct experience with multimedia is concerned, literature suggests that experience (Gardner, Dukes, & Discenza, 1993; Liaw, 2002; Yaghi, 1997) and access to computers (McIlroy, Bunting, Tierney, & Gordon, 2001) improve the students' attitudes towards them. The same is true if we consider studies carried out on adults: it is generally believed that experience with technology will result in people having more positive attitudes towards the technology (Czaja & Sharit, 1998). Even elderly people develop more positive opinions about computers after having been involved in learning activities using such a tool (Czaja & Sharit, 1998; McNeely, 1991). However, teachers' beliefs do not seem to be so closely related to their computer use. In fact, Kersaint, Horton, Stohl, and Garofalo (2003) found only a moderate connection between mathematics teachers' beliefs about the importance of technology in learning and the degree to which they have incorporated it into their teaching. Bodzin (2000) reported that pre-science teachers' attitudes towards a Web-based forum that they used for educational aims were not related to the access that they had to a networked computer. Since it is the type of experience that a person has with computers that influences attitude (Czaja & Sharit, 1998), it may be that teachers,

even though they have different *amounts* of experience in using computers, have the same *kind* of experience (since they know approximately the same typologies of software) and so have similar patterns of beliefs.

The overall impression is that teachers' ideas about the psychological correlates of instructional multimedia are rather stable. In fact, it has been showed that beliefs about the educational implications of information technologies are unlikely to change spontaneously or as a mere consequence of knowledge acquisition or practice (Antonietti, Rasi, Imperio, & Sacco, 2000; Mouza & Bell, 2001). Furthermore – as shown by Wang and Beasley (2002) who studied pre-service and in-service teachers – opinions about hypermedia are not associated with performance in the use of hypermedia.

Even if scarcely influenced by external factors, we can assume that opinions about multimedia can be related to teaching behavior. In fact, the effects of technology are mediated by teachers' beliefs about its role in learning. Thus, it is extremely important to consider what teachers think about multimedia. The present study showed that teachers share, together with opinions supported by research on instructional technologies, common statements which empirical findings failed to corroborate. For instance, contrary to what teachers maintained, computer usage is not associated with a style of visual thinking (Antonietti, Colombo, & Perez-Fabello, 2002). Conversely, there are experimentally supported features of multimedia tools that are not recognized. For example, it is commonly argued that such tools prompt a perceptual-motor way of learning, whereas experimental results showed that they tend to induce a conceptual-imaginative perspective (Antonietti & Cantoia, 2000). A comparison between teachers' naive conceptions and well-established research data is needed in order to either reinforce teachers' assumptions or to induce them to change their ideas, if not consistent or not relevant.

On the other hand, assessing teachers' beliefs is important to check whether they are sufficiently shared within the school team: it is possible to imagine that problems will arise if teachers, working within the same project, have different conceptions about the role of the multimedia instruments to be used.

Finally, it is important to test whether the teachers' perceptions of multimedia match the students' perceptions (Goh & Tobin, 1999): a common meaning should be attributed to the instructional tools that teachers intend to employ and that students are invited to use.

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