

## Article

# Definitional Skills as a Bridge towards School Achievement

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**Abstract:** The general aim of the current study was to investigate the role of definitional skills in promoting primary school achievement (third- to fifth graders) and how school learning may shape definitional skills. Marks from four school subjects, linguistic (Italian and English) and scientific (Math and Science) were collected as well as scores in a Definitional Task. These two domains were chosen as they clearly entail the two different definition types, that is, *lexicographic* and *scientific*. Results indicated that scientific school subject marks are more predictive of definitional skills than linguistic school marks are. The opposite direction (i.e., how definitional skills are predictive of school achievement) appears less clear. In sum, the results, although preliminary, suggest that definitional skills represent a bridge towards school achievement as they promote good marks in all disciplines. Moreover, definitional skills are predicted from levels of competence acquired especially in scientific school subjects that request a higher degree of formal/organized learning. It is then of primary importance to promote interaction–integration between these two kinds of concepts via formal schooling.

**Keywords:** definitional skills; school achievement; primary school



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## 1. Introduction

The current study is aimed at investigating the role of definitional skills in school achievement. The role of language in school success is well established (e.g., lexical, morphosyntactic, semantic knowledge); less is known about definitional skills, a topic relatively understudied. First, we will give an overview on what definitions are and specifically on the two main types of definitions (i.e., *lexicographic* and *scientific*). Then, we will briefly describe how definitional skills develop and in particular, how it relates to school achievement analyzing the most relevant and recent contributes. Finally, we will anticipate aims and design of the current study.

## 2. Definitional Skills: An Overview

Definition is a complex linguistic and metalinguistic skill that allows explicitation and clarification of concepts and meanings. Two main kinds of definitions can be recognized: *lexicographic* and *scientific*. The *Lexicographic* definition requires the ability to decompose a mental representation about a shared experienced object/concept into its main features; the *scientific* definition, instead, implies a creative, original activity that produces new knowledge and allows socialization of that knowledge. While the *lexicographic* definition is learnt mainly via every-day language through concrete and experiential contexts, the *scientific* definition, as a constructive one, (establishing new knowledge and new meanings), is learnt via an abstract format and in formal learning environments, such as schooling; see [1]. It is worth noticing that schooling increases and reinforces both definitional skills; thus, formal instruction has a non-marginal role on the development of such crucial ability.

Development of natural concepts, as well as *lexicographic* definition, moves from the bottom upwards, i.e., from concrete to abstract knowledge. On the contrary, development

of scientific concepts as well as *scientific* definitions, moves upwards to the bottom, that is, from abstract to concrete knowledge; in other words, children first acquire the scientific concept and afterwards look for concrete exemplifications.

Regarding the school subjects, we recognize that *lexicographic* definitions are cross-relevant to all branches of knowledge, being the verbal language and the related-semantic representations necessarily involved in communication of any kind of content; however, *scientific* definitions are more relevant and requested to learn scientific school subjects. In all, good definitional skills, either *lexicographic* or *scientific* (*definition of every-day language words vs. definition of scientific concepts*), must take on a specific abstract and formal format (see next section).

It is worth noticing that both kinds of definitions are extremely relevant and pertinent to school achievement; indeed, to learn concepts in different subjects, both scientific definitions (e.g., define what a circumference is; what gravity means) and lexicographic ones (e.g., being able to define a given word or concept using conventional language) are required. In the current work, we will specifically deal with *lexicographic* definitions as our interest is the speaker as user of words/language and not as creator of new meanings.

### 3. Formal Structure of Definitions

A fundamental assumption of both *lexicographic* and *scientific* definitions is their communicative and metalinguistic function, that is, the reflection and inter-subjective verification about the conventional meaning of words and concepts.

Defining is a task that requires awareness and meta-linguistic competence as it consists in a series of inter-related activities: (i) activates the underlying semantic representation (i.e., pertinent conceptual knowledge); (ii) assumes that the interlocutor may not have the same knowledge available; (iii) selects the words that allow to make explicit the semantic content of a word; (iv) organize words according to grammatical/morpho-syntactic rules proper of a given language; and (v) adapts those grammatical rules to formal rules of a typical definition, necessary to pursue 'semantic equivalence' between the term to be defined and the linguistic expression/sentence containing the most relevant conceptual information about that term.

The canonical definition must accomplish five requisites: four formal (i.e., *paraphrase*, *periphrastic form*, *phrasal autonomy* and *correct morpho-syntactic structure*), and one content-related (semantic equivalence). The content-related requisite of a canonical definition calls for the individuation not only of the general semantic area but also of full semantic equivalence between the stimulus word and the sentence defining it. In fact, the mere individuation of the general semantic area can produce ambiguity in meaning interpretation; for instance, a *lexicographic* definition of 'dog' as 'animal with four legs' induces to thinking of many other quadrupeds, thus not allowing the precise individuation of the specific referent intended.

Examples of *lexicographic* canonic definitions are: 'a cat is a domestic animal that meows'; 'friendly is an adjective meaning nice', and 'cooking refers to the action of arranging food'. Examples of *scientific* definitions are: 'a square is a polygon with all sides and angles even'; 'gravity is the force that attracts a body towards the center of the earth, or towards any other physical body having mass'; and 'syntax is the set of rules, principles and processes that govern the structure of sentences in a given language, also including word order'. In general, a definitional sentence is complete and communicatively adequate when it allows the correct and univocal identification of the stimulus-word.

### 4. Development of Definitional Skills

The literature shows that children's ability to improve the quality of the definitions they produce is a function of age [4]. Different studies [5–7] have indeed shown that younger children (aged five or six) usually build up mostly descriptions of objects, using the *has* structure (e.g., 'a cow *has* four legs') when answering questions such as 'What does (stimulus word) mean?'. On the other hand, older children (aged seven and onward) tend

to add a superordinate categorical term, producing the *isa* structure (e.g., ‘a strawberry *is a* red and juicy fruit’).

The formal quality of definitions was significantly better for older children (10–12 years old), who employed definitional answers that were similar to adult strategies as shown by [8] (see also [4,5,7]). Defining words is considered a metalinguistic skill [7–9] because it requires a reflection not only on the content (what to say) but also on the form (how to say it). Indeed, definitions make explicit formal and content components of language, and achieve the semantic core via other linguistic expressions.

In particular, the development from the simplest forms of definition to integrated ones requests both a good knowledge of the concept to be defined, and the awareness of what a definition is and what it is used for [8]. Indeed, only if the child understands that names are arbitrarily used to refer to objects can s/he use different linguistic labels to denote the same object.

By the end of primary school, both definitional ability and metalinguistic awareness seem well developed and the quality of children’s definitions is very similar to that of adults’ [8]. In addition, [8] showed that metalinguistic ability can be considered a crucial component in developing good definitions.

### 5. Definitional Skills, School Achievement, and Education: State of the Art

Learning to define is not a simple process and is largely influenced by formal instruction and schooling. Some authors have suggested that definitional skills (considered as a measure of decontextualized language abilities) are closely related to school achievement in general, and to literacy, in particular [10,11].

First, children gradually learn the correct formal structure and the content constraints of definitions from appropriate models (e.g., in their teachers’ speech and in textbooks), even when definitions are not the real subject of a given lesson [7]. In this process, the role of the adult who explicitly provides the conventional structures of language by improving genuine productions of children is fundamental.

Second, the acquisition of reading and writing leads to a more reflective attitude towards language as well as more formal and exhaustive ways of defining words [10]. In fact, during the process of literacy acquisition, children are asked to manipulate word meaning and to use their lexical knowledge to provide definitions for the words they read [12].

Currently, there is a debate on the *direction* of the relationship between schooling and definitional skills; in general, school experience and practicing formal definitions in the classroom do positively influence children’s definitional skills. The focus on formal definitions is more typical of school environments than other settings and during school activities, formal definitions are emphasized to develop new vocabulary. For instance, school exposure was related to children’s performance on definition tasks more than their home experience [7].

However, the inverse relationship was also supported; indeed, definitional skills positively impact school achievement in children. Typical school tasks (such as reading and writing), cannot be accomplished without a good control of abstract linguistic skills [11].

Therefore, the research just described indicates that the achievement of good definitional skills represents a valid means of pupils’ comprehension and learning. Thus, definitions can be used to arrange meaning; this role is particularly important within specific subjects, such as scientific ones, where discourses refer to highly abstract concepts (e.g., mathematical/geometrical concepts). Through practice, pupils learn to illustrate scientific knowledge via formal definitions.

In addition, definitional skills are also good predictors of the acquisition of literacy. The relation between children’s vocabulary breadth and reading skill is not based only on children’s knowledge about word meaning, but also on their metalinguistic awareness about words [11].

Evidence for the relation between definitional skills and educational level was also supported by [8]. They observed a difference between adults with a high educational level (who performed better than any other group did) and adults with a low educational level (who scored worse than six year old children did). The result suggested that formal education *per se* is more important for developing definitional skills than mere chronological age is. This finding suggests the positive effects of schooling/education on the ways individuals define words; these effects are not necessarily long-term and are likely to be linked to practice with definitions and learning. It is worth noting that these results may not be directly linked to evidence obtained with children and the conclusions may be considered independently.

Similar findings were obtained by [13] who showed that the educational level significantly influences the content and form of the definitions but also the type of definition. In particular, she found significant differences between adults with low and high educational level in defining verbs, nouns, and adjectives, both in terms of content and form.

Two groups of adults to define words belonging to the grammatical category of noun. The results showed that 80% of adults from urban areas included hypernym terms in their definitions. In contrast, only 36% of adults from rural areas included hypernym terms in their definitions. Regarding the form of their answers, the definitions in canonical formal form was 69% for adults in urban areas, and only 13% for adults in rural areas [14].

Taken together, these findings seem to suggest that education is an important factor for developing definitional skills than mere chronological age is. Moreover, the results showed that formal definitions are associated with literacy, because overall, low-educated adults used fewer formal definitions than educated adults. However, it is worth noticing that the role of age in adult cognition may be relatively marginal, particularly when it is compared to the role played by age in children, where cognitive developmental processes are observed. Therefore, the comparison between literature on children and adults may be done cautiously, more with the aim of comprehension than for a real comparison.

According to [4] the ability to accurately define words can improve the clarity of spoken and written communication in academic contexts as well. Her study included adolescents who were strong and weak readers. Each adolescent defined abstract nouns (such as *gratitude* and *friendship*) which were scored for use of class terms and characteristics. Results indicated that strong readers outperformed weak readers in providing definitions in the canonical form.

A feasibility study of definitional skills was conducted by [15]. She investigated whether a one-time lesson on formal definitions would improve nine-year-old, low reader children's production of definitions. The lesson included attention to and discussion of precise word/verb meanings in definitions (both concrete and abstract). Findings suggested that the lesson produced significant formal improvements for nouns and verbs. In both instances, children decreased use of lower-level definitional forms and increased use of formal definitions. Moreover, findings indicated significant improvements in noun content. Children increased use of definitions that contained combinations of class terms and attributes (i.e., function, concrete, or association). It is likely that the definitional lesson supported children in focusing on more precise word meaning promoting school success.

In line with the developmental literature previously reviewed, these three last studies indicate the existence of a relation between definitional skills and school success, albeit considering additional variables that are not within our current interests (i.e., reading ability and bilingualism); it is also worth noticing that they consider different age ranges (i.e., adolescents versus primary school children). More related to our current aims is the study by [15] who suggests that definitional skills may improve school success via a strong procedure of training production of definition.

## 6. The Current Study Aims and Hypotheses

The general aim of the current study was to investigate the role of definitional skills in determining primary school achievement from third to fifth grade. To this end, we

conducted two experiments: first, an exploratory cross-sectional experiment and second, a longitudinal, more theoretically driven experiment.

In Experiment 1, we aimed at replicating and adding support to existence of a general relation between definitional skills and school marks. Indeed, a study by [10] in primary school children confirmed a relation between definitional skills and school achievement, measured as school marks in two main subjects: Math and Italian. In particular, the authors found a significant correlation between definitional skill and marks in Math only. In line with this finding, we aimed at exploring the existence of such a possible positive relation, in a correlational exploratory study. Here, we considered marks from four school subjects, two for each scientific domain, i.e., linguistic (Italian and English) and scientific (Math and Science). These two domains represent different but related abilities. The linguistic domain is built on linguistic pertinence, richness, and fluency, whereas the scientific domain is built on more abstract and relational abilities (though linguistically coded). These two domains were chosen as they clearly entail the two different definition types, that is *lexicographic* (i.e., verbal language and the related semantic representations necessarily involved in communications of any content: Italian, English) and *scientific* (i.e., a more structured abstract format: Math, Science). Both skills are indeed crucial in school achievement.

In Experiment 2, we conducted a three-year longitudinal study aimed at exploring the direction of the relation between definitional skills and school achievement. Here, we hypothesized a role of definitional skill both as a predictor of school success and as a competence predicted by school marks.

In both experiments, children were recruited from public primary schools with a standard curriculum (i.e., the same school subjects and specific learning objectives established *a priori*) and traditional teaching methods (i.e., mainly frontal lessons and/or cooperative learning). This is homogeneous across all subjects, schools, and teachers. In Italian public schools, there is a teacher for humanistic subjects (i.e., Italian, History, Geography), another one for second language (here, English) and a different one for scientific subjects (Math, Science).

## 7. Experiment 1: Cross-Sectional Study

### 7.1. Methods

#### 7.1.1. Participants

The present study involved 70 Italian children aged 7.8 years to 12 years attending primary school in Central Italy. Specifically, 23 attended third grade (mean age = 8.3 years, SD = 0.39), 20 attended fourth grade (mean age = 9.3 years, SD = 0.32), and 27 attended fifth grade (mean age = 11.2 years, SD = 0.49). In the sample, 29 were females. The participants were all Italian native speakers with a middle socioeconomic status; none had been diagnosed with linguistic or cognitive delay. Data were collected in 2013–2014 school years (before the current COVID pandemic emergency).

The request of ethical approval is not mandatory according to the General Regulation of the University of Urbino Carlo Bo. However, in the current study, we have carefully and strictly implemented the procedure in force for research with children; that is, we obtained informed consent by parents to participate in the research and to the possible publication of findings (i.e., privacy form that guarantees anonymity and aggregate treatment of data). We observed the guidelines of the University of Urbino Carlo Bo, as well as the Italian Association of Psychology. The study was conducted in accordance with the Ethical Standards laid down in the 1964 Declaration of Helsinki and the standard ethical procedures recommended by the Italian Association of Psychology.

#### 7.1.2. Materials and General Procedure

Children were tested at school, in a quiet room, in individual sessions (approximately 30 min). They were administered the definition task. In addition, school marks were collected from teachers.

### 7.1.3. Definition Task

The task was devised by [2]. It comprises 24 stimulus-words belonging to three grammatical categories: eight nouns (ability, clown, donkey, kindness, orange, rivalry, spying, umbrella), eight adjectives (blonde, contagious, innocent, polite, risky, round, smooth, thin), and eight verbs (to baffle, to burn, to connect, to emigrate, to force, to hit, to think, to tolerate). The stimulus-words were presented in random order. All the words were presented in Italian, the native language of all children.

Within each category, half of the items were concrete (e.g., clown, blonde, to hit), whereas the others were abstract (e.g., kindness, innocent, to think). None of the selected terms were a compound word.

### 7.1.4. Procedure

Children were individually interviewed and asked to answer the following question: "What does the word X mean?". Their definitions were transcribed *verbatim*, and the same responses were judged on a 6-level scale, the 'Formal definition scale', that emphasizes different aspects of the same general definitional ability. No examples of answers were provided because we wanted to avoid suggesting any type of predetermined model. In fact, our aim was to observe whether and how different definitional models may emerge. Therefore, all answer types were accepted, and the experimenter made no comments about them.

The more syntactically articulated, organized, and correct a participant's sentence was, the higher its definitional level was considered. Content was not irrelevant; indeed, the responses allow for an increasingly detailed account of semantic content, which ranges from the simple expression of spatial-perceptual relations among objects, through identification of their categorical membership, to viewing them within more general conceptual framework.

Scoring was determined in terms of increments of morpho-syntactic complexity (e.g., a preposition added to a simple word; the introduction of non-conjugated verbs; the use of conjugated verbs; subordinate clauses introduced by connectives with no main clauses; the additional presence of main clauses, and so on).

The six-level definitional scale was organized as follows and is synthesized/exemplified in Table 1.

### 7.1.5. School Marks

School marks were attributed to children by their teachers in the linguistic (i.e., Italian, as native language, and English, as second language) and scientific (i.e., Math and Science) domains were collected. In these primary schools, marks were distributed on a 10-point scale (from insufficient to very good).

## 7.2. Results and Discussion

A preliminary analysis was conducted to investigate age effects on definitional skills development, in line with literature [4]. Independent sample t-tests were run on the three age groups (third, fourth, and fifth graders). Results show a significant difference between third graders (mean score 2.16) and fourth graders (mean score 2.70),  $t(41) = 4.08, p < 0.001$ , and between third graders and fifth graders (mean score 2.88),  $t(48) = 4.29, p < 0.001$ . No significant differences emerged between fourth and fifth graders,  $t(45) = 1.05, p = 0.30$ ; however, we can notice a clear developmental increase, albeit not significant, also from fourth to fifth grade.

Given that definitional skills increase as children age, a partial correlational analysis (corrected by age) between definitional skills and school marks was conducted on the whole sample and is reported in Table 2.

**Table 1.** Definitional levels, prototypical answers and scores for the definition of the word “Donkey”.

Levels	Kinds of Answers	Score
0. Non-definition	No answer or non-verbal answers	0
I. Pre-definition	One-word answers, mostly associations (e.g., <i>donkey</i> → <i>ears</i> )	1
II. Nearly-definition	Initial formulation of sentences, without autonomous forms (e.g., <i>donkey</i> → <i>with the long ears; when it brays</i> )	2
III. Narrative/descriptive definition	Formally correct and autonomous sentences, with narrative/descriptive content (e.g., <i>donkey brays; donkey is mild</i> )	3
IV. Simple categorical definition	Formally correct and autonomous sentences in simply categorical/synonymic form (e.g., <i>The donkey is an animal</i> )	4
V Partial Aristotelian definition	Formal correctness without semantic equivalence (e.g., <i>The moon is a planet in the solar system</i> )	5
VI. Aristotelian definition	Formal and semantic correctness and equivalence (e.g., <i>A donkey is an animal that brays</i> )	6

Note: Level I: Pre-definition. Linguistic answers are produced at this level, but in very simple forms: the stimulus item is followed by only one-word answers which are linked to the item by phonetic similarity or rhymes or mostly associations (e.g., ‘dog: tail’); Level II: Nearly-definition. These definitions are an initial expansion and articulation of sentences with incorrect, not autonomous forms (e.g., ‘dog: when it barks’); Level III: Narrative-Descriptive definition. This third level shows formally correct and autonomous sentences, with narrative/descriptive content (e.g., ‘dog: my father love dogs’ (narrative), or ‘dog barks’ (descriptive)); Level IV: Simple categorical definition. These definitions are formally correct and autonomous sentences with categorical/synonym format and are introduced by a *copula* (e.g., ‘dog is an animal’); Level V: Partial formal definition (or, Categorical definition with incorrect or incomplete specifications). At this last level, definitions have complete formal correctness without semantic equivalence (e.g., ‘dog is an animal which eats’); Level VI: Formal definition. At this level, definitions have complete and formal correctness and semantic equivalence (e.g., ‘dog is an animal which barks’).

**Table 2.** Partial inter-correlations (corrected by age) between definitional skill, school marks for the whole sample (N = 70).

	2	3	4	5
1. Definitional skill	0.441 ***	0.399 ***	0.319 **	0.353 **
2. Italian(L1)		0.842 ***	0.852 ***	0.809 ***
3. English (L2)			0.809 ***	0.786 ***
4. Math				0.856 ***

Note. \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$  (all significance tests are two-tailed). Italian is native language L1; English is second language L2.

The definition task is highly related to performance in both domains, linguistic and scientific: the more participants are able to define, the higher the mark they accomplish across all these four school subjects. In particular, the relation is higher for the linguistic domain, both Italian and English ( $p < 0.001$ ), and slightly lower for Math and Science ( $p < 0.01$ ). The school subjects were also highly interrelated (all  $ps < 0.001$ ). Findings confirm previous results (e.g., [10]) as they support a relation between the ability to define a word and school achievement.

However, data are not indicative of the *direction* of such relation; in fact, they do not allow the establishment, whether definitional skills are predictive of school achievements and, on the other hand, whether school achievements can predict definitional skills. This crucial issue was addressed in Experiment 2.

## 8. Experiment 2: Three-Year Longitudinal Study

In Experiment 2, we conducted a correlational/regression study aimed at exploring the *direction* of the relation between definitional skills and school achievement, in a three-year longitudinal study and along the two directions individuated in literature (e.g., [7,10]). More specifically, we investigated whether current school marks and definitional skills are predictive of next-year school marks (see question 1). We hypothesized a role of both

definitional skills and school marks in predicting next-year school achievement in the same school subject. Indeed, definitional skills are inter-related to school definitions (linguistic and scientific) but also the marks are a general index of variance in school achievement.

Also, in the opposite direction, we investigated which previous-year school subject marks are more predictive of one-year-later definitional skills (see question 2). Here, we predicted that the scientific school subjects (i.e., Math and Science) could be highly predictive of definitional skills, as they both imply similar processes, such as a greater abstract reasoning ability, and taxonomic/categorical organization of knowledge.

## 8.1. Methods

### 8.1.1. Participants

The present study involved 117 Italian children aged 8.4 years to 11.8 years attending primary school, in Central Italy. Specifically, 36 attended third grade (mean age = 8.7 years,  $SD = 0.25$ ), 42 attended fourth grade (mean age = 9.8, years  $SD = 0.33$ ), and 39 attended fifth grade (mean age = 10.7 years,  $SD = 0.33$ ). In the sample, there were 52 females. The participants were all Italian native speakers, and none had been diagnosed with linguistic/cognitive delay. None had participated in Experiment 1. Data were collected (before the current COVID pandemic).

As in Experiment 1, we obtained informed consent of parents to participate in the research and to the possible publication of findings (i.e., privacy form that guarantees anonymity and aggregate treatment of data). We observed the guidelines of the University of Urbino Carlo Bo, as well as the Italian Association of Psychology. The study was conducted in accordance with the Ethical Standards laid down in the 1964 Declaration of Helsinki and the standard ethical procedures recommended by the Italian Association of Psychology.

### 8.1.2. Materials and Procedure

Children were tested at school, in a quiet room, in individual sessions (approximately 30 min). They were administered the same Definition task described in Experiment 1. In addition, school marks were collected from teachers in four different subjects to cover two domains: linguistic (Italian and English marks) and scientific (Math and Science marks). These were collected along a period of three years (2013–2014, 2014–2015, and 2015–2016), that is the current-year (C), (the same when definition task was collected), the previous-year (P), and the next-year (N).

## 8.2. Results and Discussion

As in Experiment 1, a preliminary analysis was conducted to investigate age effects on definitional skills development. Independent sample *t*-tests were run on the three age groups (third, fourth, and fifth graders). Results did not show a significant difference between third graders (mean score 2.80) and fourth graders (mean score 2.79),  $t(76) = 0.27$ ,  $p = 0.79$ . Instead, we found a significant difference between third graders and fifth graders (mean score 3.25),  $t(73) = 3.39$ ,  $p < 0.001$ ; and between fourth and fifth graders,  $t(79) = 2.84$ ,  $p = 0.006$ . Given that definitional skills increase as children age, we conducted the following analyses guided by two main research questions.

### 1. Are Current-Year School Marks and Definitional Skills Predictive of Next-Year School Marks?

A three-year partial intercorrelation between definitional skill and school subject marks along the three years was conducted and is reported in Table 3. Here, we showed that all school subjects were highly interrelated (all  $ps < 0.001$ ) and were also significantly related to definitional skills (all  $ps < 0.001$ ).



**Table 3.** Three-year partial intercorrelations (corrected by age) between school subject marks of the current year (C), previous year (P), and next-year (N), and definition task for the whole sample (N = 117).

	2	3	4	5	6	7	8	9	10	11	12	13
1. Italian C	0.83	0.84	0.83	0.82	0.77	0.75	0.83	0.81	0.79	0.78	0.72	0.60
2. English C	-	0.82	0.80	0.77	0.83	0.76	0.78	0.68	0.74	0.70	0.66	0.53
3. Math C		-	0.84	0.81	0.80	0.87	0.85	0.76	0.80	0.80	0.71	0.45
4. Science C			-	0.75	0.79	0.79	0.80	0.78	0.80	0.78	0.76	0.49
5. Italian P				-	0.83	0.84	0.84	0.72	0.75	0.73	0.69	0.50
6. English P					-	0.83	0.82	0.64	0.73	0.66	0.67	0.48
7. Math P						-	0.86	0.73	0.80	0.79	0.75	0.40
8. Science P							-	0.80	0.82	0.81	0.79	0.53
9. Italian N								-	0.89	0.91	0.85	0.45
10. English N									-	0.90	0.90	0.48
11. Math N										-	0.89	0.41
12. Science N											-	0.41
13. Definit. skill												-

Note. All comparisons are significant for  $p < 0.001$ .

As in Experiment 1, definitional skill is directly related to performance in both domains, linguistic and scientific: the more participants are able to define, the higher the marks they accomplish across all these four school-subjects (all  $ps < 0.001$ ).

To ascertain the relative influence of the most significant variables in definitional skills, hierarchical regression analyses were conducted, one for each school-subject, with definitional skill and current-year school marks (in Italian, English, Math, and Science) as predictors and next-year school mark as the dependent variable. Findings are reported for each school subject in Table 4a–d. Age was always included as the first predictor because literature shows clear age-related effects, that is, increase in definitional skills as children age.

Results show that definitional skills increase as children age and experience schooling, in line with the literature (see [4,8]). Definitional skills are significant predictors when the school mark is not considered. Indeed, when we consider the current school marks as well, this is more predictive of future school marks in the same school subject. The finding can be well accounted for because a mark is a wider index of variance and inclusive of many skills, such as overall core cognitive abilities, memory, metamemory, and general metacognitive skills.

## 2. Do Previous-Year School Subject Marks Predict One Year-Later Definitional Skills?

To ascertain the relative influence of the most significant school marks in the definition task, hierarchical regression analyses were conducted, with school marks in Italian, English, Math, and Science of the previous year as predictors of definitional skill on the year after. Findings in Table 5 show that the Science school mark ( $p < 0.001$ ) was the most significant predictor in definitional skill followed by the mark in Math ( $p = 0.013$ ; see Step 5).

Findings show that scientific school subjects (i.e., Science, and to a lesser extent, Math) are better predictors of future definitional skill development. It is indeed plausible that as hypothesized, learning scientific school subjects (Math and Science) entails similar abstract processes to those required in *lexicographic* definition formulation.

**Table 4.** Hierarchical regression steps: The role of current-year age, definitional skill, and current-year school mark in (a) Italian, (b) English, (c) Math, and (d) Science on corresponding next-year school-subject mark.

a: Italian				
Italian Next-Year				
Predictors	R <sup>2</sup> ( $\Delta R^2$ )	Beta	t	p
Step 1	0.08 (0.08) ***			
Age C		0.28	−3.16	0.002
Step 2	0.27 (0.19) ***			
Age C		0.40	−4.72	0.000
Definitional skill		0.45	5.40	0.000
Step 3	0.70 (0.43) ***			
Age C		0.14	−2.60	0.010
Definitional skill		0.04	0.73	0.468
Italian C		0.82	12.62	0.000
b: English				
English Next-Year				
Predictors	R <sup>2</sup> ( $\Delta R^2$ )	Beta	t	p
Step 1	0.06 (0.06) **			
Age C		0.24	−2.70	0.002
Step 2	0.27 (0.21) ***			
Age C		0.36	−4.33	0.000
Definitional skill		0.48	5.75	0.000
Step 3	0.59 (0.32) ***			
Age C		0.33	−5.25	0.000
Definitional skill		0.11	1.44	0.151
English C		0.67	9.32	0.000
c: Math				
Math Next-Year				
Predictors	R <sup>2</sup> ( $\Delta R^2$ )	Beta	t	p
Step 1	0.04 (0.04) *			
Age C		0.18	−1.99	0.049
Step 2	0.20 (0.16) ***			
Age C		0.28	−3.27	0.001
Definitional skill		0.42	4.83	0.000
Step 3	0.67 (0.47) ***			
Age C		0.16	−2.83	0.006
Definitional skill		0.06	0.99	0.324
Math C		0.77	12.50	0.000
d: Science				
Science Next-Year				
Predictors	R <sup>2</sup> ( $\Delta R^2$ )	Beta	t	p
Step 1	0.07 (0.07) **			
Age C		0.26	−2.85	0.005
Step 2	0.22 (0.15) ***			
Age C		0.35	−4.16	0.000
Definitional skill		0.40	4.75	0.000
Step 3	0.61 (0.39) ***			
Age C		0.22	−3.58	0.001
Definitional skill		0.04	0.66	0.512
Science C		0.72	10.71	0.000

Note. C: current year; P: past year; N: next year. \*\*\* ( $p < 0.001$ ); \*\* ( $p < 0.01$ ); \* ( $p < 0.05$ )

**Table 5.** Hierarchical regression steps: The role of previous-year age, and previous-year school marks on next-year definitional skill.

Predictors	Definitional Skill			
	R <sup>2</sup> ( $\Delta R^2$ )	Beta	T	P
Step 1	0.06 (0.06) **			
Age P		0.24	2.65	0.009
Step 2	0.33 (0.27) **			
Age P		0.36	4.60	0.000
Science P		0.53	6.73	0.000
Step 3	0.33 (0.00)			
Age P		0.34	4.23	0.001
Science P		0.41	2.82	0.006
Italian P		0.13	0.95	0.343
Step 4	0.33 (0.00)			
Age P		0.32	3.50	0.001
Science P		0.39	2.41	0.017
Italian P		0.10	0.60	0.555
English P		0.07	0.50	0.618
Step 5	0.37 (0.04) **			
Age P		0.31	3.45	0.001
Science P		0.57	3.29	0.001
Italian P		0.22	1.30	0.197
English P		0.20	1.23	0.220
Math P		0.43	2.51	0.013

Note. P: previous-year; \*\* ( $p < 0.01$ )

## 9. General Discussion

The general aim of the current study was to investigate the role of definitional skills in determining primary school achievement, from third graders to fifth graders. To this end, we conducted two experiments: first, an exploratory experiment and second, a longitudinal, and more theoretically driven experiment.

Marks from four school subjects, two for each scientific domain, i.e., linguistic (Italian and English) and scientific (Math and Science) were collected, as well as scores in a Definitional task [2,3,8]. These two domains were chosen as they clearly entail the two different definition types, that is, *lexicographic* domain (i.e., verbal language and the related semantic representations necessarily involved in communications of any content: Italian, English) and *scientific* domain (i.e., a more structured abstract format: Math, Science). Both skills are indeed crucial in school achievement.

In Experiment 1 (cross-sectional study) we added support to the existence of a general relation between definitional skills and school marks already shown in primary school children [10]. Such a positive relation was shown across all subjects, both linguistic-based and more scientific-based.

In Experiment 2, we conducted a three-year longitudinal study to explore the direction of the relation between definitional skills and school achievement. Here, the main finding was that good marks in scientific school subjects are strongly predictive of future definitional competence (question 2). Therefore, the direction from school achievement towards definitional skills emerges more clearly and especially referred to scientific subjects, where knowledge is usually more organized, structured, and only secondarily can also be expressed in a conventional linguistic format.

The opposite direction, i.e., how definitional skills are predictive of school achievement (question 1), is not supported from our data. Indeed, here, the school mark looks clearer cut in determining future scholastic achievements. We need to recognize that marks can be biased variables, as they are evaluations that entail many different aspects, either cognitive or metacognitive. In addition, each mark also includes components, such as reading and

writing skills and also personal commitment and motivation. However, we must notice that the mark, albeit hybrid, is an ecologic assessment as it briefly measures learning performance in a context where the child skills are regularly assessed, both qualitatively and quantitatively.

Our findings agree with the literature, showing a strong relation between definitional skills and school success [7,10,11]. The novelty of our study lies in the direction we found that was not taken into account previously; indeed, we found that school success is predictive of good definitional skills, but not the opposite. The finding is quite unexpected, as results from [15] suggest a role of definitional skills in promoting school success. However, it is worth considering the different methodology used (i.e., the codification system used in [15] was simpler than the current one) and the procedure (training versus production, here). Given that findings are not conclusive and results are contrasting (e.g., different age ranges, different methodologies), it is then suitable to develop research on these topic in different directions, as we try to outline below.

Thus, in line with [15] future directions should consider the benefit of proposed at-school trainings and/or specific practices of both production and comprehension of definitions, either *scientific* or *lexicographic* (e.g., [16]). For instance, starting from different formulations of definitions, the teacher could stimulate reflection on which one better allows accessing the conventional meaning of a given word (i.e., definition-to-naming path). Or, in the opposite direction, given a word commonly used in every-day language or in the scientific domains, it would be crucial to stimulate reflection on which kind of information is necessary and essential to ensure correct comprehension by any interlocutor. To conclude, a good definition must always be de-contextualized, and comprehensible from anyone who uses the same linguistic code. Moreover, definitions should be related to other cognitive skills involved in reading and comprehension, such as updating (see [16,17]).

In addition, education-related factors, such as teaching environment, method, or level of difficulty of the curriculum, should be considered. This will enable us to transfer (or not) our conclusions in countries other than ours and with different teaching methods and curricula. Moreover, it would be of interest to analyze the use of definitions in books of different subjects (e.g., scientific subjects vs. linguistic ones). Additionally, it is of high interest to investigate how much teachers use definitions at school, for instance, whether they start from in-text definitions or from concrete examples to illustrate a new concept.

It would be also of interest to consider the relationship between definitional skills and other forms of intelligence (as Gardner's typology suggests), such as socio-relational intelligence, a skill that, by boosting interpersonal relations, enriches meta-representative attitudes of Theory of Mind (i.e., decentralization of the point of view), also involved in definitional skills, that indeed requests to keep track of the informative demands of the interlocutor (see e.g., [2,3]).

Overall, we believe that definitional skills represent a bridge towards school achievement, as they promote good marks in all disciplines (see Experiment 2, question 1). Moreover, definitional skills are predicted from the levels of competence acquired, especially in scientific school subjects that involve and require a higher degree of formal/organized learning. This is in line with our argument about the distinction between natural and scientific concepts that follow different and opposite developmental trends. Whereas development of natural concepts (as well as *lexicographic* definition) moves from concrete to abstract knowledge, development of scientific concepts (as well as *scientific* definitions), moves from abstract to concrete knowledge; in other words, children acquire the concept, and afterwards look for concrete exemplifications. Thus, it is of primary importance to promote interaction–integration via formal schooling linking the two types of concepts (natural, scientific) and definitions (*lexicographic*, *scientific*), and considering that based on their integration, the ability to communicate is shaped.

At school, children not only acquire concepts and scientific knowledge via learning of specific formal definitions but also, they refine general linguistic skills in a metalinguistic way, via the study of the linguistic code, and via reflection on its lexical, semantic, syn-

tactic, and pragmatic components that in turn allow awareness and efficacy of linguistic communication. It is therefore of primary importance in school education to promote interaction–integration between these two developmental patterns also linking the two types of concepts (natural, scientific) and definitions (*lexicographic, scientific*), considering that based on their integration, knowledge and its awareness is shaped, as well as the ability to communicate knowledge.

In conclusion, we believe that the current study contributes specifically to the discussion about the relationship between language and cognition [18], investigating the role of a metalinguistic skill (such as definitional skill) on the acquisition and buildup of different contents of knowledge. In particular, we found a positive and mutual relationship between the ability to verbally make explicit word meanings and school learning/achievement. In turn, this showed how the construction of knowledge requires sharing meanings that can be expressed via complex formal format, whose acquisition is responsible formal schooling, as a fundamental agent of the process; therefore “the shared meaning of the community [ . . . ] gradually enter into individual child’s representations and to a large, but nonetheless limited, extent take over the child mind. Thus, individuality is balanced with sociality” [19] (pp. 352).

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**Informed Consent Statement:** We obtained informed consent by parents to participate in the research and to the possible publication of findings (i.e., privacy form that guarantees anonymity and aggregate treatment of data). The study was conducted in accordance with the Ethical Standards laid down in the 1964 Declaration of Helsinki and the standard ethical procedures recommended by the Italian Association of Psychology.

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