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# Relations between EFL teachers' formal knowledge of grammar and their in-action mental models of children's minds and learning

Orly Haim<sup>a,\*</sup>, Sidney Strauss<sup>b</sup>, Dorit Ravid<sup>b</sup>

<sup>a</sup>English Department, School of Education, Beit-Berl College, Doar Beit-Berl 44905, Israel

<sup>b</sup>School of Education, Tel-Aviv University, Ramat-Aviv, Tel-Aviv 69978, Israel

## Abstract

We studied the relations between English as a foreign language teachers' grammar knowledge and their in-action mental models (MMs) of children's minds and learning. The grammar knowledge we examined was English wh-constructions. A total of 74 teachers completed an assessment task and were classified to have deep, intermediate or shallow knowledge. Ten teachers (five with deep and five with shallow level) were videotaped teaching wh-questions. The data were analysed qualitatively to determine the teachers' MM, and then quantitatively to test similarities/differences in their MM's expression. The findings revealed an identical MM among all teachers that is expressed differently as a function of knowledge level.

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## 1. Introduction

The purpose of the present study was to explore the relations between teachers' subject matter knowledge (SMK) and their in-action mental model (MM) of children's minds and learning. The current study is based on the claim that teachers' MMs (e.g., teachers' understandings of

aspects of the learner) and their SMK are two distinct kinds of knowledge which are not necessarily intertwined, and moreover, the former has priority over the latter. In this study, this claim was put to empirical test.

The teachers who participated in our study were English as a foreign language (EFL) teachers. The subject matter we examined was formal knowledge of grammar which constitutes an aspect of EFL teachers' SMK (Richards, 1998; Spolsky et al., 2002). Specifically, we tested the concept of English wh-constructions (e.g., wh-questions and

\*Corresponding author. Present address: 30/A Hasnunit St., Ra'anana. Tel: +972 9 7476335; fax: +972 9 7476334.

E-mail address: [haimorly@zahav.net.il](mailto:haimorly@zahav.net.il) (O. Haim).

wh-relatives). We now present the theory and empirical findings relevant to the research paradigm of our study. In what follows, we discuss: (1) teachers' MMs, (2) teachers' SMK, (3) wh-constructions, and (4) the relations between teachers' SMK and their MMs.

## 2. Mental models

MMs are powerful cognitive entities that organize how people interpret their world and how they act on it (Johnson-Laird, 1983). We view the construct of MMs which developed from a scientific understanding of how the mind works (Johnson-Laird, 1983; Norman, 1983) as an heuristic device for thinking about teachers' knowledge representation (Strauss, 1993, 1996, 1999). A major purpose of an MM is to enable a user of that model to predict the operation of a target system (Johnson-Laird, 1983; Norman, 1983). Within the realm of teachers' MMs, the target system is children's minds and learning. Following Norman (1983), we describe the following primary functional features of MMs from the perspective of children's minds and learning: (1) people's MMs represent their beliefs concerning children's minds and learning; (2) parameters and states of the MM correspond to the perceived or conceived aspects and states of children's minds and learning; and (3) the MM enables people to make inferences and predict the behaviour of children's minds and how learning takes place in them. In addition, MMs are tacit, hidden and implicit rather than explicit and self-conscious. Teachers' MMs are, therefore, inferred from what is explicit, observable and external, such as teachers' actual instruction (Strauss & Mevorach, 1996).

There is a distinction between kinds of MMs found among teachers: espoused, in-action and on-action MMs. This distinction, made by Argyris and Schon (1974) and Schon (1983), points to differences between what teachers know when they speak about their profession (*espoused*), what they know when they practice it (*in-action*), and what they know when they talk about their actual teaching (*on-action*). Thus far, research on the

relations between MMs and SMK has addressed the espoused and in-action MMs. Empirical work to describe and determine the nature of the on-action MM has begun only recently (Steiner, 2002). In the present study, we examined teachers' in-action MM.

### 2.1. Teachers' in-action mental model

An implicit in-action MM refers to the MM teachers possess about children's minds and learning when they actually teach. The notion of teachers' in-action MMs is based on the fundamental assumption that teachers' instruction is guided by a psychological entity that describes learning. In other words, the external, explicit teaching reveals teachers' implicit MMs. For instance, when a teacher asks the students at the beginning of the lesson, "Do you remember what we did in our previous lesson?" she/he is attempting to help children identify the place in their memory where knowledge about the previous lesson is located. The teacher is presumably interested in the children searching for, locating, and retrieving the relevant knowledge. Thus, the teacher's question is motivated by an implicit, powerful MM which guides classroom instruction.

Work initiated by Mevorach (1994) and then replicated and extended by Strauss and Mevorach (1996), Mevorach and Strauss (1996) described and determined the in-action MM. In the Strauss and Mevorach (1996), the participants were 24 first grade arithmetic teachers: eight pre-service, eight novice, and eight experienced. The researchers videotaped an arithmetic lesson given by each teacher on the process of adding two numbers that yield a third number. All the teachers taught the same lesson in the normal course of teaching arithmetic, using the same curriculum unit.

In order to infer teachers' in-action MM, a two-tier classification scheme was developed, each of which includes four units (see Appendix A). The first tier's four units are comprised of aspects of teachers' explicit teaching behaviours. These units are (1) the teacher's and the pupils' behaviours, e.g., the teacher asks a question. (2) An *episode* is a combination of several behaviours on the part of teacher and pupils, e.g., the teacher asks a

question, a pupil responds, and the teacher makes a remark about the pupil's response. (3) An *event* includes several episodes (e.g., a series of episodes in which the teacher asks–pupil answers–teacher responds) whereby the aim of this event is to present a certain concept. (4) A *lesson* is composed of a number of events, whereby the lesson has a particular purpose, say, introducing the topic of addition.

The second tier's four units were inferred from the teaching and comprised the teachers' MM. The second tier's four units are (1) *Cognitive Goals* the teacher wants his pupils to accomplish (e.g., to connect new material with pre-existing knowledge). (2) *Cognitive Processes* that the teacher thinks lead to the accomplishment of the cognitive goals (e.g., retrieval of previously learned material from memory). (3) *Assumptions* the teacher has regarding the factors that enable the cognitive processes to occur (e.g., reminding the students of the material dealt with in the previous lesson may lead to retrieval of learned material). And (4) the most comprehensive of all assumptions, *Meta-Assumptions*, a teacher has about the processes of learning and teaching (e.g., knowledge is stored in the child's mind). The study showed that the most significant unit in teachers' MM is their meta-assumption concerning children's minds and learning. These underlie the cognitive goals the teachers want to bring about in their pupils, and the assumptions they have about how their instruction, which lead to the implementation of the cognitive processes that, in turn, induce the cognitive goals they set for their pupils.

Indeed, recent studies that investigated the nature of the in-action MM have revealed the same MM among teachers who have taught different grade levels and various subject matter (e.g., Rauner, 2002; Wallenstein, 2002; Zimet, 2002).

### 3. Teachers' subject matter knowledge

Scholars and researchers have studied the concept of subject knowledge and its related aspects from various psychological points of view and with various assumptions since the beginning

of the century (see review in Shulman & Quinlan, 1996). Among the most influential contemporary scholars who addressed the construct of teachers' SMK is Shulman (1986), who argued that an important omission in research on teaching and learning to teach has been the study of teachers' understanding of the subject matter and the role it plays in helping children develop their understanding of the subject matter.

Following Schwab (1962), Shulman emphasized the distinction between *substantive* and *syntactic* structures which according to Schwab comprise the main aspects of a discipline. The former pertain to the ways in which ideas, concepts, and facts of a discipline are organized, and the latter refer to ways of establishing new knowledge and determining the validity of claims within a discipline.

In the present study, we investigated English teachers' substantive knowledge. Teachers' SMK was examined from the point of view of how wh-constructions are represented in their minds. We now turn to discuss English wh-constructions.

### 4. English wh-constructions

Wh-constructions refer to two main structures: wh-questions (e.g., *What do you think? Who do you want to speak to?*) and wh-relative clauses (e.g., *The girl who speaks French is my cousin*). The former constitutes a major subtype of interrogative clauses in English, and the latter refers primarily to a dependent clause that modifies a noun occurring in another clause.

Wh-constructions cover a broad spectrum of English grammatical knowledge, and carry important pragmatic functions in spoken and written discourse (Celce-Murcia & Freeman, 1999). They are considered important in linguistic theory as well as in first and in second/foreign language acquisition research (e.g., Chomsky, 1986; Ellis, 1996; Quintero, 1992; Stromswold, 1995).

The various wh-questions, due to their important communicative function, are generally taught implicitly in primary school and with different degrees of explicitness and complexity in secondary school (IEC, 2001). They are also part of the

matriculation exams. The superficial similarities between the different wh-question types and the wh-relatives as well as the central role they play in English grammar and discourse were the main reasons they were selected to assess EFL teachers' SMK. (For further description of wh-constructions, see Strauss, Ravid, Magen, & Berliner, 1998.) We now turn to discuss the relations between teachers' SMK and their MMs.

### 5. Relations between teachers' SMK and their MMs

While teachers' SMK and their MMs are considered important components in the knowledge base for teaching, the nature of the relations between the two is rather complex and ambiguous.

Teachers' SMK and their MMs, e.g., their knowledge about children's minds and learning, are generally viewed as two interrelated types of knowledge that teachers employ when teaching in the classroom. According to traditional views, the first has precedence over and actually guides the latter. Briefly, the argument underpinning this approach is that teachers' SMK is a crucial aspect of their knowledge that bears directly on their teaching practice, i.e., teaching strategies, including posing questions, assessing children's understanding or, in short, how they make classroom decisions (most notably, Ball & McDiarmid, 1990; Grossman, Wilson, & Shulman, 1989; McDiarmid et al., 1989). Similar views were expressed by Gudmundsdottir (1991), Even (1993), and Stodolosky (1988).

The claims offered by these scholars and their followers relate to the notions that teachers possessing deep SMK are more capable of implementing curricular content and delivering information more effectively than those with insufficient knowledge. Thus, adherents of this approach seem to believe that teachers with deep SMK will teach differently than teachers who have shallow SMK.

We propose a different approach to this conventional view. Here the claims are not intuitive and are not represented in the current literature. We argue that teachers' SMK and their MMs are

two separate entities that are not necessarily intertwined. Hence, teachers with deep SMK and teachers with shallow SMK will teach in the same way since the way they teach reflects their understanding of what learning is. However, the content of teachers' instruction is influenced by their SMK. That is, the kinds of explanations, examples, analogies, demonstrations performed, etc. provided by the teachers are influenced by the depth of their SMK.

The precedence of teachers' MMs over their SMK is argued to be the case for both espoused and in-action MMs. Whether teachers' SMK base is broad or narrow, and whether it is organized in a deep or shallow fashion, they will speak about their instruction basically in similar ways, ways that actually guide their espoused MM. Similarly, the instruction of teachers with varying levels of SMK will be quite the same, as it is driven primarily by their in-action MM (Strauss, 1993, 1996, 1999).

Indeed, recent research supports the argument of the precedence of teachers' MMs over SMK (Strauss, Ravid, Zelcer, & Berliner, 1999; Strauss & Berliner, 1996; Strauss et al., 1998; Strauss & Rosenberg-Meltzer, 1996; Strauss & Shilony, 1994). As noted, the most relevant study here is Strauss et al. (1998) in which the relations between EFL teachers' SMK and their espoused MMs of children's minds and learning were investigated. Their findings were that despite the differing levels of SMK the teachers held the same espoused MM.

#### 5.1. Research questions

The following research questions guided our study:

- (1) In light of the differences in the depth of SMK will there be differences between the two groups of teachers with respect to both the units of analysis and the components of our teachers' in-action MM? In other words, will all units of analysis of the second tier be used by the two groups of teachers?
- (2) Will the two groups of teachers show differences in the expression of the components of the in-action MM?

## 6. Method

### 6.1. Sample

The study included 10 seventh grade English teachers: five with shallow and five with deep grammatical knowledge.

#### 6.1.1. Teachers' selection

A total of 74 teachers currently teaching English in seventh grade Israeli junior high schools were administered the classification task.

Seventh grade was the level chosen for the study for two reasons. First, in the Israeli schools, wh-questions, the grammatical subject matter, which was used to check teachers' depth of SMK, is dealt with more intensively and explicitly at grade 7 and above. Second, the students at this level are developmentally ready for formally learning the topic of wh-questions (Ellis, 1996).

Among the 74 teachers who completed the assessment task, 12 teachers had shallow SMK and seven had deep SMK. The remaining 55 teachers had intermediate SMK. Thus, five teachers assessed as having deep SMK and five assessed as having shallow level were videotaped in the classroom.

#### 6.1.2. Teachers' academic background

The academic degrees of the teachers were as follows: three teachers had an MA degree (one in linguistics and two in TESOL education); six had a BA (in linguistics or in education); one teacher had a Bachelor in Education (B.Ed.); one teacher did not have a university degree.

All teachers were certified teachers with a teaching diploma of teaching EFL. They received their teaching diploma in the following institutions: universities (six teachers), teacher training colleges (four teachers).

#### 6.1.3. Teaching experience, mother tongue, place of work, classroom characteristics, and sex

The teaching experience of teachers ranged from 7 to 31 years. In terms of mother tongue, seven teachers were native speakers of English and three were Israeli born but with native-like proficiency

levels, as they had lived a few years in an English speaking country.

The teachers taught in junior high schools in cities located in the central area of Israel. The teachers taught heterogeneous seventh grade classes. The size of each class was about 30–37 students. Each lesson lasted 45 min. The teachers were all female and their ages ranged between mid-thirties and mid-fifties.

## 7. Procedure

The study had three phases: (1) assessing grammar knowledge organization; (2) videotaping teachers' teaching; and (3) assessing teachers' in-action MM.

### 7.1. Phase 1: assessing grammar knowledge organization

As mentioned, teachers were first administered a classification task to determine whether their knowledge organization was deep or shallow. The instrument was used by Strauss et al. (1998) to assess depth of teachers' grammar knowledge and was found to be valid and highly reliable.

The task involved sentence classification. It consisted of two stages. In the first stage, the teachers were given open-ended classification instructions (e.g., the teachers were asked by the researcher to classify the sentences according to any category they wished). In the second stage, the teachers were asked to classify the sentences according to 'wh' element to make certain that we were assessing teachers' grammatical knowledge of wh-elements.

The task was administered to the teachers in their homes. A few teachers completed the task in the school where they work. The researcher met with all teachers individually in the teachers' lounge or in a private study. It took the teachers between 20 and 30 min to complete both parts of the task.

#### 7.1.1. The wh-constructions assessment task

The classification task that was used as a measure of the depth of the teachers' grammatical

knowledge, is comprised of a series of 12 wh-constructions of two types: wh-questions (e.g., Which students do you like?) and wh-relative clauses (e.g., The books which he recommended were boring.). (Dekeyser, Devriendt, Tops, & Geukens, 1984; Huddleston, 1984). The sentences are presented in Appendix B.

The wh-questions included 12 questions. There are nine questions that are subclassified into six direct questions (e.g., Whose papers does he always steal?) and three indirect questions (They want to know whose book you prefer.). Direct questions are of two types: three subject questions and three object questions. The first replace the subject NP (e.g., Who saw the murder?) and three object questions, replacing the object of the sentence (e.g., Who(m) did he see?). The nine questions contain four wh-question words: who, whose, which, and how many. The three remaining sentences are wh-relative constructions which include the following wh-words: *who* (I didn't like the man who spoke first.), *which* (The books which he recommended were boring.), and *whose* (The man whose sister you married has disappeared.).

Thus, the items of the task though bearing superficial resemblance (e.g., the wh-element) differ grammatically, e.g., sentence structure and syntactic complexity. They may thus serve as a useful tool to assess teachers' depth of grammatical knowledge organization. English teachers teaching at this level are presumed to be highly familiar with the organizational, syntactic, semantic, and pragmatic aspects of these structures.

### 7.1.2. Assessment criteria for levels of grammatical knowledge organization

The task was designed to assess subjects' depth of knowledge organization on the grammar topic of wh-constructions. Teachers were required to classify the 12 sentences according to categories.

The optimal level of classification (presented in Appendix C.1) consisted of two categories (direct wh-questions and wh-non-questions), each of which was further differentiated into two categories. The first refers to two types of questions, e.g., subject and object questions. The latter refers to indirect questions and wh-relatives. Thus, there

were two categories down and four subcategories across.

Criteria for assessment are presented as follows:

*Level 1—Shallow grammatical knowledge organization:* The criteria for shallow grammatical knowledge (examples are presented in Appendix C.2) were that: (1) the teachers were not able to make the first-level classifications and (2) either did not use wh-element as the content for classification or used it incorrectly.

*Level 2—Intermediate grammatical knowledge organization:* The criteria for intermediate grammatical knowledge (examples are presented in Appendix C.3) were a classification with the first categorization (indicating knowledge that the sentences are wh-elements) and either no further classification or an incorrect classification.

*Level 3—Deep grammatical knowledge organization:* The criteria for deep grammatical knowledge (an example is presented in Appendix C.4) were full classification and correct labels for each of the categories.

### 7.2. Phase 2: assessing teachers' in-action mental model

To determine the teachers' in-action MM, the 10 teachers who had either deep (five teachers) or shallow (five teachers) grammatical knowledge were videotaped in the classroom, teaching the topic of wh-questions to seventh grade classes. The teachers were asked to be videotaped in a lesson in which the pedagogic focus was wh-questions. Each lesson included teacher frontal teaching in which the topic of wh-questions was dealt with explicitly (e.g., a presentation of the topic by the teacher, reviewing a homework assignment that focuses on wh-questions, etc.) as well as pair and group work activities.

### 7.3. Phase 3: assessing teachers' in-action mental model—the categorization system

The categorization system developed by Mevorach (1994) was used as our research tool to assess the in-action MM of the two groups of teachers. The 10 videotaped lessons were described and analysed qualitatively in order to determine the

implicit MM the teachers hold. We added the unit one unit, Specific Assumptions, which is actually an extension of the unit Basic Assumptions of the second tier to the original categorization system to accommodate the MM into the context of EFL grammar teaching. The instrument combines the interpretive research approach and quantitative approach. The interpretative–qualitative aspect of the tool provides the data to test the similarities and differences in the MM of the two groups of teachers.

In order to decide if the teachers' MMs were the same or different, we used the following criteria:

If both groups of teachers had the same four units of the MM, we could claim that they have the same in-action MM. However, if the findings revealed that one group of teachers had at least one unit that was different than those of the other group (and also different than the one's found in Mevorach's (1994) and the subsequent Strauss and Mevorach's (1996) models, we could claim that the two groups of teachers had *qualitatively* different MMs.

A second criterion we used to determine if the teachers from the two groups have the same in-action MM or not relates to the quantity of the units, i.e., the existence of an *equal number* of units in the lessons of the two groups of teachers. If we found that the teachers in both groups had the same units of analysis appearing in the original model, but one group of teachers had additional units than the other group, we could claim that the groups were different *quantitatively* in terms of their MMs.

#### 7.4. Validity and reliability

The present study is based on the original Mevorach's (1994) study and subsequent studies by Strauss and Mevorach (1996) and Mevorach and Strauss (1996), all of which were found to have face and content validity and high reliability. In the current study, inter-rater reliability of the category system was checked. This was conducted by two independent raters. Both raters analysed the same lesson using Mevorach's (1994) (extended) category system. The analysis included all

components of the first and second tiers. The inter-rater reliability was found to be 0.73.

## 8. Results

The qualitative analysis of the lessons revealed that there were no differences between the two groups' in-action MM. The criteria for establishing the existence of a common in-action MM among the teachers were met: all teachers from both groups used all four units of the MM. There were no exceptions to this finding. Thus, both groups of teachers, despite their different depth of knowledge organization, have the same in-action MM.

However, the quantitative analyses reveal differences in the expression of the in-action MM held by the two groups of teachers. The statistical analyses were conducted in two main phases: (1) descriptive statistics and (2) inferential statistics.

### 8.1. Phase 1: descriptive statistics

The frequencies of occurrence and the percentages of the first and second tiers' units of analysis and the components of the MM obtained from the qualitative analysis of the 10 videotaped lessons were computed. The frequencies and percentages of occurrence of the components of the MM were computed on two levels: (1) the lessons of each group of teachers: teachers with deep grammatical knowledge organization and teachers with shallow level, and (for the sake of completeness only) (2) each lesson individually. Summaries of the frequencies of occurrence (*f*) and percentages (%) of most prominent components of each unit of analysis of both the first and second tiers used by the teachers with deep grammar knowledge organization and those with shallow level are given in Appendix D.

On the whole, the data suggest that more or less the same components of the MM were used by the 10 teachers, yet they get played out differently in the lessons of the two groups of teachers.

Having observed similarities and differences in the use and expression of the components between the two groups MM, we conducted further

statistical analyses. We now turn to our second phase of statistical analyses.

### 8.2. Phase 2: inferential statistics

We statistically compared the profiles of the MM's units in order to determine whether there are significant differences between the two groups as to the use and expression of the MM. Below is a description of the methods of analysis that were performed:

First, we normalized the data due to differences in lessons' length. For example, we did not want to claim that one group of teachers used a particular component more than the other group without normalizing the data because those data might be due to different lengths of lessons. Normalization was done by dividing the frequencies of the components by the total number of Episodes in each analysed lesson. For example, the frequency of the item "to apply language knowledge" (a component of the unit Cognitive Goals) in a certain lesson was divided by the number of Episodes occurring in that lesson. The purpose of this procedure was to obtain a ratio of the use of each component of the MM in the teacher's instruction.

After the normalization, as we had a relatively small number of subjects, we performed a Mann–Whitney rank-order test for each component across teachers to test whether the two groups of teachers differ significantly from each other, e.g., in their profiles of use of the MM's units. The Z-

scores of each unit were then combined according to Strube (1985). A significance level of the teachers' group differences was computed for each unit ( $\alpha = 0.05$ ). We found differences between the two groups with regard to their use of certain units. Finally, we performed a binomial test to assess the significance of the differences in relation to the MM as a whole. Here, we performed a binomial test in order to compute the significance level across units and determine whether the two groups of teachers have statistically significant different profiles of their MM's use.

The results of the significance tests (sum of Z-test and binomial test) which were computed are found in Table 1, where we see that a statistically significant difference was observed for the following units of analysis: first tier, *Behaviours*; second tier (the MM), *Cognitive Processes*; and *General Assumptions*. The results of the unit of analysis *Cognitive Goals* were borderline significant ( $p = 0.052$ ). The use of the MM as a whole by the two groups of teachers was also found to be significantly different ( $p = 0.0058$ ). Thus, the results indicate that the teachers from the two groups express their common MM differently. The difference between the two groups may indicate the influence of the independent variable of depth of grammatical knowledge on the expression of the MM.

Having found different profiles of the use of the teacher's MM held by the two groups of teachers as a function of their depth of knowledge of grammar knowledge, we now turn to the nature of

Table 1  
Results of the sum of Z-test

Unit	Sum of Z	Sum of internal correlation	Number of components	P
1. Events	3.747	-3.690 <sup>a</sup>	12	0.14
2. Episodes	1.107	-4.213 <sup>a</sup>	13	0.38
3. Behaviours	16.498	27.574	33	0.039 <sup>b</sup>
4. Cognitive goals	4.887	-2.817 <sup>a</sup>	9	0.052 <sup>c</sup>
5. Cognitive Processes	7.517	4.737	9	0.040 <sup>b</sup>
6. General Assumptions	15.496	12.829	22	0.012 <sup>b</sup>
7. Specific Assumptions	1.319	10.66	12	0.41
8. Meta-Assumptions	-0.073	-2.107 <sup>a</sup>	10	0.51

<sup>a</sup>Negative intercorrelations were regarded as zero correlation.

<sup>b</sup>Significance at  $\alpha = 0.05$ .

<sup>c</sup>Borderline significance.

the differences between the two groups of teachers as to the expression of the components of the MM.

8.2.1. Nature of differences between the two groups

In this stage of our analysis, we ran a factor analysis for the entire data set. The method we used was Principal Component Analysis.

The interrelationships between and among the units of analysis and their components were examined in an attempt to find out how many independent factors could be identified in the teachers' MM. The units and the components of the MM which had the highest loadings (above 0.250) with the factors were used to define the factor. After these had been identified, the factors were examined to find out what they had in common, and interpreted as to what feature they represent. (High loadings in both positive and the negative direction were considered. Factors with loadings in negative direction were considered as not like the factor.)

The factor analysis was run twice for the entire data set. The first time, the patterns of intercorrelations among the units of the MM and their components were analysed and isolated. The second time, the variable of teachers' depth of grammatical knowledge organization was added to the analysis. The purpose of conducting two factor analysis tests was to account for patterns of correlations and to allow inferences concerning the nature of the construct represented by each factor in general and also in relation to teachers' depth of grammatical knowledge. More specifically, we ran the second factor analysis in order to examine the correlations of the factors with the independent variable of teachers' depth of knowledge.

The results of the factor analysis tests indicated nine factors that underlie the teachers' instruction in terms of the in-action MM. Among them three were found to be most significant. Factors 1 and 2 related to teachers' level of grammatical knowledge.

In these two factors, the loading of the variable of 'teachers' depth of grammar knowledge organization was the highest (above 0.300). The factor loadings on this variable are given in Table 2.

Although factor 3 is not related to teachers level of grammatical knowledge it was decided to

examine it since it was found to be close in its explanatory power to factor 2 as is shown in Fig. 1.

In Fig. 1, we see the nine factors which emerged from data (e.g., the factors with non-zero positive eigenvalues). The factors are ordered in a steeply graded series with respect to their relative explanatory power of the variance in the data set, i.e., the expression of the MM. The positions of factors 1, 2, and 3 shows that they have the most explanatory power in comparison to the other factors as they have the highest eigenvalue. The position of factor 1 shows that it is the highest in the hierarchy of factors and thus has the most explanatory power (e.g., as it has the highest

Table 2  
Factor matrix showing proportion of loadings of the variable of 'teachers' depth of grammar knowledge organization'

Factor	Loading
1	0.681
2	-0.486
3	0.02
4	0.03
5	0.08
6	-0.384
7	0.187
8	0.255
9	0.21

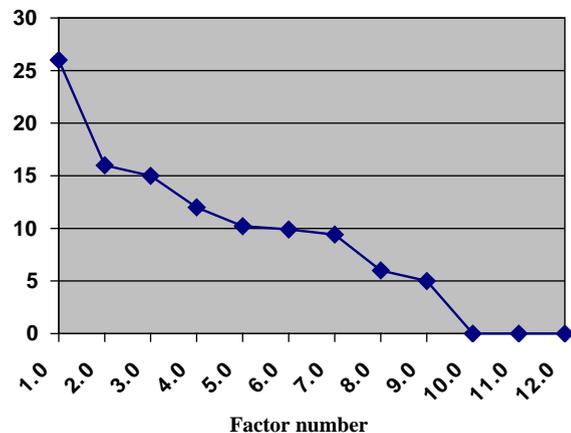


Fig. 1. Relative explanatory power of the factors. Approximate eigenvalue for relevant factors.

approximate eigenvalue). The positions for factors 2 and 3 treat them more or less as equals in terms of their importance in the hierarchy of factors from these data. Factors 1, 2, and 3 are, therefore, factors of higher importance in the hierarchy of factors and of much greater general interest. Factors 4, 5, 6, 7, 8, and 9 are lower level minor factors of limited importance in the hierarchy of factors.

On the basis of the results obtained from factor analyses the factors were interpreted to mean the following in terms of the teachers' instruction.

The results of the factor analyses revealed patterns of variation in the expression of the MM with evidence for the existence of three major factors which were interpreted as three types of teaching orientations that characterize the instruction of the teachers in our study:

- (1) *In-depth analytic approach: inquiry oriented grammar teaching.* This orientation characterizes teaching of teachers with *deep* grammar knowledge organization.
- (2) *Limited-analytic approach: goal oriented grammar teaching.* This orientation characterizes the teaching of teachers with *shallow* knowledge.
- (3) *Holistic learner-cantered approach: language use oriented towards grammar teaching.* This orientation characterizes the teaching of teachers with deep and/or shallow level. As a reminder, this factor was not related to teacher grammar knowledge organization.

As consequence of the above, we believe we have an answer to the second research question of our study, namely, that the two groups of teachers exhibit differences in their expression of the MM according to their level of grammatical knowledge. The factors identified suggest that the variable of teachers' depth of grammatical knowledge is related to teachers' orientation to teaching.

## 9. Discussion

The results of the qualitative analysis of the data show that teachers with deep and shallow gram-

mar knowledge organization had the *same* in-action MM about children's minds and learning. All teachers participating in the study irrespective of their level of grammar knowledge used the *same* units of analysis (both in quality and in quantity) of the first, as well as the second, tier of the in-action MM.

These data support the view that teachers' MMs and SMK are two separate and independent entities. Moreover, teachers MMs have precedence over their SMK.

The data are in general accord with previous studies in the area of teachers' MMs.

We now turn to discuss similarities and/or differences in the expression of the identical MM held by the two groups of teachers.

### 9.1. Similarities and/or differences in the expression of the in-action MM

According to the results, *there are differences in the expression* of the two groups of teachers' MM. The differences in the expression of the MM are a function of their grammar knowledge organization. This finding is the study's main contribution. As already noted, previous studies revealed the existence of a powerful general MM that is common to various teachers belonging to different populations. The first part of our research replicated these findings. But we took those studies one step further by attempting to determine whether or not teachers can be similar and/or different with respect to the expression of their common MM.

As a reminder, the statistical comparisons revealed two distinct profiles of the two groups' expression of the in-action MM. We found that the two groups of teachers differed substantially with respect to the expression of the MM as a function of their grammar knowledge organization. The results of the factor analyses identified three underlying dimensions that were interpreted to represent three teaching orientations. A summary of the main characteristics of the three teaching orientations is presented in Appendix E.

Two distinct differing teaching orientations have been identified which reflect the differences in level of the teachers' knowledge. The teaching

orientation that characterizes teachers with deep grammar knowledge organization emphasizes conceptual understanding, higher-order thinking and elaboration of the content of instruction. The teacher shows a tendency to exploit a wide range of the MM components (e.g., different types of questions, analogies, examples, etc.) to enable the pupils to conceptually understand aspects of the target grammar forms. The learner is perceived as an active participant in the teaching–learning process.

In contrast, the orientation of the teachers with shallow grammatical knowledge places more emphasis on rehearsing and practicing grammar forms through careful monitoring with relatively limited, superficial analyses of language forms. The teacher makes use of fewer components of the MM. The main instructional goal seems to be to transmit knowledge to the pupils in a direct and uncomplicated way. Knowledge seems to be viewed as transferable, hence the tendency to impart information directly to students, and to seek generalizations. The learner is perceived primarily as a receiver of information.

These differences are manifest particularly within the dimension of teacher-centered type of instruction. The dimension of the learner-centered type of instruction in which the focus was holistic language teaching (e.g., more implicit grammar instruction) characterizes the instruction of the teachers irrespective of the grammar knowledge organization. (The relationship between the three instructional orientations identified in the present study and teachers' grammar knowledge organization is illustrated in Appendix F.)

These findings are significant for two areas. The first area concerns MMs. The finding relating to differences and similarities in the expression of the teachers' MM is an important outcome of the study in that they may contribute to our understanding of the variability in the frequency of occurrence of the components of the in-action MM found in previous studies investigating differences and similarities between the MM of different teacher populations (e.g., Mevorach, 1994; Mevorach & Strauss, 1996).

Second, from the perspective of theory and research concerning the relations between tea-

chers' SMK their MMs, our findings stand in contrast to the contemporary views that postulate that the former has precedence over the latter. On the surface, it could be argued that some of the differences between the two groups' expression of the MM found in the present study are similar to the claims made by traditional views, e.g., that teachers' SMK influences their capacity to ask questions, their ability to give explanations, make analogies, etc.

However, despite the apparent similarities, we argue that the results of the present study are essentially and substantially different. In fact, what distinguishes the results of this study from expectations from the traditional view is two-fold. First, while the conventional view and related studies show that SMK has priority over teachers' MMs (e.g., teachers' knowledge how to apply subject matter), the findings of the present study demonstrate that teachers' MMs have a greater influence than their SMK on their classroom teaching. Our study has shown that despite the differences in the level of knowledge, all teachers—with no exception—had the same in-action MM in the 10 lessons we analysed.

Second, while most other studies concentrated on the differences between the instruction of teachers with different levels of subject matter, the findings of the present study indicated an instructional dimension in which teachers' expression of MM was different as a function of different level of grammatical knowledge and an instructional dimension in which the expression of the MM was similar despite the differences in level of knowledge. In other words, unlike other studies, the findings of the current study revealed that the organization of teachers' grammar knowledge had an impact on the expression of their MM not in every instructional context, but within the a certain instructional context, namely the teacher-centered analytic mode.

Thus, the findings of the current study challenge the traditional view relating to the role of SMK in teachers' instruction and support the claim that the manner in which teachers teach is guided by their MM. However, the content of their instructional practices.

## 10. Implications for teacher education

This study suggests a number of implications for the area of teacher education and continuing professional development. They relate to: (1) training teachers to develop ‘meta-instructional’ awareness of their in-action MM of children’s minds and learning; (2) the kind and amount of subject matter teachers need to know; and (3) acquiring knowledge relating to developmental aspects of teachers’ subject matter.

### 10.1. *Training teachers to develop ‘meta-instructional’ awareness of their in-action MM of children’s minds and learning*

As mentioned, teachers’ MMs are implicit (Strauss, 1993, 1996). Teachers are not aware of the existence of their MMs and the influence they exert on their classroom teaching. Implicit aspects of teachers’ instruction cannot be studied until they are first made explicit. Teachers are unaware of the existence of their MMs about children’s minds and learning and do not use this kind of knowledge in classrooms not because teachers are unwilling to use it, but because they have not been given the opportunity to study their MM and relate it to their own knowledge, personality, experience, methodological approaches, and teaching contexts. Therefore, in the area of pre-service and in-service education recognition of the existence of teachers’ MMs and their influence on the classroom practice and learning to teach is recommended.

Courses aimed at assisting student teachers and teachers developing ‘meta-instructional’ awareness of their MMs in teacher education programmes could be helpful. By understanding their own MMs student teachers, as well as practicing teachers, may in a better position to improve the quality of their professional actions. In acquiring ‘meta-instructional’ awareness teachers not only become aware of their MMs and how their MMs affect their classroom teaching, but they also gain control over their MM, so that they can use their MM in such a way as to distinguish between appropriate and inappropriate opportunities for applying aspects of the model, and can adapt the model to the needs and abilities of their learners.

In order to help teachers acquire a deep personalized understanding of their MM it is recommended to consider an experiential approach that incorporates methods of inquiry, e.g., using stimulated recall, microteaching followed by reflection and analysis, analysis of audio and videotaped lessons, classroom observations, journals, diaries, lesson reports, and action research. It should be noted that in pre-service education, student teachers could first be introduced to their own existing internal MMs about children’s minds and learning prior to theories of learning of psychologists, such as the Piaget or Vygotsky.

### 10.2. *The kind and amount of subject matter teachers need to know*

One point that emerges from this study is that although teachers’ SMK is subordinate to their MMs, it has a pervasive influence on aspects of their instruction. As such, SMK constitutes a central requirement of teaching and learning to teach.

Pre-service education programmes could be designed in such a way as to help student teachers acquire deep well-organized knowledge of various aspects and domains of their subject matter, as well as how it informs classroom practice. It must be stressed that in addition to studying various aspects of subject matter, student teachers should be made aware of the instructional dimensions in which these aspects manifest themselves. In other words, teacher preparation programmes should have to emphasize both: (1) an in-depth study of subject matter and (2) its potential use in various classroom contexts.

As for teachers, one of the teacher’s most important tasks must be to continuously explore aspects relating to their knowledge of subject matter. In doing so, they promote their own professional growth, as well as contribute to the development of their students.

### 10.3. *Acquiring knowledge relating to developmental aspects of teachers’ subject matter*

As important as their knowledge about subject matter is teachers’ knowledge about its developmental aspects (Strauss et al., 1998). Teacher

education programmes need to ensure that knowledge of subject matter is combined with an understanding of the child's mind (e.g., the child's capacity to learn and absorb). During the process of learning, the learner progresses from one level to the next. For instance, as discussed in our literature review, in the area foreign language teaching, it has been found that formal instruction is effective, regarding the teaching of certain language forms, only if the learner is developmentally ready to acquire them (Ellis, 1996). In order to facilitate the progression, the teacher should take into account these developmental knowledge acquisition processes.

There is a great body of literature in educational psychology related to developmental stages involved in knowledge acquisition in general as well as a growing body of research specifically concerned with developmental aspects pertaining to second/foreign language acquisition in which the teacher can draw upon when teaching the subject matter. This information may be useful for the teachers in making classroom decisions, such as setting instructional goals, choice of classroom tasks and materials, the manner in which they give explanations, examples, corrective feedback, etc.

In sum, we hold that if teachers were made aware of their own MMs of children's minds and learning and were they to acquire deep well-organized SMK that also combines knowledge about its developmental aspects, the process of subject matter teaching would become more effective. Moreover, it would be helpful were they to develop the ability to manage and regulate consciously the use or expression of their MM in such a way as to tailor their instruction to the needs and abilities of their pupils. Thus, a dual pedagogy is recommended here. The first, relates to awareness of the teacher's MM and the second refers to its actual implementation in relation to the needs and abilities of the language learner.

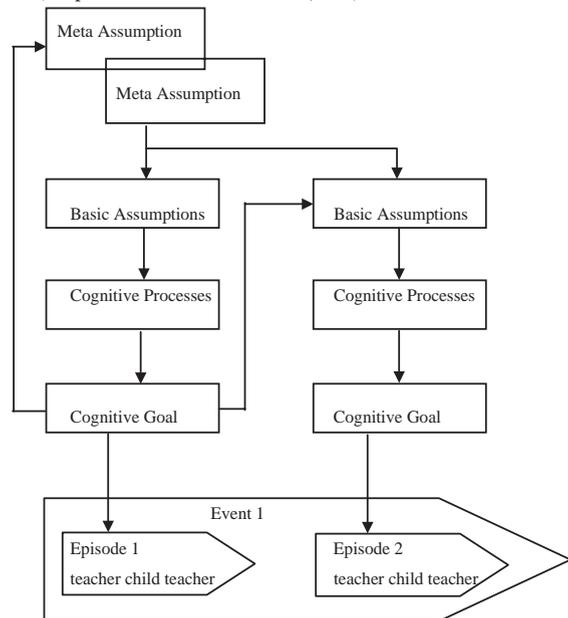
## 11. Conclusions

The current study reveals the precedence of teachers' in-action MMs about children's and learning over their SMK. It sheds light about the

nature of the relations between these two kinds of teachers' knowledge. This line of research has the potential to help us better understand the complex nature of classroom teaching.

## Appendix A. Teachers' in-action MM of children's minds and learning (adapted from Strauss & Mevorach, 1996)

**Teachers' In-Action Mental Model of Children's Minds and Learning**  
(Adapted from Strauss & Mevorach, 1996)

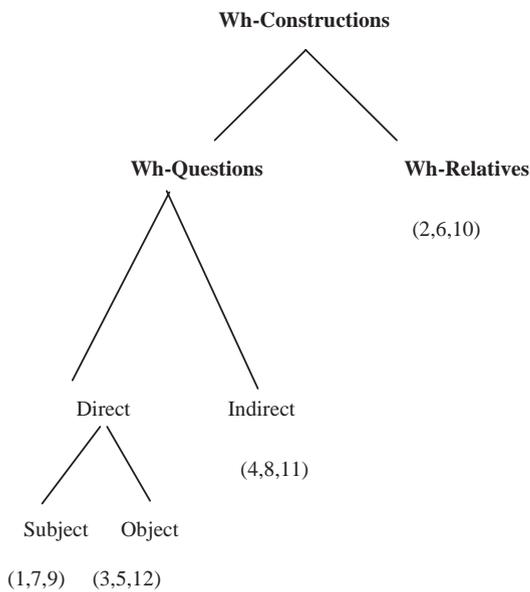


## Appendix B. Sentences given for classification task (Strauss et al., 1998)

- 1 Who(m) did he see?
- 2 I didn't like the man who spoke first.
- 3 Who saw the murder?
- 4 She told me which students she liked in that class.
- 5 Whose students drink coffee every morning?
- 6 The books which he recommended were boring.
- 7 Whose papers does he always steal?
- 8 He always mentions how many stories he writes every year.

- 9 Which students do you like?
  - 10 The man whose sister you married has disappeared.
  - 11 They want to know whose books you prefer.
  - 12 Which books belong to you?
- 

(1) Optimal Classification of 12 Wh-Construction Sentences



**Appendix C**

*C.1. Optimal classification of 12 wh-construction sentences*

*C.2. Examples of shallow grammar knowledge organization of wh-constructions*

*Wh-word*

Who	Which	How Many	Whose
(5, 7, 10, 11)	(8)	(4, 6, 9, 10)	(1, 3)

*Sentence content*

Law/crime	Books/stories	Students	Dis/liking people
(2, 4, 9)	(5, 9)	(6, 8, 11, 12)	(1, 3, 7, 10)

*Tenses*

Past simple	Present simple
(8)	(1, 2, 3, 4, 6, 10)

*Positive or negative sentences*

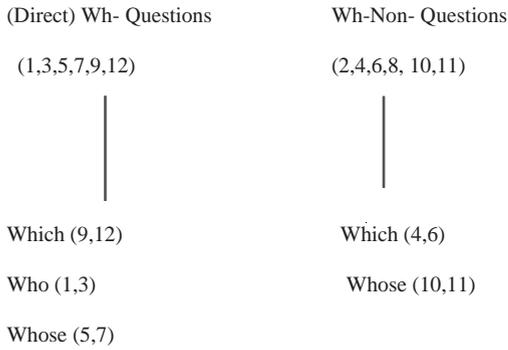
Positive	Negative
(2, 6, 8, 10)	(4, 11)

*Incomplete and non-inclusive*

Wh-questions	Wh-sentences
(1, 3, 4, 5, 7)	(2, 6, 8, 9, 10, 11, 12)

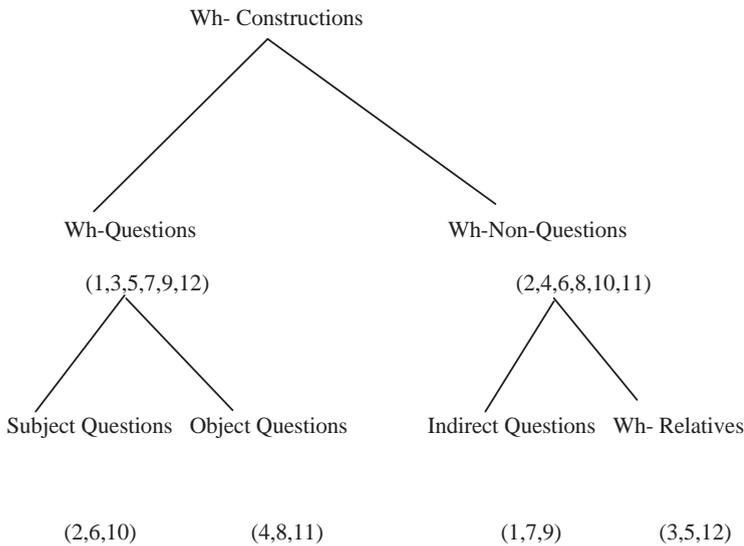
C.3. Examples of intermediate level grammar knowledge organization of wh-constructions

(3) Examples of Intermediate Level Grammar Knowledge Organization of Wh-Constructions



C.3. Teachers' deepest organization of wh-construction sentences

(4) Teachers' Deepest Organization of Wh-Construction Sentences



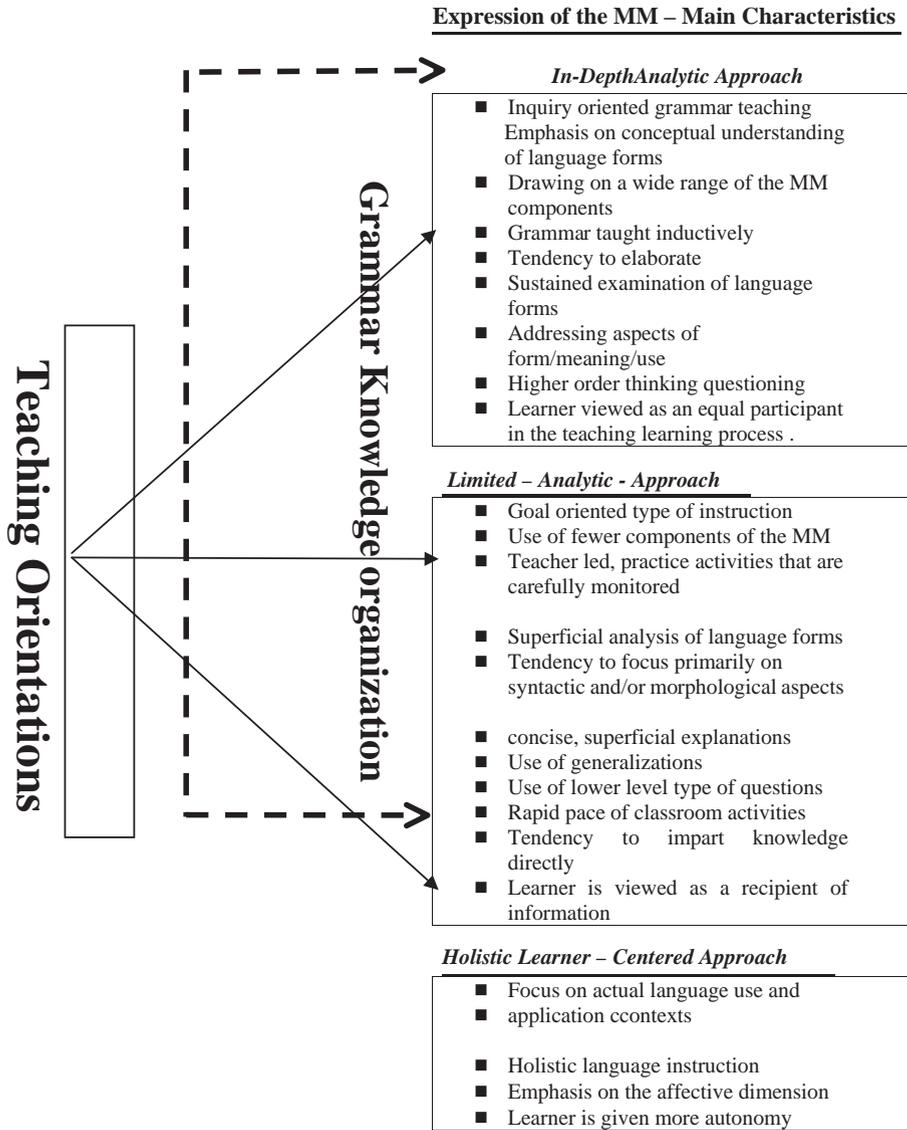
## Appendix D

### *D.1. Summary of distribution of frequencies and percentages of the most prominent components of the MM used by the teachers with deep grammar knowledge organization*

Units of analysis and components of the MM	Frequency	Percentage		
<i>First tier behaviours</i>				
1. Motor action	446	17.0		
2. Verbal feedback	254	9.7		
3. Question about the content of the lesson	223	8.5		
4. Explanation, comment, summary	191	7.3		
5. Teacher interacts with one or two pupils	191	7.3		
<i>Episodes</i>				
1. Application of language knowledge	185	32.3		
2. Leading	105	18.4		
3. Clarification	94	16.4		
<i>Events</i>				
1. Recall	4	16.0		
2. Control	4	16.0		
3. Performance	4	16.0		
<i>Second tier—the mental model Cognitive Goals</i>				
1. To arrange and connect a certain language concept	223	41.1		
2. To apply language knowledge	214	39.4		
<i>Cognitive Processes</i>				
1. To apply	513	24.6		
2. To identify	467	22.4		
3. To connect	354	17.0		
4. To preserve	335	16.1		
<i>General Assumptions</i>				
1. Specific instruction, asking a question, clarification requests, guidance,	518	26.3	confirmation checks, etc. enables application of pupil's knowledge	278 14.1
			2. Visual and auditory presentation enables identification/preservation of language knowledge	263 13.4
			3. Feedback maintains application of knowledge and enables preservation of material	
			4. Use of examples, demonstrations, repetition, analysis, isolating parts of sentences, etc. enables identification/application of the relevant language knowledge	200 10.2
<i>Specific assumptions</i>				
			1. Using meta-language (e.g., grammatical terminology/concept/category) to connect/apply specific language knowledge	228 46.0
<i>Meta-Assumptions</i>				
			1. Existing knowledge can be activated/applied	7 29.2
			2. Introducing/presenting/practicing a certain grammatical concept in a different way) leads to generalization	5 20.8
			3. Rehearsal activates existing language knowledge and contributes to its preservation	4 16.7



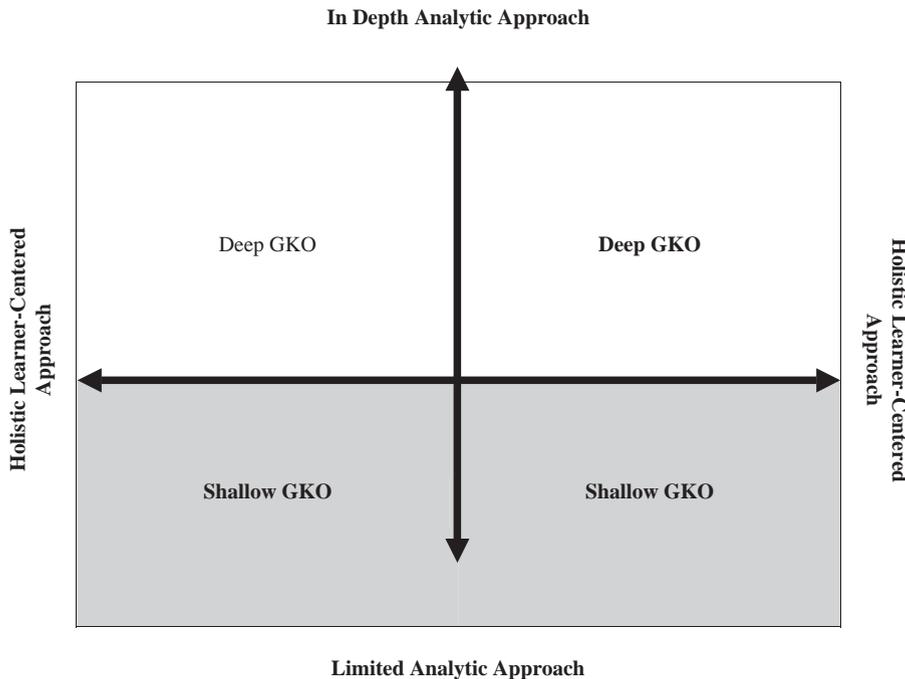
**Appendix E. Expression of the MM—main characteristics**



## Appendix F. The relationship between the three teaching orientations and teachers' grammatical knowledge

### The Relationship between the Three Teaching Orientations and Teachers'

#### Grammatical Knowledge



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