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METACOGNITIVE MONITORING ACCURACY AND ACADEMIC PERFORMANCE AT UNIVERSITY STUDENTS

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Abstract

Metacognitive monitoring is a complex psychological construct materialized in the metacognitive judgments that a subject may perform before or after covering a cognitive task. The accuracy, biases and variability of the judgments on the correctness of answers reflects the quality of the metacognitive monitoring. This study highlights the relation between the accuracy of metacognitive monitoring at the local and global level, as well as the academic performance of students who attend the pedagogical study programme. The results highlight the relevance of an explicit and sustained metacognitive training of students.

Key words*:* accuracy bias, confidence judgments, monitoring accuracy

Theoretical background

The students' learning regulation represents a significant issue of the learning psychology research. Metacognitive monitoring of ongoing cognitive processing (learning, problem solving) is a key component of learning regulation. As a metacognitive process, monitoring is more or less reliable, closer to or further from the actual performance, therefore monitoring is accurate to various degrees. Monitoring refers to one's awareness of comprehension or/and task performance in the process of performing a specific cognitive task (Nietfeld, Cao, Osborne, 2005).

Metacognitive accuracy was operationalized in different ways: confidence judgments, ease of learning judgments, judgments of learning, feeling of knowing (FoK) judgments (Schraw, Wise, Rose, 2000). These various definitions were used to measure accuracy in local and/or global

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monitoring of cognitive tasks, for each item of a test and for the whole test, respectively (Schraw, 1994). The regulation of cognition is the supervising of one's cognitive processes and the use of regulatory strategies when necessary. Without monitoring accuracy, efficient control of one's performance may be impossible (Nietfeld, Cao & Osborne, 2005).

For this reason, it becomes important to determine the factors correlated with metacognitive accuracy, namely those factors that may have an impact upon it, especially for the educational implications of this concept. Therefore, the purpose of the present study is to examine how local and global monitoring accuracy is related to performance in a test situation for students attending the teacher's training module.

In order to measure metacognitive accuracy, we have decided to operationalize it in the form of confidence judgments that imply estimating the correctness degree of a given or expected answer to an item from a test that implies cognitive tasks. The confidence judgments are compared with the test performance in order to determine their calibration, namely the match between the estimated performance and the recorded performance. Accurate calibration is not common at adults (Pressley, Yokoi, Van Meter, Van Etten, Freebern, 1997), whereas overconfidence and underconfidence are associated with poor academic performances (Hacker et. al, 2000) and regarded as *judgment bias*. The more the *confidence judgements* overlap with the score obtained for the items and test as a whole, the better the calibration and the greater the accuracy of the metacognitive monitoring. Accurate calibration seems to be specific to any expert in any domain (Glenberg, Epstein, 1987).

Calibration differs according to the moment of achieving the cognitive task. The authors concerned with this aspect distinguish between the calibration of comprehension and the calibration of performance. The calibration of comprehension refers to an anticipatory estimation of the ability to solve the following item, whereas the calibration of performance refers to an estimation of the solution subsequent to the cognitive approach to the item (Glenberg & Epstein, 1987).

The calibration of performance may be done either locally or globally. The local calibration derives from the confidence judgments regarding the solution of each item. Thus, the local (item-by-item) monitoring results from grouping the accuracy scores for the answer to each item. In a test, we may also have a global calibration of judgments resulting from one single global judgment on the accuracy of solving the test as a whole. (Schraw, 1994, Hacker et. al, 2000).

Procedure

Our study approaches the calibration of performance at the local level, item by item, as well as at the global level, at the end of a knowledge test applied to students. The accuracy of monitoring the solving of the test items was operationalized in the form of confidence judgments on a scale from 0 to 100, with intervals marked 10 by 10.

We start by assuming the existence of some connections between the performance in the knowledge test and the accuracy of monitoring, both at the local and global level. We also assume that the accuracy biases will mainly occur as *overconfidence*, in the absence of a systematic self-evaluation exercise at the participants to the study.

We chose to conduct the present research in the context of usual teaching activities during lectures; because the ecological validity of the results is important, testing in natural circumstances is more relevant for the subsequent use of the results in an educational context, compared to laboratory testing. We have collected the data by applying a docimological/ knowledge test of school pedagogy to 2^{nd}-year students from a socio-human faculty, also attending the pedagogical study programme, at a big university from Romania. The test comprised 14 open-ended and multiple-choice items (each multiple-choice item having 4 answering alternatives). After solving each item, as well as at the end of the test, the subjects indicated, on a scale from 1 to 100, the degree of correctness of their solution to the item, respectively the test as whole. We have determined the accuracy of metacognitive monitoring in the form of three indices: (1) the index of local accuracy or calibration (for the 14 test items); (2) the index of global accuracy (for the whole test); (3) the accuracy bias index. (1) The local accuracy index is calculated as an absolute value of the difference between the sum of the confidence judgments and the sum of the performance in the test items, divided to the total number of the test items. The low values (close to 0) indicate a high local accuracy monitoring and a good calibration. The values may range between -1 and 1, where 0 represents perfect accuracy, whereas -1 and 1 the total absence of accuracy. The further from 0 the value of the local accuracy index, the more biased the accuracy (Nietfeld, Cao & Osborne, 2005).

(2) The global metacognitive accuracy index is calculated as the relation between the total test score and the global confidence judgment (for the test as a whole, at the end of it). Here, unlike the global accuracy index that we have related to the value 0, the reference value is 1. The global accuracy index nearing or equalling 1 indicates the fact that the global confidence judgment (the estimated score) overlaps the score obtained for the test. The low values between 0 and 1 indicate a lower overlapping, whereas those nearing 1 indicate a higher overlapping.

(3) Another indicator relevant to our research was the bias index, highlighted in our research only for the score of local accuracy. The bias index reflects the confidence judgment deviation from the reference value 0 and is determined in relation to the positive or negative direction of this difference. The positive scores indicate *overconfidence*, whereas the negative ones indicate *underconfidence*. (Schraw, Roedel, 1994).

In order to establish the relations existing between metacognitive accuracy and performance, we resorted to calculating the correlations between the variables involved in the research. Thus, we have calculated the correlations between the test score and the local accuracy (for all the test items) as well as the global accuracy (for the test taken as a whole). The results are shown in Table 1.

Table 1. *The results referring to the correlations between the variables involved in the research*

		Test total score	Local accuracy for the test items	Global accuracy for the whole test
Test total score	Pearson Correlation	1	-.491**	.732**
	Sig. (2-tailed)		.002	.000
	N	46	36	43
Local accuracy for the test items	Pearson Correlation	-.491**	1	-.864**
	Sig. (2-tailed)	.002		.000
	N	36	36	35
Global accuracy for the whole test	Pearson Correlation	.732**	-.864**	1
	Sig. (2-tailed)	.000	.000	
	N	43	35	43

**. Correlation is significant at the 0.01 level (2-tailed).

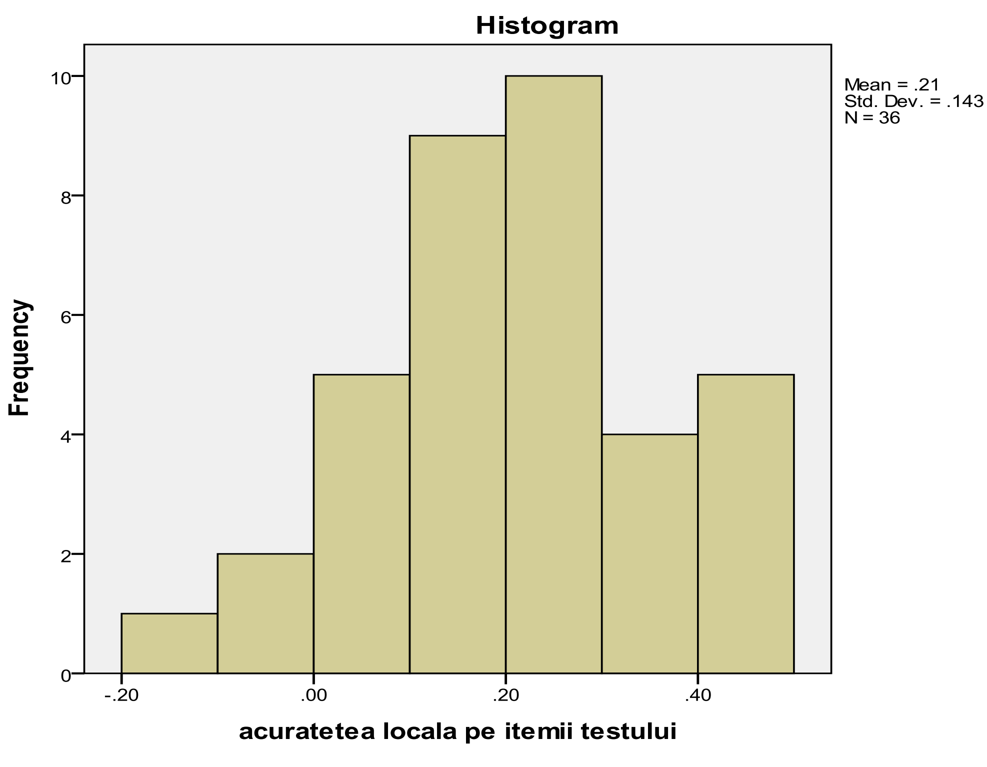
Table 1. The correlations between local accuracy, global accuracy and the test score

We observe, first and foremost, a relevant negative correlation between the test performance and the local accuracy, $r(36) = -.491$ $p<.005$. This means that the test performance and the metacognitive accuracy score for all the test items are inversely proportional: high test performance is correlated with high accuracy, namely with accuracy indices close to 0. As noted above, the close to 0 the partial metacognitive accuracy index, the better the accuracy (0 indicates perfect accuracy, meaning perfect overlapping of the confidence judgment and the achieved performance). Whereas accuracy scores that move away from 0 are correlated with poor test performances. This result is consistent with the theory on the relation between metacognitive accuracy and performance (Nietfeld, Cao & Osborne, 2005).

Secondly, there may be observed a strong positive correlation between the global accuracy (for the whole test) and the test score, r (43)=.732, p<.001. This means that the test performance and the global metacognitive accuracy score (for the test as a whole) are directly proportional: high test performances are correlated with high values of global accuracy. As noted above, the index of global metacognitive accuracy varies between 0 and 1, the indices nearing 1 reflecting a high global accuracy. This result is consistent with the theory on metacognitive accuracy (Nietfeld, Cao & Osborne, 2005). Moreover, comparing the two values of the Pearson correlation indices, we may observe the fact that the global confidence judgment is more accurate than the local one (Schraw, 1984).

The third indicator we have taken into consideration is the bias index, namely the direction in which the metacognitive accuracy varies, as overconfidence or underconfidence in relation to the performance in the test items. If the local accuracy index has the sign, this indicates underconfidence, whereas if the value is positive, this indicates overconfidence.

The graphical representation of this relation may be traced in the histogram below.



Graph 1. *The representation of metacognitive accuracy biasing in the form of underconfidence and overconfidence in relation to the test items*

As Histogram 1 shows, given the value .00 as indication for perfect accuracy, most of the subjects are inclined to overestimate their answers; this result is consistent with other research on accuracy bias, for example Scraw's and Roedel's study (1994) according to which low metacognitive accuracy occurs in the form of *overconfidence*.

Discussions

The results of this study are consistent with the results of other studies on metacognitive accuracy and its parameters, in relation to performances in knowledge tests.

A first general conclusion is the fact that metacognitive accuracy is correlated with test performance; therefore, students with high performance levels obtain high scores for metacognitive accuracy, whereas those with poor performance have low levels of metacognitive accuracy (Hacker et. al, 2000).

The second relevant conclusion of our study derives from the analysis of the two forms of accuracy, local and global, and highlights a higher correlation between the test results and global accuracy, by comparison with local accuracy. Global accuracy is reflected by the degree of overlapping of the confidence judgment and the level of solving the items from the test viewed as a whole. Local accuracy reflects the overlapping between the synthetic confidence judgment obtained for each of the 14 test items and the test score. The students participating in the study perform more accurate performance judgments when viewing the test as a whole, compared to when issuing these judgments in relation to each item viewed separately (Nietfeld, Cao & Osborne, 2005).

The third major conclusion of our study refers to the variation direction of metacognitive accuracy. The predominantly positive values of inaccuracy indicate *overconfidence*, namely that the respective participants in the study tend to overestimate their performances (Schraw, Roedel, 1994).

Study limitations

One limit of the study is the relatively small group of subjects that does not enable a relevant generalization of results. Another limitation consists in not taking into account certain parameters such as the type of the knowledge test items (open-ended items and multiple-choice items) or the items' level of difficulty. Future research may complete and correct these drawbacks.

Study implications

Accurate metacognitive confidence judgments characterize students with good performances; on the other hand, *overconfidence,* displayed by the majority of the investigated subjects, reveals the need for improving the students' confidence judgments with the aim of a better calibration, a more accurate self-evaluation, with possible implications in improving academic performances. The explicit, sustained training of confidence judgments issued prior to or following a task performance, the solving of a problem or of items in a test may ameliorate the *regulation of learning* and, especially, the students' metacognitive accuracy (Nietfeld, Cao & Osborne, 2005).

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