ISSN: 2038-7296
POLIS Working Papers
[Online]

Istituto di Politiche Pubbliche e Scelte Collettive – POLIS
Institute of Public Policy and Public Choice – POLIS

POLIS Working Papers n. 215

October 2014

Are better students realle less overconfident? A preliminary test of different measures

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UNIVERSITA' DEL PIEMONTE ORIENTALE "*Amedeo Avogadro*" ALESSANDRIA

Periodico mensile on-line "POLIS Working Papers" - Iscrizione n.591 del 12/05/2006 - Tribunale di Alessandria

Are better students really less overconfident? – A preliminary test of different measures

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Abstract

In this work we use data from two sets of midterm exams and question-by-question evaluations of confidence levels and construct different indicators in order to study predictive ability and overconfidence. Our results show that (1) there is a significant evidence of a good ability of self-evaluation on the side of the best students; (2) worse metacognition does not seem to explain overconfidence. This suggests that different methods of investigating overconfidence might lead to results which are at least partially different from the ones discussed in the existing literature

JEL codes: A22

Keywords: overconfidence; metacognition; predictive ability; performance

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1 Introduction

The idea that overconfidence is a common problem among students – particularly the less able – is widely spread among those who work on educational economics and is supported by a series of articles. In Grimes (2002) the mark forecasts of the most able students are more pessimistic (underconfident) and anyway nearer – in absolute value – to the effective value with respect to the forecasts of the less able students, who tend to overestimate their performance. Similar results are found for students in Economics by Grimes et al (2004), Nowell and Aston (2007) and for psychology students by Ochse (2001), as well as by the cognitive psychologist Chew (2011) in the data shown in his video guide for teaching[1] and in different contributions to the mailing list on educational economics[2]. In a previous study Novarese (2009) finds a correlation between ability and overconfidence also among the students of the course in Economics of the Law Faculty in the University of Piemonte Orientale.

The literature on overconfidence in general is vast, following the article by Russo and Schoemaker (1992). A key point of this literature already proposed by Russo and Schoemaker themselves underlines the connection between the possibility of having a feedback and potential overconfidence. Those who receive clear and continuous feedback should be more able to evaluate themselves. Students have by definition a continuous feedback and in this perspective it seems weird that they cannot adapt to the situation. Chew (2012) states that "students who have the poorest metacognition have no clue how weak the understanding of a concept is" (slide 20). If on one side this sounds reasonable, on the other it suggests that less able students do not know they are so and this seems a less credible statement: many students know they do not understand, have lower aspiration levels (Castellani et al 2010), they do not feel much like studying and so on.

Grimes (2002), Ambrose et al (2010) and many participants to the above mentioned discussion on the mailing list on educational economics connect overconfidence to meta-cognitive abilities. The best students are better able to think about what they know; this makes them more aware of their own knowledge and therefore more able to evaluate themselves. However, this mainly explains the higher predictive ability of the better students, but not necessarily overconfidence.

Willingham (2009) proposes a model on students' ability based on cognitive science. Knowledge depends on integrated units of knowledge (*chunks* in Herbert's Simon 1983 language) or, more simply, in a series of building blocks, without whom short time memory has to record and organize too much information (for instance, one thing is to remember a series of letters, another a meaningful word). Skills are built step by step, pulling together different information in order to create *supersign*s, or Scitovky's (1976) so called *redundancy* (already known, understood information, which has become granted and therefore more easily processed directly by memory). For example, when a child who is learning to read must understand a sentence, the short time memory effort is enormous: he must recognize letters, keep them in mind to compose words, keep these in mind and so on, while an adult reads the words directly (Illingham, 2009). A student who hardly reads English will strive enormously to study for instance philosophy in English – his mind has to organize too much information simultaneously (understand words, sentences and then interpret them); if the text were written in Chinese a little expert in the language would have to interpreter the single letters also, with more effort.

[1] http://www.youtube.com/playlist?list=PL85708E6EA236E3DB there is a set of videos on how to study
[2] http://khufu.openlib.org/~tchecndg/archive/2007/1495.html

The difficulties he meets are evident: they cause effort and limit the interest in the subject; according to this representation, one who does not know clearly realizes that he does not understand and makes effort. The difficulty in understanding causes less interest and also uncertainty and this hardly goes with overconfidence.

The above considerations do not intend to undervalue the role of metacognition, whose role in relation to overconfidence should, however, be rethought and redefined.

Some contributions to the above mentioned list of educational economics raise the suspect that the inverse relation between mark and overconfidence may be the result of some artifice. Overconfidence is defined by comparing the predicted mark (generally asked immediately before or after the exam) with the actual mark. If the mark forecast were utterly random (that is, if people drew a ticket from an urn with marks between 18 and 30[3], as nobody who takes the exam would forecast not to pass it) or if everybody would forecast a mark similar to the average mark it would be normal to find overconfidence among the low marks (if everybody forecast a 25, those who take a lower mark are overconfident and those who take a higher mark are underconfident). Obviously the predicted mark is not random and is generally correlated to the actual mark, but the more random is the mark or the more people tend to forecast a similar average mark, the more an effect of this kind is likely to be observed.

From an econometric point of view, if we use a model in which the dependent variable is some ratio (or difference) between the actual and predicted mark and among the independent variables we have the actual mark, obviously a problem arises (the higher is the actual mark, the lower is the variable which measures overconfidence). For this reason Grimes (2002) correlates forecasting ability to an indicator of student's cognitive abilities, more than to the actual mark. This is a solution that may technically solve the endogeneity problem, but in fact only bypasses it. The best students inevitably have better performance in the exam and then the cognitive abilities indicator is inevitably correlated to the actual mark. One could have students who are generally good but perform badly in the exam (for instance, they have little time to study for it) and are able to predict it. In this case however overconfidence should occur with low marks more than with high ones.

The measurement problem can also be seen from a different perspective. Gigerenzer (1991) notes that overconfidence depends among other things also on the way in which forecasts are elicited. One thing is to ask an overall forecast of the mark, another is to ask for an evaluation question by question. To forecast a mark can be complicated and then forecast becomes necessarily something random. Moreover, a student who always takes the top marks will have less difficulty in forecasting the mark he will obtain. Besides, it is possible that the best students will simply be favoured with respect to the worst ones (at least if the worst students have a higher mark variance – there are students who always take the top mark, while students who always take the lowest mark are possibly less).

Understanding whether the answer to a question is correct is likely to be easier. Students can value how fast they get to the answer. In some cases they cannot be able to answer at all. Obviously a person who knows he will get it wrong will not give the wrong answer, but if he realizes he gives a random answer his confidence should be low. A different way of evaluating overconfidence could take to different results also for the students.

[3] In the Italian system 18 corresponds to a pass and 30 to the highest mark.

Another problem in the analysis of overconfidence lies in the incentives: for what reason a student should reveal the mark he expects to get or why should he make the effort to make a sensible forecast? Besides the problem occurs in differentiating expectations, hopes and aspirations: what I hope to get as a minimum, which mark I would like and so on.

Aim of this work is to show some preliminary evidence of how a different way of studying overconfidence might lead to results which are at least partially different from the standard ones. The present analysis is limited by the fact that the data are obtained by different classes of the same teacher, so that the lack of overconfidence might depend by particular conditions (related to the particular class or to teaching, even if overconfidence has never been mentioned). However, the study can stimulate a further and wider debate on possible implications on the way in which overconfidence could be reduced – if the way in which the question is asked changes or in some way stimulates different evaluations, appropriate ways of constructing exercises might help to reduce overconfidence.

Section 2 describes how the data for the analysis have been collected; section 3 introduces the different indicators of predictive ability and overconfidence and discusses the results; section 4 concludes.

2 The data

Our analysis is based on two different data sets. The first one concerns the course in Economics of the Law degree (University of Eastern Piedmont) in Alessandria, Italy. The second concerns the courses of two different degrees: Legal services for firms and Tourism marketing in Novara (same University). The two courses are analogous in content; the first is for first-year students; the second for second-year students.

2.1 The first dataset

The course has been held between the end of September and December 2011. The data concern the first midterm at the end of October. In order to take the midterm the students had to solve a series of exercises (quizzes and multiple choices) on the Moodle platform in the previous month, with some intermediate deadlines. The quizzes could be taken more than once and many students did that.

Moodle is a platform for long-distance learning, in which it is possible to hand out material, prepare quizzes that can be solved online, together with a series of other activities. Students' activity can be wholly traced and checked. Quizzes can be constructed with different characteristics. One of the possibilities is the *confidence based mark (CBM)*, in which students have to state the level of confidence in the answer: low, intermediate or high. The score depends on whether the answer is correct and on the level of confidence according to the values in Table 1. This system strongly penalizes the wrong answers with an intermediate or high level of confidence[4]. Two of the trial quizzes the students could use to exercise at home (which had no effect on the midterm mark) were based on the CBM with the values given in Table 1.

[4] The points in the table have to be considered in relation to the score given to the question. Let's imagine that a question gives one point. That whole point is gained with a very confident correct answer. Therefore the six points of penalty become, for instance, two points less on the total score of the quiz.

Table 1. The score assigned by Moodle in the CBM modality

Forecast:	Right answer	Wrong answer	Missing answer
High	3	-6	0
Intermediate	2	-2	0
Low	1	0	0

The midterm was divided in two parts and was run on Moodle, at the faculty lab. The first part (QUIZ) included 30 questions (each valued one point if correct, and minus one fourth of point in case of wrong answer). The second part (CBM) included six questions, of the value of 0.5 points each. Besides answering to the questions, in the CBM students had to declare how confident they were in giving that answer. 94 students participated in this part.

The score has been calculated in a way different from the standard one in Moodle, according to what described in Table 2. The wrong answers with intermediate/high levels of confidence are still penalized, but less than before. The score given by Moodle can be used for a tutorial, but it is too penalizing for a real exam. Anyway a risk to lose points still remains, which can have an important role in stimulating a correct thinking. This risk is not present clearly in the classical analyses on overconfidence, but is present in many real decisions in which people have to estimate their own abilities (for instance, if I run a firm and fail, I lose money). Even to take an exam if one is not well prepared at the end determines a sort of failure.

Table 2. The score assigned by the CBM modality in the midterm

	Answer	
Forecast:	Right	Wrong
High	1	-0.5
Intermediate	0.5	-0.25
Low	0.25	0

Moodle allows to show the score immediately. However, when taking the CBM test students did not know the score obtained in the other quiz (revealed only at the end of the second test). The CBM test concerns different topics of the main quiz; it is not about specific topics, but is a sort of smaller quiz, with the same meaning of the long one. This allows to have two independent evaluations of the same program, where the second allows also to evaluate the student's level of confidence in his own answers, while the first one is somehow more valid as it is based on a higher number of answers.

2.2 The second dataset

The course has been held between the end of February and the end of May 2012. The data concern the first midterm at the end of April. Modalities to have access to the midterm are analogous to the previous ones. However, in this case among the trial quiz there were no trials with CBM quiz. Therefore students have met the CBM quiz for the first time during the exam (with the score as in Table 2). 67 students participated to this part. Another important difference in this case with respect to the first dataset is that before taking the CBM test students have seen the score in QUIZ. As a consequence, differences between the two classes do not allow to test the effect of a single variable (reveal or not the mark of the midterm) but are nonetheless a guarantee for a robustness analysis. The effect of knowing the mark of the main quiz might after all be twofold: students have a reference for evaluation, and this should lead the good ones to be more confident; on the other hand those who have scored a higher mark in the main test have less interest to take risk.

The following table summarizes the features of the two different datasets:

Table 3. Summary of the design features

	Trial exercise	Midterm exam	
		QUIZ (30 questions with no confidence level)	CBM with values in Table 2
Dataset 1 N = 94	With CBM and values in Table 1	Yes	Before knowing the results from QUIZ
Dataset 2 N = 67	Without CBM	Yes	After knowing the results from QUIZ

3 Results

3.1 An introductory analysis

Literally, overconfidence occurs when the actual probability of answering correctly is below the estimated probability of doing it. Among all the answers in which one declares a 50% level of confidence, half of them must be, for instance, correct. If the percentage of mistakes is above 50% one is overconfident; if it is below, one is underconfident. Here it is not possible to test the ratio between level of confidence and right answers, because confidence is measured in a qualitative manner, with only three levels.

One could reason about which is the convenient choice, on the basis of different probabilities of answering correctly or not. For example, if the probability of answering correctly is 1, the expected value when one chooses “high” is 1, against 0.5 or 0.25 one would get by choosing “intermediate” or “low”. In this way, it can be seen that “intermediate” is never the expected value maximizing choice, and then it should never be chosen. When the probability of answering correctly reaches around 0.333, it starts being convenient to declare “low” instead of “high”. However, these are very abstract reasoning, which require for the students to have too much knowledge.

On the other hand, by comparing the right answers for each confidence level for the trial exercise tests (only for the first dataset) and for the midterm exam test (both datasets) it is possible to have a first general indicator of the ability of self-evaluation. Table 4 shows that the values of the three tests are very similar. In all cases the percentage of correct answers for each confidence level is significantly different from the other ones (both with parametric t and nonparametric Wilkinson rank-sum tests) always at the 99% significance level, apart from the difference between “intermediate” and “low” in the first dataset exercise, which is significant at the 90%. This is a first evidence of some ability in evaluating the level of confidence; in other words, the confidence level is correlated with the percentage of correct answers. When confidence is low, in fact, the number of wrong answers is higher. This ability of self-evaluation is good even in the tutorial phase, where students are less motivated and, possibly, even less prepared.

Table 4. Differences in percentages of correct answers for pairs of declared confidence levels

	Declared level of confidence			N	Pvalue t test	WR test
	High	Intermediate	Low			
Dataset 1 midterm exam QUIZ	0.93	0.65		76	0.000	0.000
		0.81	0.44	32	0.001	0.001
	0.85		0.47	32	0.000	0,000
Dataset 1 trial exercise	0.98	0.80		40	0.00	0.001
		0.80	0.76	18	0.739	0.722
	1		0.84	15	0.110	0.102
Dataset 2	0.95	0.65		41	0.000	0.000
		0.83	0.45	27	0.001	0.001
	0.96		0.46	35	0.000	0.000

Note that all the tests are paired tests, therefore they necessarily apply only to those students who answered, for example, both High and Intermediate in a certain test and then N is lower than the total sample size in that test.

On the first dataset it is also possible to run a test on the match samples in order to evaluate possible differences at an individual level between the trial test and the exam (as evaluation was different in the two cases) for each declared confidence level. Table 4b shows that there are no significant differences: motivation does not influence the ability of self-evaluation.

Table 4b. Differences in percentages of correct answers between the exercise and the exam for each declared confidence level - dataset 1

	N	Midterm exam QUIZ	Trial exercise	Pvalue t test	WR test
High	66	0.92	0.91	0.882	0.91
Intermediate	61	0.73	0.77	0.450	0.532
Low	14	0.54	0.44	0.557	0.537

Note that all the tests are paired tests, therefore they apply only to those students who answered, for example, 'High' both in the midterm exam and in the trial exercises and then N is different from the previous table. A student who answers 'High' in the exam but not in the trial exercise does not appear in the test.

3.2 Preparation and confidence

In a test of the kind illustrated here overconfidence occurs when declaring a high or intermediate confidence level, then giving a wrong answer; this determines partially negative scores for that specific question. Underconfidence on the other hand occurs when declaring low (or intermediate) levels of confidence, then giving a correct answer. A good ability of self-evaluation occurs when the correct answers are valued at their best and wrong answers do not cause (big) losses. As a consequence, a student with a good ability to self-evaluation obtains a high score from correct answers and does not lose points from the wrong ones.

When correlating these observations to the student's abilities, one has to consider that the best students also have less wrong answers or (in some cases) they have none. An individual comparison is made impossible by the fact that somebody never declares low levels. By itself the lack of low or high levels does not mean much, as it has to be compared to the correctness of the answers.

Let us consider now the following indexes:

Gain of points from correct answers (GC) = points obtained in the quiz from correct answers/number of correct answers

A student with a perfect ability to know what he knows, should have a value of this index equal to 1, as the answers with a high level of confidence are valued 1; the index cannot be higher than 1 and if it is lower it means that correct answers have not been valued at best (and then there is some kind of underconfidence or at least a reduced ability of self-evaluation).

Loss of points from wrong answers (LW) = points lost from wrong answers/wrong answers

A student with a perfect forecast ability, should not lose points (given that he has wrong answers; but being good and not losing points for wrong answers are two different things; aim of this work is just to verify whether good students do not lose points when they have wrong answers); this index has a negative value or at most is valued zero (when mistakes are classified with a low confidence level and therefore do not cause loss of points) . The more negative is this index the higher is the confidence level of the student with respect to mistakes and, therefore, he is overconfident (high values are therefore the more negative).

Overconfidence indicator (OVER) = (wrong answers with high confidence level * 2) + wrong answers with intermediate confidence level – correct answers with intermediate confidence level - (correct answers with low confidence level * 2)[5]

This indicator assigns a positive and high weight to the wrong answers with an intermediate or high confidence level and a negative score to the correct answers with a low or intermediate level. A student who fails six answers and gives a high level has a value equal to (2*6). A student who gets all the answers right and chooses a low level has a value of (-2*6). A student with a perfect ability for self-evaluation has an index value equal to 0.

Ability of self-evaluation indicator (CAL) = (wrong answers with high confidence level * 2) + wrong answers with intermediate confidence level + correct answers with intermediate confidence level + correct answers with low confidence level * 2)[6]

In this case all the answers in which there is a wrong calibration are valued in the same way, irrespective of whether they are overconfident or underconfident. The higher the index, the less calibrated the answers[7].

Table 5 shows Pearson correlation and Kendall's Tau-b coefficients among these indicators and the performance in the main exam, as well as the mark of the CBM quiz, for the first dataset. Table 6 shows the same values for the second dataset.

In both cases and significantly for both the statistical tests:

1) the mark of QUIZ is, as could be expected, correlated at 99% with the mark of CBM both in the first and in the second dataset according to both tests;

2) the mark of QUIZ is positively and significantly correlated to GC, the variable which measures the ability to transform the correct answers into points, and therefore an indicator of awareness: the best students not only answer better to more questions, but also manage to better exploit their answers, which happens as the worst ones are less confident in their answers. Table 7a shows that the best ones use the level 'high' more often; the correlation between the mark of QUIZ and the number of 'high' is significant (at 99% with both tests for dataset 2, at 90% and 95% for dataset 1) and positive. For the second dataset the correlation between the mark and the number of 'low' is significant (95%) and negative: the best ones use 'low' less often, as shown in Table 7b. Instead, there are no differences in points lost for wrong answers as shown in Table 6 for the second dataset (therefore the worst students, who make more mistakes, do not lose, in proportion, more points for that reason);

3) the mark of QUIZ is negatively and significantly correlated to CAL, the indicator of the inability to calibrate the answers, in both datasets with both tests; therefore, the best ones are more calibrated; instead, the mark of QUIZ is never correlated to the indicator of overconfidence.

[5] Other versions of the same indicator with different weights given to the various addends lead to similar results.
[6] In this case too other versions of the same indicator with different weights given to the different addends lead to similar results.
[7] Another indirect indicator of self-evaluation ability was calculated using the number of questions the students leaved unanswered in QUIZ where, in case of mistake, students had a penalty equal to 0.25, to disincentive random answers when the solution was not known. This indicator is not included in the tables as it did not lead to any significant result.

Overall, the worst students seem less able to exploit their abilities, as obviously they are less confident of what they do.

4 Conclusions

As discussed above, Chew (2012) states that students who have the poorest metacognition have no idea of how deeply they understand a concept. A similar consideration should hold whatever method it is used in order to test overconfidence. Even more so, a student who is good at predicting his/her mark, should be even better at it when asked an evaluation on his/her knowledge of a specific question. This is the reason why in this work we tried a test of overconfidence by using a question-by-question evaluation of the confidence level in the correctness of the answer. Therefore, the results found in the literature should be confirmed by our analysis. In fact we find that better students are more calibrated and then more able to evaluate themselves. However, it is not true that worse metacognition explains overconfidence.

Our data seem to show results which are partially different from the standard ones by using a procedure different from the one generally used to evaluate students' confidence in relation to their ability. Since the procedure used in our analysis departs in many respects from the one normally used in the literature, it is not possible to disentangle which of the aspects might lead to the different correlation between ability and overconfidence. The difference in results could be due either to the step-by-step evaluation used or to the specific award system.

Our results seem to suggest that a wider consideration and careful analysis of the theme of overconfidence and further research on the topic would be of great interest, for example by using different classes of students in different subjects with different instructors.

Table 5. Correlation between the midterm mark and the different indexes of measurement of overconfidence – dataset 1

		Midterm mark QUIZ	CBM mark	GC	LW	CAL	OVER
		Pearson correlation coefficients					
Midterm mark QUIZ	Kendall tau-b		.437***	.219*	.080	-.395***	-.068
	N		88	88	64	88	88
CBM mark		.246***		.096	.507***	-.620***	-.502***
	N	88		88	64	88	88
GC		.140*	.102		-.433***	-.700***	.781***
	N	88	88		64	88	88
LW		.035	.397**	-.338***		-.216	-.693***
	N	64	64	64		64	64
CAL		-.242***	-0.287***	-.591***	-.178*		-.276***
	N	88	88	88	64		88
OVER		-.010	-.449***	-.591***	-.605***	-.216***	
	N	88	88	88	64	88	

Note: Significance levels are: *** 99%; ** 95%; * 90%. The values in the top-right part of the table are Pearson coefficients; values in the lower-left part are Kendall tau-b. The number of observations change for each couple, as not all students have, for instance, wrong answers.

Table 6. Correlation between the midterm mark and the different indexes of measurement of overconfidence – dataset 2

*		Midterm mark QUIZ	CBM mark	GC	LW	CAL	OVER
		Pearson correlation coefficients					
Midterm mark QUIZ	Kendall tau-b		.505***	.334***	.149	-.267**	.007
	N		64	65	49	67	67
CBM mark		.387***		.860***	-.421***	-.339***	.492***
	N	64		62	47	64	64
GC		.257***	.705***		-.341**	-.823***	.846***
	N	65	65		49	65	65
LW		.094	-.312***	-.270*		-.093	-.609***
	N	49	49	49		49	49
CAL		-.215**	-.109	-.685***	-.096		-.714***
	N	67	64	65	49		67
OVER		.055	.412***	.715***	-.557***	-.564***	
	N	67	64	65	49	67	

Note: Significance levels are: *** 99%; ** 95%; * 90%. The values in the top-right part of the table are Pearson coefficients; values in the lower-left part are Kendall tau-b. The number of observations change for each couple, as not all students have, for instance, wrong answers.

Table 7a. Correlation between the midterm mark and the number of confidence levels declared – dataset 1

Dataset 1		Midterm mark QUIZ	Number of high	Number of low	Number of intermediate
	Correlazione di pearson		.179*	-.200**	-.072
Midterm mark QUIZ	N		88	88	88
	Kendall Tau b		.153**	-.029	-.093
Midterm mark QUIZ	N		88	88	88

Table 7b. Correlation between the midterm mark and the number of confidence levels declared – dataset 2

Dataset 2		Midterm mark QUIZ	Number of high	Number of low	Number of intermediate
	Correlazione di pearson		.386***	-.251**	.085
Midterm mark QUIZ	N	67	67	67	67
	Kendall Tau b		.305***	-.215**	.105
Midterm mark QUIZ	N		67	67	67

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