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SPECIAL SERIES

Science Ethics Education
Part II: Changes in attitude toward scientific fraud among medical researchers after a short course in science ethics

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Summary

Purpose: *To determine the impact of the short science ethics courses on the knowledge of basic principles of responsible conduct of research (RCR), and on the attitude toward scientific fraud among young biomedical researchers.*

Methods: *A total of 361 attendees of the course on science ethics answered a specially designed anonymous multiple-choice questionnaire before and after a one-day course in science ethics. The educational course consisted of 10 lectures: 1) Good scientific practice - basic principles; 2) Publication ethics; 3) Scientific fraud - fabrication, falsification, plagiarism; 4) Conflict of interests; 5) Underpublishing; 6) Mentorship; 7) Authorship; 8) Coauthorship; 9) False authorship; 10) Good scientific practice - ethical codex of science.*

Results: *In comparison to their answers before the course, a significantly higher ($p<0.001$) number of students qualified their knowledge of science ethics as sufficient after the course was completed. That the wrongdoers deserve severe punishment for all types of scientific fraud, including false authorship, thought significantly ($p<0.001$) more attendees than before the course, while notably fewer attendees ($p<0.001$) would give or accept undeserved authorship*

Conclusion: *Even a short course in science ethics had a great impact on the attendees, enlarging their knowledge of responsible conduct of research and changing their previous, somewhat opportunistic, behavior regarding the reluctance to react publicly and punish the wrongdoers.*

Key words: attitude, education, ethics, medicine, scientific misconduct

Introduction

One of the proposals of an international commission for safeguarding good scientific practice recommends that "the education and development of young scientists and scholars need special attention" [1]. The emphasis is on the education in science ethics as a very important part of responsible RCR.

In accordance with this recommendation, a group of Serbian scientists has been teaching during the last decade science ethics at one- or two-day seminars and courses [2,3]. The target population consisted of younger medical researchers and postgraduate medical students [4].

In this paper, we report the impact of our short-term educational course on the attendees' attitudes toward any type of scientific fraud.

Methods

Study population

The study group consisted of 361 subjects, mainly beginners in science, and most on PhD training, or on postdoctoral training. Other characteristics of the group have been described earlier [5].

Course description

The educational seminar/course consisted of 10 lectures: 1) Good scientific practice - basic principles; 2) Publication ethics; 3) Scientific fraud - fabrication, falsification, plagiarism; 4) Conflict of

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interests; 5) Underpublishing; 6) Mentorship; 7) Authorship; 8) Co-authorship; 9) False authorship; 10) Good scientific practice - ethical codex of science.

Questionnaire

After completion of the course, students were asked to complete (anonymously, voluntarily and in private) a specially designed multiple-choice questionnaire, consisting of the same questions the students had completed before the start of the course.

Statistical analysis

Descriptive methods of statistical analysis (mean, median, N and percentages) were used to summarize the data before and after the course, obtained from the questionnaires. For testing the differences between parameters, the Stuart-Maxwell marginal homogeneity and McNemar's x^2 tests were used.

Results

In comparison to their answers before the course, a significantly higher ($p<0.001$) number of students qualified their knowledge of science ethics as sufficient after the course was completed. However, more than one third was still not sure whether or not their knowledge on this particular topic was sufficient enough (Table 1).

The previous firm negative attitude toward undeserved authorship and its qualification as wrong remained the same after the course was completed, but the opinions about the punishment of the wrongdoers turn significantly more severe than before ($p<0.001$). In addition, a much smaller number ($p<0.001$) of attendees would give or accept undeserved authorship (Table 2).

The number of attendees who qualified neglected authorship as wrong was similar before and after the lectures (course), but they significantly ($p<0.001$) changed their opinion concerning the measures to be undertaken against the violator: instead of mere warning, they thought that sanctions should be imposed, and severe rather than moderate ones. Like before the course, they thought they would never devoid other persons of deserved authorship, and three quarters, which was more than before ($p=0.002$), would turn against the violator (Table 3).

The negative attitude towards fabrication of data became even stronger after the course: a significantly higher number of students thought that the wrongdoers deserve punishment ($p<0.001$), that they themselves would never fabricate research data ($p<0.001$), and that they would uncover the fabrication publicly ($p<0.001$) (Table 4). Similar attitude was expressed towards the falsification of data (Table 5).

In a situation where the student's superior was found responsible for plagiarism, a significantly higher percentage of attendees (after the course) would impose severe sanctions against the plagiator ($p<0.001$) instead of warning, and would uncover publicly the plagiarism ($p<0.001$). When placed as plagiarized authors, a high percentage of students would react publicly, and this percentage was similar to that obtained before the course ($p=0.061$). However, when placed as plagiator, a significantly higher number of students would admit the wrongdoing than would have done so before the lectures ($p<0.001$) (Table 6).

When plagiarism was executed by the student's

Table 1. The attendees' pre- and post-lecturing perception of knowledge of SEE

Perception of knowledge of SEE	*Before course N (%)*	*After course N (%)*	*p-value*
Sufficient	47 (13.0)	162 (44.9)	$p<0.001^{\#}$
Insufficient	136 (37.7)	46 (12.7)	
Not sure	171 (47.4)	138 (38.2)	
No data	7 (1.9)	15 (4.2)	
Total	361 (100)	361 (100)	–

$^{\#}$Stuart-Maxwell marginal homogeneity test, SEE: Science Ethics Education

Table 2. Perception and attitude toward gifted authorship

Undeserved (gifted) authorship	*Before course N (%)*	*After course N (%)*	*p-value*
Qualification of undeserved authorship			
Right	8 (2.2)	0 (0)	p=NA^
Wrong	351 (97.2)	353 (97.8)	
No data	2 (0.6)	8 (2.2)	
Sanctions of undeserved authorship			
No sanction	85 (23.5)	26 (7.2)	$p<0.001^{\#}$
Warning	228 (63.2)	171 (47.4)	
Punishment	46 (12.7)	156 (43.2)	
Moderate	29 (8.0)	61 (16.9)	
Severe	17 (4.7)	95 (26.3)	
No data	2 (0.6)	8 (2.2)	
Anticipation of future behavior			
Would do	154 (42.6)	48 (13.3)	p<0.001*
If forced	138 (38.2)	2 (0.6)	
If given the opportunity	16 (4.4)	46 (12.7)	
Would never do	205 (56.8)	304 (84.2)	
No data	2 (0.6)	9 (2.4)	
Future acceptance of gifted authorship			
Yes	49 (13.6)	15 (4.2)	p<0.001*
No	307 (85.0)	337 (93.3)	
No data	5 (1.4)	9 (2.5)	

$^{\#}$Stuart-Maxwell marginal homogeneity test, *McNemar's x^2-test, ^Statistical testing not applicable due to the identical answers before and after SEE

Table 3. Perception and attitude toward ignored (neglected) authorship

Ignored (neglected) authorship	*Before course N (%)*	*After course N (%)*	*p-value*
Qualification of ignored authorship			
Right	3 (0.8)	2 (0.5)	p=1*
Wrong	357 (98.9)	349 (96.7)	
No data	1 (0.3)	10 (2.8)	
Sanctions of ignored authorship			
No sanction	24 (6.6)	11 (3.1)	
Warning	218 (60.4)	107 (29.6)	p<0.001#
Punishment	119 (33.0)	233 (64.5)	
Moderate	27 (7.5)	59 (16.3)	
Severe	92 (25.5)	174 (48.2)	
No data	–	10 (2.8)	
Anticipation of future behavior			
Would do	13 (3.6)	3 (0.8)	
If forced	10 (2.8)	2 (0.6)	p=0.039*
If given the opportunity	3 (0.8)	1 (0.3)	
Would never do	347 (96.1)	348 (96.4)	
No data	1 (0.3)	10 (2.8)	
Would turn against violator			
Yes	247 (68.4)	272 (75.3)	p=0.002*
No	110 (30.5)	79 (21.9)	
No data	4 (1.1)	10 (2.8)	

#Stuart-Maxwell marginal homogeneity test, *McNemar's x^2-test

Table 4. Attitude toward fabrication of data

Fabrication of data	*Before course N (%)*	*After course N (%)*	*p-value*
Sanctions for fabrication of data			
No sanction	12 (3.3)	3 (0.8)	
Warning	151 (41.8)	80 (22.2)	p<0.001#
Punishment	195 (54.0)	268 (74.2)	
Moderate	77 (21.3)	64 (17.7)	
Severe	118 (32.7)	204 (56.5)	
No data	3 (0.8)	10 (2.8)	
Anticipation of future behavior			
Would do	26 (7.2)	4 (1.1)	
If forced	25 (6.9)	4 (1.1)	p<0.001*
If given the opportunity	1 (0.3)	–	
Would never do	332 (92.0)	347 (96.1)	
No data	3 (0.8)	10 (2.8)	
Would uncover publicly fabrication of data			
Yes	136 (37.7)	230 (63.7)	p<0.001*
No	212 (58.7)	118 (32.7)	
No data	13 (3.6)	13 (3.6)	

Stuart-Maxwell marginal homogeneity test, *McNemar's x^2-test

Table 5. Attitude toward falsification of data

Falsification of data	*Before course N (%)*	*After course N (%)*	*p-value*
Sanctions for fabrication of data			
No sanction	11 (3.0)	7 (1.9)	
Warning	126 (34.9)	77 (21.3)	p<0.001#
Punishment	224 (62.0)	265 (73.4)	
Moderate	81 (22.4)	61 (16.9)	
Severe	143 (39.6)	204 (56.5)	
No data	–	12 (3.3)	
Anticipation of future behavior			
Would do	11 (3.0)	4 (1.1)	
If forced	10 (2.7)	2 (0.6)	p=0.070*
If given the opportunity	1 (0.3)	2 (0.6)	
Would never do	350 (97.0)	345 (95.6)	
No data	–	13 (3.3)	
Would uncover publicly fabrication of data			
Yes	176 (48.8)	232 (64.3)	p<0.001*
No	177 (49.0)	115 (31.9)	
No data	8 (2.2)	14 (3.9)	

#Stuart-Maxwell marginal homogeneity test, *McNemar's x^2-test

coworker, similar answers were obtained. In comparison to the answers given before the lectures, after the completion of the course a much higher percentage would uncover and punish the plagiator, and would also react publicly as plagiarized author (p<0.001, p<0.001, p<0.001, respectively) (Table 7).

Table 6. Attitude toward plagiarism done by a superior (professor)

Plagiarism	*Before course N (%)*	*After course N (%)*	*p-value*
Would uncover publicly			
Yes	187 (51.8)	267 (74.0)	p<0.001*
No	160 (44.3)	79 (21.9)	
No data	14 (3.9)	15 (4.2)	
Attitude toward plagiator			
No measures against plagiator	9 (2.5)	7 (1.9)	
Warning	121 (33.5)	67 (18.6)	p<0.001#
Punishment	226 (62.6)	275 (76.2)	
Moderate	59 (16.3)	46 (12.7)	
Severe	167 (46.3)	229 (63.4)	
No data	5 (1.4)	12 (3.3)	
As plagiarized author			
Would react publicly	338 (93.6)	340 (94.2)	p=0.061*
Would not react	17 (4.7)	8 (2.2)	
No data	6 (1.7)	13 (3.6)	
As plagiator			
Would admit	281 (77.8)	309 (85.6)	p<0.001*
Would not admit	68 (18.8)	37 (10.2)	
No data	12 (3.3)	15 (4.2)	

#Stuart-Maxwell marginal homogeneity test, *McNemar's x^2-test

Table 7. Attitude toward plagiarism done by a coworker

Plagiarism	*Before course N (%)*	*After course N (%)*	*p-value*
Sanctions of plagiarism			
No sanction	10 (2.8)	4 (1.1)	
Warning	150 (41.6)	78 (21.6)	
Punishment	200 (55.4)	267 (74.0)	p<0.001#
Moderate	67 (18.6)	56 (15.5)	
Severe	133 (36.8)	211 (58.5)	
No data	1 (0.3)	12 (3.3)	
Would uncover publicly			
Yes	204 (56.5)	242 (67.0)	
No	147 (40.7)	102 (28.3)	p<0.001*
No data	10 (2.8)	17 (4.7)	
As plagiarized author			
Would react publicly	198 (54.8)	249 (69.0)	
Would not react	158 (43.8)	99 (27.4)	p<0.001*
No data	5 (1.4)	13 (3.6)	

#Stuart-Maxwell marginal homogeneity test, *McNemar's x^2-test

Discussion

In the international scientific community, there is consensus that education in science ethics should be provided at all educational levels [1,6-13]; even short courses targeting at postgraduate students may be useful [14]. In accordance with that, we designed our teaching course with the aim of helping students learn the rules of responsible RCR, that is, to adopt norms for conduct that distinguish between acceptable and unacceptable behavior in science.

First of all, although our students showed a high level of integrity before any formal education in RCR [5], in the post-course questionnaire they reported their need to learn even more about science ethics, thus showing their aptitude for further personal development in regard to science integrity. Also, their answers showed that even a short course of lectures in research integrity changed considerably the perceptions and attitudes toward violations of rules of good scientific practices.

The shift from the attendees' previous reluctance to uncover and punish all kinds of misbehavior to a more ethical attitude might be the result of the lecturers' detailed explanations why scientific fraud is wrong and how much damaging the consequences may be for science itself [12].

The attendees' pre-course somewhat permissive attitude toward plagiarism, also observed in another survey [15], was likewise changed after the course. The awareness of recently developed tools for detecting plagiarism, as the most common breach of the publication ethics [16-19], might also contribute to the change of the attendees' attitudes.

Similarly, the attitude toward any kind of false authorship, an issue to which all researchers are highly sensitive, was much more negative than before. This also might be due to our emphasis on authorship criteria [20], and explanations how authorship abuse can affect one's personal career. However, in another study [21] related to authorship criteria, instructions about formal authorship criteria had no effect on the students' decisions in more complex situations.

Would education be able to change behavior from the ethically wrong or problematic conduct to a responsible one? Would the training and education in research ethics help reduce the rate of misconduct in science? Based on the results of this survey and other reports [6, 7, 22-25], it seems it would. Therefore, we conclude that any kind of education, however brief, may hopefully help the inexperienced to avoid any breaches of high standards of science, and to make the right decisions in delicate situations they might face in their professional life.

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