

# Maintaining Scientific Integrity through Academic-Industrial Research and Development Cooperation

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**Abstract.** Studies in modern universities are closely integrated with research, innovation, and knowledge transfer. Research and development activity can improve the quality of education and help to achieve the desired demands of the labor market, especially if high-tech enterprises are involved in the process. However, employers may be dissatisfied with graduates because of their unethical research practices. The latter is a complex multi-faceted phenomenon that requires a holistic response, beyond just a policy of information and sanctions. This is especially true for master and doctoral degree students involved in research and development. It is more preferable to encourage them to build their creativity and critical thinking skills as a precondition for research integrity than institutionalize policies and procedures. The aim of the paper is to develop avenues to maintain scientific integrity among second- and third-level students of higher education institutions by establishing effective cooperation between universities and high-tech enterprises in the field of research and development. The paper outlines the problem of unethical research practices, the analysis of the reasons and typology of research dishonesty is undertaken. The infrastructure, information technology, and appropriate tools for academic-industrial cooperation providing ethically sustainable research and innovation practices are proposed. High-tech enterprises are involved in feedback using monitoring and audit tools for a systematic and independent examination of the research and development activities of students. The adoption of developed information technology and tools will ensure scientific integrity in practice and allow teaching students to think like scientists through building their creative and innovation skills in close cooperation with leading high-tech enterprises.

**Keywords:** research and development, university-enterprise cooperation, scientific integrity, higher education institution, monitoring and audit, information technology.

## 1 Introduction

The role of higher educational institutions (HEIs) is not restricted to education and research activity. The crucial task is the development of research culture characterized by integrity and commitment of academic members to moral values. Research integrity means academic honesty and implies that students and teachers involved in science

abide by a code of honesty, trust, fairness, respect, and responsibility related to the production, publication, assessment, and exchange of knowledge in research.

Current global, national and institutional pressures and restrictions (such as limited or lack of resources (money, time, institutional support), as well as lack of institutional interest or capacity to invest in maintaining research integrity) often give rise to diverse unethical research practices in Europe. The worst situation with research integrity is reported in the countries of Eastern Europe. Research conducted in Ukraine shows a twofold increase in the percentage of students involved in unethical behavior in the last decades. Tight deadlines and the rush to produce and publish results, funding and financial incentives, competition, prestige and fame often lead to a high incidence of 'sloppy' results and irreproducible outcomes, which are characterized by a lack of scientific novelty and research validation, publishing the same paper in several different journals, plagiarizing ideas, etc.

Hyper-competition for funding, globalization, industry-academic partnerships, interdisciplinary research challenges give rise to increasing demand for research integrity. A novel approach to the scientific process, so-called Open Science, makes scientific research, data, and dissemination accessible to all levels of an inquiring society, and consequently requires that ethically sustainable practices be applied in all stages of the research process. Being based on cooperative work and information distribution Open Science promotes collaborative research and development (R&D) activities in an effective manner. Research and business enterprises often spend resources on certain research undertakings in order to make discoveries that can help to develop new products or ways of doing things or work towards enhancing pre-existing products or processes. R&D shall be conducted and communicated in accordance with the highest scientific, professional, and ethical standards and in a manner that fosters mutual respect and enhances the reputation of the individual researcher, his/her colleagues, the university and the country he/she represents. It's paramount to conduct research with integrity, i.e. doing research in a way which allows others, especially business enterprises spending on R&D, to have trust in the developed methods, findings and any publications based on the research [1-5]. R&D requires that research activity should be made understandable and its quality should be measurable.

The idea of this paper grew up from the contradiction between increasing in diverse unethical research practices and a lack of methods to deal with them on the one hand, and requirements imposed by R&D on the other hand.

European countries have already made great progress in the field of maintaining academic integrity. There are many trainings and guidelines for maintaining academic integrity in European countries reflected in Erasmus+ projects, such as "European network for academic integrity" (2016-1-CZ01-KA203-023949) [6], "Integrity", "Academic integrity for quality teaching and learning in higher education institutions in Georgia (INTEGRITY)", "Innovative approaches towards teaching anti-corruption in formal education".

However, none of these projects covers existing problems of bridging the gap between research activity in the universities and the requirements of business enterprises through research integrity. Training and guidelines developed within existing Erasmus+ projects are necessary, but not sufficient to change behavior: the actual reward

structure is what matters most. To realize the balance of reward and punishment new approaches to quantitative and qualitative assessments of research activity should be developed.

The paper is aimed at the development of research ethics information technology (REIT) for fostering research integrity in higher educational institutions (HEIs) through establishing effective cooperation between universities and high-tech enterprises in the field of research and development (R&D). The main components of REIT are the tools for research integrity monitoring and research integrity audit provided as feedback from enterprises.

The main target groups of the developed technology are second-level and third-level students (master degree and Ph.D. degree) of HEIs, as well as their teachers and supervisors. There are no common rules for assessing research integrity and responding to research misconduct for these target groups that could be adapted to the countries less developed in terms of research integrity.

Except for master degree, Ph.D. degree students and their teachers REIT covers the following audience: HEIs' management, ethics committees, all career stage researchers, business enterprises investing in R&D, employers.

The aim of REIT is to develop avenues to maintain scientific integrity among second- and third-level students of higher education institutions by establishing effective cooperation between universities and high-tech enterprises in the field of research and development.

## 2 Typology of Research Misconduct

Research misconduct covers a vast array of behaviors that can be classified in the following way [7-9].

*Data fabrication and falsification.* Data fabrication implies inventing fake data, whereas data falsification means manipulating research materials, equipment or processes, as well as changing, omitting or suppressing data or results to obtain some specific results without justification [10].

*Plagiarism and self-plagiarism.* Plagiarism implies stealing other people's work or ideas, and self-plagiarism means using one's own ideas or re-publishing parts of one's own earlier publications, including translations, without providing proper credit to the original source [10].

*Duplicate publication, redundant publication, and salami publication.* The duplicate publication indicated publishing two identical papers in different journals, whereas redundant publication means publication of two similar papers. Salami publication involves publishing several papers from a single study.

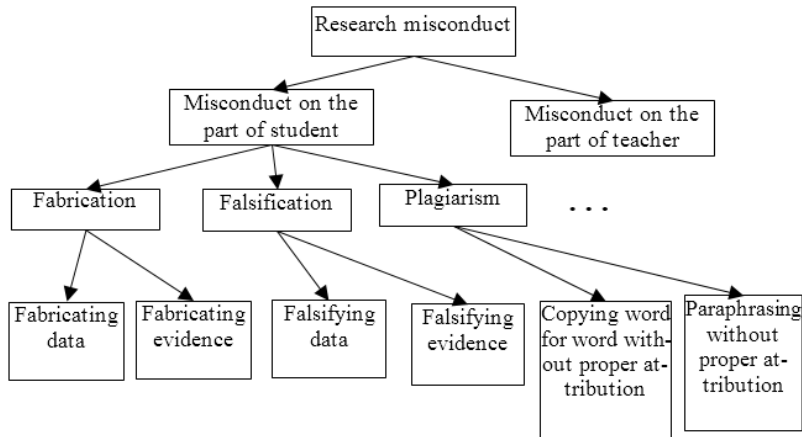
*Wrongdoings in the process of data analysis.* Any wrong doings in the process of data analysis such as ignoring outliers, ignoring missing data, reporting post-hoc analyses without declaring them could have serious impacts on the results. Each outlier and the missing result should be admitted and declared. Any type of post-hoc analyses should be declared in advance by the researchers.

*Authorship disputes.* Authorship disputes indicate any disagreements between researchers about the names and orders of the authors in a given paper including guest or ghost authorship.

*Failure to carry out a thorough literature review before commencing new research.* Failure to carry out a thorough literature review before commencing new research is judged to be a questionable research practice since inadequate literature review might lead to flawed or repetitive research.

*Establishing or supporting journals that undermine the quality control of research.* Predatory publishers offer authors a quick and easy route to publication in exchange for a fee and usually without any apparent peer review or quality control [10].

It's been proposed to build research misconduct classification tree (Fig.1).



**Fig. 1.** Research misconduct classification tree

Each research misconduct can be referred to a separate type  $T$  and assessed in terms of severity using  $n$  predefined parameters [11].

### 3 Components of Research Ethics Information Technology

The main components of REIT are the tools for research integrity monitoring, assessment of research misconduct, and research integrity audit provided as feedback from enterprises.

#### *Monitoring.*

Research integrity monitoring is a process meant to provide accurate and real-time information concerning research activity of the main target group with the aim of diagnosis of research misconduct.

Information about violations can be provided by different sources. For example, information about plagiarism can be detected using special plagiarism check software. Information about cheating and fabrication can be obtained from the special video control system.

The responsibility for monitoring in the HEI rests with a monitoring team that acquires evidence either directly or through information supplied by others that a violation of research integrity by student or teacher may have occurred and recorded the information in the database [12]. Monitoring team conducts an initial review of allegations of academic dishonesty at the HEI to determine whether there is sufficient evidence of a violation. The monitoring team is responsible for determining whether charges will be filed against a student or teacher. When a student or a teacher admit responsibility for an infraction, the monitoring team recommends a sanction.

The sanctions include, but are not limited to [12]:

- a reduced grade for the course for the student;
- temporary dismissal from class;
- dismissal from class for the remainder of the term;
- a reduced rating, which leads to a cut in scholarship (salary).

*Assessment.*

Each research misconduct event should be assessed in terms of severity using  $n$  pre-defined parameters. The violation severity  $Sev$  is a point in  $n$ -dimensional space of parameters  $x_1, x_2, \dots, x_n$ . The parameters of misconduct severity assessment in each particular case are as follows:

1. an amount of violence committed by a definite person;
2. a frequency of violence committed by a definite person;
3. a number of study years or a number of years in the profession. The more the number of years the more deliberate the violation is.

Knowing the violence type  $T$  and the level of its seriousness  $S$  we can assess it using definite quantitative measure  $A$  (assessment), which allows determining an appropriate punishment.

Let us determine zones in  $n$ -dimensional space characterizing the violations of different level:

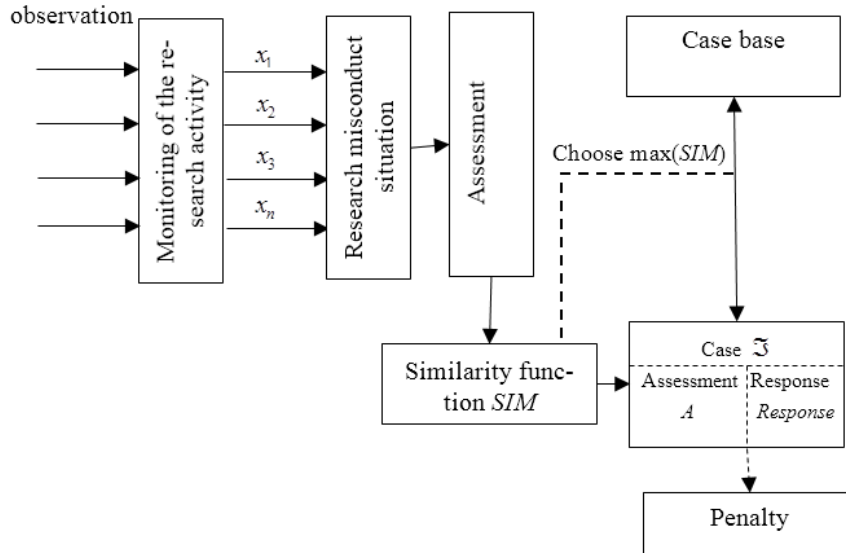
1. violations characterized by inexperience or a lack of knowledge of research integrity principles;
2. violations characterized by the dishonesty of a more serious nature or by dishonesty that affects a more significant aspect or portion of the course work.
3. violations characterized by dishonesty that affects a major or essential portion of work done to meet course requirements, or involve premeditation, or are preceded by one or more violations at levels one and two.
4. violations characterized by the most serious breaches of intellectual honesty and academic integrity:

$$A = f(T, S).$$

Violation response is based on a case base consisting of the following rules:

$$A \rightarrow Response,$$

represented as cases. Case base is developed to create and store these rules, as well as to respond to research misconduct (Fig.2).



**Fig. 2.** Research integrity monitoring

Each case includes a description of the research misconduct situation and corresponding response as a kind of penalty that the system prompts a responsible person to choose for the detected violation. A search for a suitable case requires a given similarity function assessment for the observed situation with respect to the existing situations stored in the case base.

To build a similarity degree evaluation function we can use the well-known nearest neighbor method based on measuring the coincidence degree for the case parameter values.

Using a case base allows us to take into account the history of violations committed by a certain student, as well as his (her) overall track record.

#### *Audit.*

Research Integrity Audit is systematic and independent examination of research activities and documentation, to determine that the research study is being conducted in accordance with established or predetermined criteria which can then be communicated to interested parties [13].

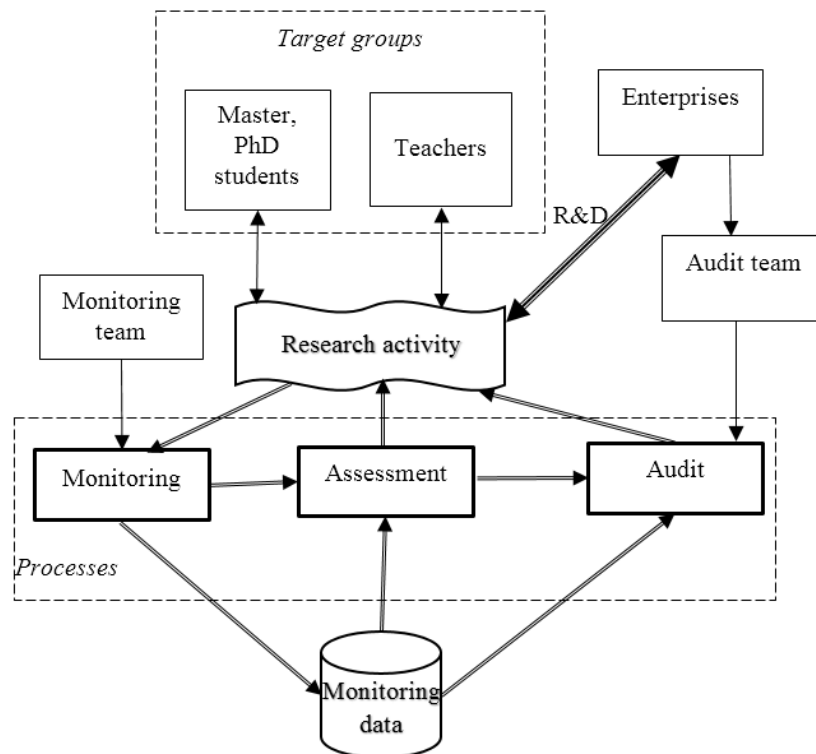
According to the developed information technology, academic research audit is provided by the representatives of enterprises taking part in R&D cooperation with the HEI who spend resources on certain research undertakings. They check the degree of correspondence between conducted research and R&D agreement [14].

The audit can be conducted systematically or “for cause” if there are suspected problems with the research. Research integrity audit should involve objective evidence to

evaluate research data and their derivatives. It should determine the degree of correspondence between assertions based on the data (e.g., results, conclusions, tables, figures) and the original data, using prior criteria. Auditors should communicate the audit outcome to affected parties.

#### 4 Research Ethics Information Technology through Academic-Industrial Cooperation

REIT contains a series of interrelated processes such as research integrity monitoring, assessment of research integrity, and research integrity audit (Fig.3).



**Fig. 3.** Information technology for research integrity through academic-industrial cooperation

Monitoring is provided by monitoring team composed of the representatives of the institution (faculty members or administrators). The parameters obtained during monitoring enter the assessment subsystem where the research activity of students and teachers is assessed. Such assessments should be rational for appropriate sanctions.

The audit is an effective way to gather feedback from enterprises about the effectiveness of the research. How often this is done depends on the amount of research

undertaken in the institution. In major institutions, it is anticipated that an audit should be undertaken for at least one research project per year.

## **5 Impact**

Concerning the main target groups, master and Ph.D. students, as well as their teachers and supervisors, the following impacts are expected as a direct result of implementing REIT:

- a better understanding of the concept of research integrity;
- increased capacity for professional development for the HEI staff involved in research activities;
- improved conditions for researchers and subsequently higher chances to be involved in international scientific projects;
- increased adaptability and flexibility in an increasingly diverse, mobile, multicultural and interdisciplinary work environment and society.

REIT will also influence HEIs' management, ethics committees and all career stage researchers allowing to increase their awareness in audit as a procedure, what steps should be taken to embed it institutionally.

As a result of implementing REIT HEIs will obtain the following benefit:

- research ethics development for academics, research staff, and postgraduate researchers;
- decreased volume of research misbehavior will be obtained as a result of developed practices of research monitoring and audit, as well as a result of planned training;
- the increased reputation of organizations;
- increased number of students who want to be engaged in research;
- a higher number of the good-quality thesis, scientific papers, and successful graduates, they will be more credible and respected by the general public and experts.

Business enterprises investing in R&D will obtain confidence that all possible steps of research are being taken properly and the funding is not wasted. Potential employers will get higher efficiency, productivity, responsibility, and creativity of their future employees.

REIT addresses scientific malpractices which are applicable across the whole research sector not only in Ukraine but in other countries.

Apart from the impact to the universities, there will be a significant impact on the local associations/institutions as well. Local associations/organizations will be informed about the advancements as a result of REIT adoption, in general, through dissemination activities.

On a national level, REIT will be taken in stronger consideration by Ukrainian national science education system. The produced research integrity practices will continue to be available and may become a point of reference for all subsequent attempts in the field, both from the point of innovation and the suitability for a future accreditation and recognition throughout EU.



The main tool for measuring impacts from implementing REIT is feedback from students and teachers, as well as stakeholders. During public events, feedback from relevant participants (students, teachers, academic workers, creative employees, businesses) can be collected to find out the level of REIT adoption usefulness. The questionnaires can be written and spread, discussions can be held among students, teacher, and stakeholders.

In the long term universities will compare:

- the percentage of the diploma or master/Ph.D. thesis detected by the developed research integrity audit system to be made using unacceptable practices before and after the launch of REIT
- the number of master degree students applied to postgraduate study before and after the launch of the REIT
- the number of R&D cooperation agreements (collaborative R&D projects) before and after the launch of REIT.

## 6 Case Study

The proposed REIT was implemented in Kherson National Technical University. The technology has been being tested during the last three years among master, Ph.D. students, and researches of Program Tools and Technologies department, as well as enterprises involved in R&D activities with them.

The impacts obtained as a direct result of the implementation of REIT are represented in table 1.

**Table 1.** Results of REIT implementation

Indicator \ Year	2017	2018	2019
A percentage of master / Ph.D. thesis made using unacceptable practices	41	35	15
A number of master degree students applied to postgraduate study	1	3	7
A number of R&D cooperation agreements	0	2	5

Besides that, the REIT implementation allows master and Ph.D. students, as well as their teachers and supervisors, to obtain the following impacts:

- a better understanding of the concept of Research Integrity;
- increased capacity for professional development for the staff of Program Tools and Technologies department involved in research activities;
- improved conditions for researchers and subsequently higher chances to be involved in international scientific projects;
- increased adaptability and flexibility in an increasingly diverse, mobile, multicultural and interdisciplinary work environment and society.

Business enterprises investing in R&D obtain confidence that all possible steps of research are being taken properly and the funding is not wasted. The impact for the employers is higher efficiency, productivity, responsibility, and creativity of their future employees.

## 7 Conclusions

Cooperation between HEIs and business enterprises within the frame of proposed REIT will enforce the responsibility of researches in HEIs. It will allow HEIs and enterprises to benefit from the experiences and contacts of each other. Mutually beneficial and sustainable university-enterprises R&D cooperation will provide graduates with a high understanding of research integrity principles [14-20]. Ukrainian graduates will meet the requirements of the international labor market and can enhance the integration of Ukraine into the European IT sector.

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