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Developing and Validating the Competency Profile for Teaching and Learning Research Integrity

Jurij Selan*[1] and Mira Metljak[2]

Since research integrity is not external to research but an integral part of it, it should be integrated into research training. However, several hindrances regarding contemporary research integrity education exist. To address them, we have developed a competency profile for teaching and learning research integrity based on four assumptions: 1) to include all levels of study (BA, MA, and PhD); 2) to integrate research integrity into research education itself; 3) to address research integrity issues in context-specific practices; and 4) to pay particular attention to the 'grey zone' or questionable research practices. To assess the validity of the content of the competency profile and to determine if some adjustments to the profile are needed, we translated the competencies of the profile into items of a measurement instrument (a questionnaire) and conducted a survey amongst University of Ljubljana students that allowed us to 1) obtain information about students' attitudes toward issues of integrity in research; 2) analyse differences in these attitudes among BA, MA, and PhD students; and 3) statistically validate the competency profile and suggest possible improvements. The results showed that 1) students are highly aware of research integrity issues, as scores were high on all items assessed. However, there were some deviations to lower scores, especially in relation to questionable research practises, confirming our assumption that the 'grey zone' issues are those that should be particularly addressed and given special attention in contemporary research integrity education. 2) The differences in the attitudes of BA, MA, and PhD students showed that higher-level students showed significantly more awareness of integrity issues than lower-level students did, suggesting that research integrity issues should be given special attention at the BA study level. 3) The measurement characteristics showed that the reliability of the questionnaire was very high, suggesting a good overall structure of the competency profile. The principal component analysis

1 *Corresponding Author. Faculty of Education, University of Ljubljana, Slovenia; jurij.selan@pef.uni-lj.si.
2 National Institute of Biology, Ljubljana, Slovenia.

also confirmed the four-field structure of the Competency profile (Values and Principles, Research Practise, Publication and Dissemination, and Violations). However, the analysis also showed that the substructure of the four main areas of the profile did not fully match the results of the factor analysis, suggesting that the distribution of competencies in the competency profile could be reconsidered, especially in the area of Research Practice. The most recent developments in the field of research integrity also suggest that the competency profile should be updated with issues regarding the impact of artificial intelligence on research integrity.

Keywords: competency profile, research integrity, responsible conduct of research, factor analysis, artificial intelligence

Razvoj in validacija kompetenčnega profila za poučevanje in učenje raziskovalne integritete

Jurij Selan in Mira Metljak

Ker raziskovalna integriteta ni nekaj ločenega od raziskovanja, ampak njen sestavni del, jo je treba vključiti v usposabljanje na področju raziskovanja. Obstaja pa več ovir v povezavi s sodobnim izobraževanjem o raziskovalni integriteti. Da bi jih odpravili, smo razvili kompetenčni profil za poučevanje in učenje raziskovalne integritete, ki temelji na štirih predpostavkah: 1) vključiti vse stopnje študija (dodiplomski, magistrski in doktorski študij); 2) vključiti raziskovalno integriteto v raziskovanje; 3) obravnavati vprašanja raziskovalne integritete v kontekstualno specifičnih praksah; 4) posebno pozornost nameniti »sivi coni« ali spornim raziskovalnim praksam. Da bi ocenili veljavnost vsebine kompetenčnega profila in ugotovili, ali so potrebne njegove prilagoditve, smo kompetence v profilu prevedli v postavke merilnega instrumenta (vprašalnika) in izvedli raziskavo med študenti Univerze v Ljubljani. Raziskava nam je omogočila naslednje: 1) pridobiti informacije o odnosu študentov do vprašanj raziskovalne integritete; 2) analizirati razlike v tem odnosu med študenti dodiplomskega, magistrskega in doktorskega študija; 3) statistično potrditi kompetenčni profil in predlagati morebitne izboljšave. Rezultati so pokazali naslednje: 1) študentje se zelo dobro zavedajo vprašanj raziskovalne integritete, saj so pri vseh ocenjenih postavkah dosegli visoke rezultate. Kljub temu je bilo nekaj odstopanj pri nižjih ocenah, zlasti v povezavi z vprašljivimi raziskovalnimi praksami, kar potrjuje našo domnevo, da so vprašanja »sive cone« tista, ki jih je treba v sodobnem izobraževanju o raziskovalni integriteti še posebej obravnavati in jim nameniti posebno pozornost; 2) razlike v stališčih študentov dodiplomskega, magistrskega in doktorskega študija so pokazale, da so se študentje višje stopnje bistveno bolj zavedali vprašanj integritete kot študentje nižje stopnje, kar nakazuje, da bi bilo treba vprašanjem raziskovalne integritete nameniti posebno pozornost že na ravni dodiplomskega študija; 3) merske značilnosti so pokazale, da je bila zanesljivost vprašalnika zelo visoka, kar kaže na dobro splošno strukturo kompetenčnega profila. Tudi analiza glavnih komponent je potrdila strukturo kompetenčnega profila (vrednote in načela, raziskovalna praksa, objava

in razširjanje ter kršitve). Analiza pa je pokazala tudi, da se podstruktura štirih glavnih področij profila ni povsem ujemala z rezultati faktorske analize, kar kaže, da bi bilo treba ponovno razmisliti o razporeditvi kompetenc v kompetenčnem profilu, zlasti na področju raziskovalne prakse. Nedavni razvoj na področju raziskovalne integritete prav tako kaže, da bi bilo treba kompetenčni profil posodobiti z vprašanji glede vpliva umetne inteligence na raziskovalno integriteto.

Ključne besede: kompetenčni profil, raziskovalna integriteta, odgovorno izvajanje raziskav, faktorska analiza, umetna inteligenca

Introduction

Research integrity as an integral part of research

In its project 'OECD Future of Education and Skills 2030', the Organisation for Economic Co-operation and Development (2019, pp. 59–70) emphasises 'reconciling tensions and dilemmas' and 'taking responsibility' as crucial transformative competencies that students need to develop in the future to meet the challenges of the 21st century. These competencies are closely related to issues of research and, therefore, to the issues of research integrity.

Acting in accordance with moral and ethical principles is an integral part of research. According to Böttcher and Thiel (2018), research competencies can be divided into five skills, which Hauser, Reuter, Gruber, and Mottok (2018) reconfigured into four factors that are particularly characteristic of research, one of which is 'ethical issues'. The United States' National Postdoctoral Association (NPA Core Competencies Committee, 2007–2009) also lists 'Responsible conduct of research (RCR)' among six core research competencies. Similarly, The US National Academies of Sciences, Engineering, and Medicine (2017, p. 174) lists the best practices in research related to Research Integrity, Data Handling, Authorship and Communication, Mentoring and Supervision, Peer Review and Research Compliance.

Thus, research integrity or responsible conduct of research (RCR) is not something external to the research but is an integral part of it and should, therefore, also be integrated into research education (National Research Council, 2002, p. 84).

Objectives and goals of RCR education: a four-component model

We can distinguish between the Objectives, Goals, and Benefits of Research Integrity Education (The US National Academies of Sciences, Engineering, and Medicine, 2017, p. 166). Objectives are the general aims that RCR education seeks to achieve in the long term. The US National Academies of Sciences, Engineering, and Medicine (2017) summons the eight major objectives of RCR education identified in the literature: 1) Ensuring and improving the integrity of research; 2) Promoting good behaviour and quality research conduct; 3) Preventing bad behaviour; 4) Decreasing research misconduct; 5) Making trainees aware of the expectations about research conduct within the research enterprise and as articulated in various federal, state, institutional, and professional laws, policies, and practices that exist; 6) Making practitioners

and trainees aware of the uncertainty of some norms and standards in research practices due to such factors as changes in the technology used in research and the globalisation of research; 7) Promoting and achieving public trust in science and engineering; 8) Managing the impact of research on the world beyond the lab, including society and the environment. (p. 197)

Since RCR educational objectives are difficult to measure within a given course, learning goals or learning outcomes, as opposed to objectives, are established to be narrower in scope and more specific to be measured in the assessment of a given activity. Therefore, learning goals are specific learning outcomes related to learning objectives in the sense that they can contribute to them.

Learning goals or learning outcomes are statements of what a learner knows, understands and can do on the completion of a learning process (The European Centre for the Development of Vocational Training, 2011). Learning goals are defined in terms of competencies, which '[…] represent a dynamic combination of knowledge, understanding, skills and abilities'. (Gonzáles & Wagenaar, 2008, pp. 16–17).

Learning goals in RCR education could be divided into four aspects according to Rest's four-component model of morality, which stresses four categories of research integrity learning outcomes: ethical problem-solving skills, ethical sensitivity skills, knowledge of research ethics, and attitudes and values (Rest, 1983, Antes & DuBois, 2014). These four aspects could be summarised as (Bebeau, 2002b; Bebeau, 2002c; Bebeau & Thoma, 1999; Davis & Riley, 2008; Davis & Feinerman, 2010):

1. *Ethical sensitivity* (interpreting the situation as ethical): improving and increasing students' sensitivity to issues concerning the standards of their profession and the ability to identify the ethical issues in a specific situation;
2. *Ethical knowledge or judgment* (judging which of the available actions are most justified): increasing and improving students' knowledge of how to resolve an ethical problem once it has been noticed (from being aware of the appropriate standard to consider (and how to interpret it) to know where to go to make a complaint or seek advice);
3. *Ethical motivation* (prioritising ethics over other important concerns): improving students' judgment and ability to develop an acceptable course of action and provide an appropriate rationale;
4. *Ethical commitment or character* (being able to construct and implement actions that serve ethical decision-making): reinforce and increase student commitment to the standards of their profession and the likelihood that the student will act on them.

According to the National Research Council (2002), the four-component model of morality, therefore, introduces the crucial abilities in research education that enable responsible conduct:

These include the ability to (a) identify the ethical dimensions of situations that arise in the research setting and the laws, regulations, and guidelines governing one's field that apply to those situations (ethical sensitivity); (b) develop defensible rationales for a choice of action (ethical reasoning); (c) integrate the values of one's professional discipline with one's own personal values (identity formation) and appropriately prioritise professional values over personal ones (showing moral motivation and commitment); and (d) perform with integrity the complex tasks (e.g., communicate ideas and results, obtain funding, teach, and supervise) that are essential to one's career (survival skills). (p. 86)

Intermediate concepts

The important aspect that should be introduced into RCR education is intermediate concepts that mediate two levels in moral or ethical cognition (Bebeau & Thoma, 1999). The most general level involves abstract concepts and related principles (e.g., the concept of equality and the corresponding principle, 'everyone must be treated equally'). However, such abstract concepts are difficult to apply to practice because they offer little guidance for one's actions. The six stages of moral development described by Kohlberg (1969, 1976) tend to be general and abstract, like epochs in history, rather than detailed. At the other end of the spectrum, there are very concrete concepts in professional codes of ethics, which are very specific and highly contextual, based on the profession, as different scientific groups have different codes. Such codes are rarely explained in terms of general ethical theories but are taken for granted, functioning like the Ten Commandments.

RCR education, however, takes place somewhere between the abstract and the concrete. It is organised around concepts that are somewhere 'in-between': They are concrete but still general enough to combine practical instruction with moral theory and reasoning. These are concepts such as 'professional autonomy', 'confidentiality', 'informed consent', 'whistleblowing', and similar. Such concepts mediate the abstract and the concrete and can be referred to as 'intermediate level' concepts, which provide more concrete guidance for actions than the general concepts and link concrete actions to theory (see Davis & Feinerman, 2010, pp. 354–355, footnote 5, for a list of such intermediate concepts for teaching RCR to graduate engineering students).

How can research integrity be taught?

Having identified the four aspects of learning outcomes in RCR education, the most important question that follows is: How should these four aspects be taught?

One might draw an analogy to the training of students in the critical analysis of research literature. Students are first introduced to the primary literature, and then complexity is added, for example, through critical reading of journal articles under the supervision of a mentor, through scholars teaching other aspects of the research serving as primary role models, and through assessment of student competence when students are asked to provide evidence for their theories and conclusions. Students are assessed and receive ongoing feedback from the initial seminar presentation through the dissertation defence and submission of the manuscript for publication. (National Research Council, 2002, p. 85)

Similarly, just as a critical analysis of research literature is an integral part of training in all subjects in a study programme, RCR education should be an integral part of training in all subjects in a field of study. In this sense, the four aspects of RCR education (ethical sensitivity, ethical knowledge, ethical judgment, and ethical commitment) should be considered from the perspective of Teaching Strategies and Assessment Methods (National Research Council, 2002, pp. 87–97).

Ethical sensitivity

Ethical sensitivity involves the researcher's awareness of how his actions affect others. It includes the following skills: anticipating the reactions and feelings of others involved in the research (colleagues, mentors, participants, etc.); anticipating alternative courses of action and their effects on all those involved in the research; constructing possible scenarios with knowledge of cause-and-effect chains of events; having empathy and the ability to assume roles; seeing things from the perspective of others involved in the research and considering research scenarios from the perspective of legal, institutional, and national viewpoints; recognising when to apply laws, regulations, and standards in one's profession.

Ethical sensitivity (to issues) differs from the capacity for ethical reasoning (about issues) in the following ways. Ethical sensitivity is the ability to recognise (and not overlook) an ethical issue in a complex situation. In contrast, ethical reasoning is the ability to argue and discuss why an already identified ethical problem is a problem. Thus, focusing on policies and practises related to

the conduct of research (e.g., the use of humans and animals in research; codes related to health and safety; procedures for dealing with allegations of misconduct; authorship practices and policies; data management; conflicts of interest, etc.) is merely a foundation that allows students to develop sensitivity to identifying ethical issues. Ethical sensitivity, however, is not about memorising policy documents and passing knowledge tests but about understanding that such policies and regulations exist and, more importantly, why they exist and how to apply them in real-world situations. Therefore, policies and regulations should be referred to as often as possible in courses so that students become familiar with them and their ability to identify ethical issues and refer to policies becomes habitual.

In training ethical sensitivity, students should develop the ability to recognise ethical problems in complex situations. Therefore, a useful training strategy for improving students' ethical sensitivity is to design complex, real or hypothetical cases or situations that require students to refer to policies, identify stakeholders, consider consequences, and engage in probabilistic reasoning. Sensitivity training differs from standard ethics courses in that cases are presented without any preconceived interpretation to stimulate sensitivity in identification and subsequent discussion. The cases simply present clues to an ethical problem, and students should refer to guidelines and codes themselves to demonstrate proper behaviour. Therefore, the student ethical sensitivity test should assess the student's ability to identify ethical problems, meaning to distinguish relevant from irrelevant information in the cases presented and to identify the norms and values from the guidelines by which the cases should be considered. Several such tests have been developed in which students are presented with hypothetical situations via video; students respond to the cases presented to them, and their responses are assessed.

Ethical reasoning or judgement

Ethical reasoning implies that professionals should be able to critically analyse their own moral arguments and develop defensible points of view for new problems that are likely to emerge during the course of their professional lives (National Research Council, 2002, p. 90).

Students should develop the ability to determine how to modify existing rules to meet the new moral problem. The most useful instructional strategy for promoting ethical reasoning is a teaching and assessment strategy that incorporates the dilemma discussion technique (see also Bebeau, 2002a). The greatest improvement is achieved when the teacher's intervention is added gradually with instruction to enable students to develop well-reasoned written

arguments. In this way, the intervention affects students' reasoning in two ways: developing new thinking to meet new moral problems and reducing or rejecting students' simplistic thinking based on personal interest arguments.

According to the US National Research Council (2002, p. 92), ethical or moral reasoning is defined as the ability to systematically examine a situation and then choose and defend a position on that issue. Arguments are evaluated in terms of the respondent's ability to describe ethical issues and points of conflict, including precedents, principles, rules, or values that support the prioritisation of one interest over another; stakeholders or parties that have a vested interest in the outcome of the situation; likely consequences of possible courses of action; and ethical obligations of central characters.

The difference between hypothetical cases intended to stimulate ethical sensitivity and those intended to stimulate ethical reasoning is this: cases designed to enhance sensitivity are designed to make finding and understanding the ethical problem or conflict difficult (to stimulate sensitivity to ethical issues); in contrast, cases for improving reasoning are designed so that ethical problems or conflicts are relatively easy to identify. However, they are presented as dilemmas that stimulate argumentation and interpretation. Because discussion of dilemmas can lead to fruitless exchanges of student opinions, the teacher should intervene and encourage students to explore the criteria for evaluating moral arguments before engaging in discussion and then to use the criteria to critique each other's oral or written arguments. Assessing ethical reasoning is, therefore, different from assessing ethical sensitivity. In assessing sensitivity, students are presented with complex cases in which they are asked to detect an ethical problem; in tests assessing ethical reasoning, ethical problems are presented through dilemmas, and students are expected to be able to reason and debate them.

Ethical motivation

Why be moral? This is the fundamental question that promotes ethical motivation. Ethical motivation requires the individual to weigh many legitimate concerns that may be incompatible with moral choices (e.g., financial and professional pressures, established relationships, personal concerns) that compete for the researcher's attention (National Research Council, 2002, p. 94). Ethical motivation is the responsibility to bridge the gap between knowing the right thing to do and doing it. Therefore, ethical motivation (doing the right thing) is linked to personal responsibility in identity formation (doing the right thing because I truly believe it is my responsibility to do so). Indeed, individuals may do the right thing not for the sake of personal responsibility but for

other opportunistic reasons (e.g., to gain rewards or esteem to avoid negative consequences) without achieving personal responsibility.

Although the development of personal responsibility in identity formation is a lifelong process, instructional strategies could be used to encourage it. In the past, personal responsibility was developed informally through social interaction with a positive research environment and role models, such as mentors and colleagues; today, it can also be developed in more formal ways, such as through lectures on norms and values in science or by presenting exemplary scientists and their stories. Doing so encourages students to identify with good examples of scientists who have contributed to a larger society and thus develop their sense of responsibility.

Assessment of ethical motivation can be achieved by asking students to write and reflect on the role of scientists ('What does it mean to be a scientist?') and to refer to the norms and values of science in their writing. This work is then assessed by a teacher. Another more quantitative method, as described by Bebeau (2002c), is to use a norm-referenced measure of role concept that measures the extent to which the individual incorporates norms and values of the profession into their identity.

Ethical commitment or character

Becoming 'streetwise' in research integrity requires not only ethical sensitivity, reasoning, and judgement but also commitment: these are the 'survival skills' that enable researchers 'to perform the complex tasks of the discipline with integrity' (National Research Council, 2002, p. 96). A researcher can be ethically sensitive and make good ethical decisions, but if he or she slacks off under pressure or has a weak will, moral failure can result because of a lack of character.

Ethical commitment or courage could be fostered so that students develop skills that are often neglected in research training but are essential as survival skills for a scientist: how to present results at scientific meetings; how to defend one's methods; how to write written reports; how to learn from critical comments made by one's colleagues and how to comment or evaluate one's colleagues; how to obtain funds for one's research; how to hire collaborators; how to teach courses; and how to mentor students. Therefore, the assessment of ethical commitment could be achieved by asking students to edit a description of an experiment, review a research article written by a colleague, and perform similar tasks. The point of stimulating and assessing ethical commitment is that students should develop the courage to communicate with the research community, to express and accept criticism of their work, and thereby be prepared for the types of evaluation they will encounter and experience in their careers.

At which study level should RCR be taught?

Historically, the primary responsibility for training scholars in RCR has rested with their mentors, meaning RCR training occurred informally, led by examples within a research group, led by a senior researcher who served as a mentor to all novices in the group. In recent decades, RCR has been formalised at the initiative of national agencies and governments, resulting in widely varying approaches to RCR education, with the majority of institutions adopting a framework that requires students to complete online courses (Diaz-Martinez et al., 2019). Despite these efforts, according to Diaz-Martinez et al. (2019), the following three hindrances remain: 1) Research integrity is mostly reserved and taught at the PhD level when students are more intensively engaged in research and research collaboration. 2) Although RCR is an integral part of research, RCR training is mostly taught in a stand-alone format that places it outside the context of the research sphere. 3) RCR education is most often designed to address issues in general and does not address context-specific practices and standards of research integrity.

With the recent impetus to include authentic research opportunities as part of the undergraduate curriculum, there is also a growing need for undergraduate RCR education that does not stand alone but is integrated with research itself. Diaz-Martinez et al. (2019) suggest that teaching teams seeking to implement RCR education effectively within their undergraduate research consider an approach that includes: 1) identification of appropriate RCR student learning objectives (SLOs) and specific topics that are relevant to the research; 2) The design and/or identification of curricular minilessons that are aligned with assessment(s) and SLO(s); 3) development and/or identification of appropriate assessments that are aligned with respective curriculum and SLO(s); 4) facilitation of professional development for those individuals implementing E/RCR education within CUREs (e.g., instructors of record, teaching assistants, peer leaders).

Grey Zone and Questionable Research Practices (QRP)

Butler et al. (2017) caution that obvious examples of overt fraud revealed in public, such as in falsification, fabrication, and plagiarism (FFP), obscure less blatant and more subtle instances of 'questionable research practices' (QRP), which often involve misrepresentations, inaccuracies, or bias (e.g., misattribution of authorship, omission of outliers, and the so-called salami slicing of data). They attribute the existence of QRPs to three reasons: the inadequate training of researchers, the pressures and incentives to publish in certain outlets, and

the demands and expectations of journal editors and reviewers. Studies have shown that QRPs are far more widespread than FFPs, with between 30% and 90% of researchers using them.

The rise of QRPs could be attributed – ironically – to the increasing awareness of FFP, which leads scientists to systematically 'push' their results in the desired direction by artificially inflating significance in some way while being careful not to cross the line into overt misconduct (Butler et al., 2017). Like athletes, scientists are aware of the 'black' line of misconduct and are therefore careful not to cross it but to approach it as closely as possible to increase 'performance'. However, the responsibility for QRP does not rest on individuals, and exposing a few individuals only masks systemic problems, such as the role of journals in creating an environment in which QRPs thrive (see also Western cultural bias by which publication is more complicated for non-Western academics and other discriminative practices in an academic environment; Alemu, 2020, p. 84; Hussain, 2023), as editors want to inflate impact factors and increase journal rankings, and therefore encourage authors to 'play the game' to increase their chance of publication. Therefore, we should emphasise that misconduct does not occur in a vacuum but arises from organisational or institutional constraints and incentives, so-called 'organisational misconduct.' (Hall & Martin, 2019, p. 415)

Wherever one chooses to draw the line, FFPs are seen as inherently negative, 'black' practices, while QRPs fall into an ethical 'grey area' between acceptable (scientific best practices) on the one hand and unacceptable ('black' FFPs) on the other. For this reason, the grey zone QRPs should be taken into full consideration to promote research integrity instead of merely simply exposing and punishing wrongdoers for their flagrant transgressions (Butler et al., 2017).

Focusing only on FFP allows a whole range of practices to fall through the cracks and results in published work that is misleading in some way (Butler et al., 2017, p. 106). Fanelli (2013, p. 149; see also Butler et al., 2017, p. 106) therefore suggests redefining academic misconduct as 'distorted reporting', which can refer to any omission or misrepresentation of information necessary to assess the validity and significance of the research, meaning any discrepancy between what was done and what was reported. Such an approach would capture not only FFPs but also QRPs, shifting the focus from the most egregious cases of FFP to more subtle forms of potential misconduct where the greatest public harm occurs (Steneck, 2006, p. 66).

For that reason, Hall and Martin (2019) developed a formal taxonomy that:

1. Distinguishes appropriate conduct from blatant misconduct but with a particular focus on the 'grey areas' between these extremes in the form of questionable and inappropriate behaviour. The taxonomy differentiates

between the categories of blatant misconduct (e.g., data fabrication, data falsification), inappropriate conduct (e.g., selective reporting, omitted data), questionable conduct (e.g., HARKing), and appropriate conduct (e.g., Winsorisation).

2. Assesses these categories based on the stakeholders (other researchers, employees, students, editors and journals, societal stakeholders) affected by the misconduct as well as the severity, ranging from very high severity (in premeditated dishonesty and intentional rule-bending) to medium (in less intentional poor behaviour that may arise due to complexity, sloppiness, ignorance) and to low severity (in honest error).

Research problem and research goals

Acting in accordance with the principles of research integrity is increasingly complex and challenging in contemporary science and research. Since research integrity is not something that is external to research but an integral part of it, it should be integrated into research training. Although there are many codes of conduct, policies, guidelines, and manuals on what research integrity encompasses and how it should be taught, our theoretical review shows that there is no common educational model–a competency profile–that could address all the drawbacks of current RCR education and thus provide a systematic and all-encompassing RCR education that activates the four levels of RCR education (sensitivity, reasoning, motivation, commitment).

The drawbacks regarding RCR education can be summarised in four interrelated points, as explored above: 1) Research integrity education is mostly reserved for the PhD level, while it is less systematically addressed at the undergraduate level. In particular, there is no set progression regarding how RCR education should become more complex from BA, MA, to PhD levels. 2) Although research integrity is an integral part of research, it is usually taught 'per se' and not integrated into the professional disciplines in which the research 'takes place'. 3) As a result, RCR training in such a stand-alone format is often very general but does not address the standards of research integrity in the specific context and practices within the professional fields. 4) Because RCR training mostly provides only general directions from codes of conduct, policies, and guidelines, it usually includes and addresses only the obvious research misconduct (FFPs), but not the 'grey area' or questionable research practices (QRPs) where the real research integrity issues occur.

With this in mind, we have developed a competency profile for teaching and learning research integrity (See Selan et al., 2021, for more detail on

the development and structure of the profile) that responds to these drawbacks and could serve as a basis for systematic and all-encompassing RCR education to students of different study programmes and at all three levels of study (BA, MA, and PhD).

Our competency profile (Selan et al., 2021) identifies four main areas of research integrity: Values and Principles, Research Practise, Publication and Dissemination, and Violations. Each area is divided into four sub-areas covering topics within the main area. The goal was to create a cross-section and unified set of competencies that name all possible aspects of research integrity that might be encountered. The profile thus includes 80 competencies (15 for Values and Principles; 16 for Research Practice; 17 for Publication and Dissemination; and 32 for Violations). This overall structure of competencies is then translated into specific actions or behavioural indicators that progressively increase in complexity according to the three levels of study (BA, MA, PhD) and are summarised in core learning objectives and outcomes for all levels of study (BA, MA, PhD) that round out the four levels of RCR education (sensitivity, reasoning, motivation, commitment).

It is important to emphasise that the competencies in the competency profile are conceptualised and designed as 'intermediate concepts' that link concrete actions (behavioural indicators) to abstract principles and theories. They are intended to cover all aspects of research integrity, and the user (teacher, student) can select from them those that are relevant to his or her field of research.

The competency profile has been implemented into educational practice and served as a basis on which the courses on research integrity for students of BA, MA and PhD levels of different study programmes were designed. The courses were designed and conducted at the University of Ljubljana, Karlova University, and the University of Utrecht within the project 'INTEGRITY' with the support of the Erasmus+ programme of the European Union, project number 2018-1-NL01-KA203-038900. Some of these courses are also evaluated in papers presented in this special issue of CEPS Journal (See article Academic Writing in Teaching Research Integrity on pages 129–154).

However, the competency profile has not yet been empirically validated with regard to the content of the competency profile and to see if some adjustments to the profile are needed. Thus, our goal for empirical research was threefold. Because the profile is intended to provide a foundation for teaching and learning about integrity in research for students at all levels of study (BA, MA, and PhD), we wanted to obtain information about 1) students' attitudes, awareness, and opinions about issues of integrity in research that are addressed

in a profile; 2) specifically, how students' attitudes, awareness, and opinions about issues of integrity in research differ among BA, MA, and PhD students; 3) because the competency profile is theoretically based, we wanted to validate it empirically and, if necessary, modify the categories in the profile (by accentuating some categories and eliminating others) based on a statistical analysis similar to how Hauser, Reuter, Gruber, and Mottok (2018) validated and modified the factor structure of Böttcher and Thiel's (2018) F-Comp questionnaire to measure research competencies.

Method

To achieve these three goals, we used a quantitative research method: a survey. We translated the categories of the profile into items of a measurement instrument: a questionnaire. Based on four fields (and corresponding subfields) of research integrity identified in the competency profile (Values and Principles, Research Practice, Publication and Dissemination, and Violations), the questionnaire also formed four basic scales with comparable items. The 80 competencies in the competency profile were translated into 74 items (18 for Values and Principles, 17 for Research Practice, 15 for Publication and Dissemination, and 24 for Violations) of a questionnaire that asked students to rate, on a scale of 1 (not at all) to 5 (fully), the extent to which they understand, know, are aware of, or are able to act as researchers in the area of research integrity.

Sample

A total of 177 University of Ljubljana students responded and participated in the survey: 84.2% were female, and 14.7% were male. The BA students represented 65.5% of the total, 29.4% were MA students and 5.1% PhD students. They were of different study areas; see Table 1.

Table 1
Area of study (FORD classification)

	f	f %
Natural sciences	26	14.7
Technical and technological sciences	18	10.2
Medicine and medical sciences	12	6.8
Social sciences	97	54.8
Humanities	24	13.6
Total	177	100.0

Instrument

The online questionnaire, designed in the 1ka platform[3], was sent via e-mail through administration support systems to all University of Ljubljana students of different study programmes and of all three levels of study (BA, MA, PhD). Data were collected between December 7, 2022, and January 5, 2023.

Based on the data and to obtain an answer to our research goals, we then 1) made descriptive statistics about the importance of each item (students' answers) in four designed scales; 2) analysed differences between subgroups (BA, MA, and PhD students); and 3) calculated the measurement characteristics of the questionnaire.

Data analysis

The questionnaire and students' responses were analysed and verified by statistical analysis in the following way. Data were processed using the SPSS software (version 22) for statistical analysis to measure the characteristics of four basic scales, individual items, and the profile as a whole. Descriptive statistics are presented with mean and standard deviation parameters; sub-groups differences were analysed with the Kruskal-Wallis test since the distribution was not normal. The Cronbach alpha coefficient was calculated for the reliability of the measurement characteristics of the questionnaire and, finally, a principal component analysis (PCA) was performed to test validity.

Results

Descriptive statistics

To measure the importance of each item, we analysed students' responses/assessments in four designed scales that provided answers to our first research goal: to obtain information about students' attitudes, awareness, and opinions about research integrity issues addressed in a profile.

The following four tables (Tables 2–5) show the three highest and three lowest-scoring items of the four scales: Values and Principles, Research Practice, Publication and Dissemination, and Violations. The entire questionnaire with descriptive statistics for all 74 items is included in the Appendix (see Appendix 1).

3 1KA is an application that enables online surveys (www.1ka.si).

Table 2

Three highest and lowest assessed items of the Values and Principles scale

Item no.		N	Min	Max	Mean	Std. Dev.
	3 highest assessed items					
6	I am aware that I must not encourage participants to participate in the research in an inappropriate way (coercion, bribery, etc.).	177	2	5	4.85	0,453
7	I am aware that, as a researcher, my conduct should not affect the judgment, actions, or responses of the participants in the research.	175	2	5	4.82	0.452
4	I am aware that participants in the research must participate on a voluntary basis.	176	2	5	4.82	0.521
	3 lowest assessed items					
17	I believe that research must be regulated at the national level with appropriate laws, codes, regulations and, as a result, sanctions for violations.	177	2	5	4.45	0.804
15	I am aware that, as a researcher, before starting the research, I have to check possible harmful effects or research implications.	177	1	5	4.44	0.909
10	I am aware that I can only conduct research with animals if I am properly qualified to do so.	177	1	5	4.40	1.056

All items in the Values and Principles scale scored quite high: the lowest mean score was 4.40 out of 5. Students indicated that they are most aware that they must not motivate participants to be part of research in the wrong way (e.g., coercion, bribery, etc.). They are least aware that they must not involve animals in research unless they are properly qualified to do so.

Table 3
Three highest and lowest assessed items of the Research Practice scale

Item no.		N	Min	Max	Mean	Std. Dev.
	3 highest assessed items					
25	I believe that older (more experienced) researchers should not abuse their position (e.g., to sign the research as authors, even though they did not participate in it).	140	2	5	4.84	0.517
33	If we are conducting research in a group, I understand that I must share the data I obtain with the other researchers in the research group.	141	3	5	4.82	0.441
34	If we are conducting research in a group, I am aware that everyone who participates in the research is responsible for the proper conduct of the research.	141	2	5	4.73	0.546
	3 lowest assessed items					
27	I know different research approaches.	141	1	5	3.84	0.973
26	I know the research methodology in my field of expertise.	141	1	5	3.82	0.968
29	I know the appropriate procedures for data processing (e.g., statistics).	141	1	5	3.70	0.941

The lowest average scores in the Research Practice scale are slightly lower than in the Values and Principles scale. It is interesting to note that the highest score is for the item that senior researchers should not abuse their position (e.g., sign as author of research in which they were not involved). The lowest scores were for items related to knowledge in the research field: knowledge of research styles, knowledge of methodology in the field, and knowledge of data analysis.

Table 4

Three highest and lowest assessed items of the Publication and Dissemination scale

Item no.		N	Min	Max	Mean	Std. Dev.
	3 highest assessed items					
40	I am aware that I must also publish negative results in the research report if they occur.	132	2	5	4.79	0.539
39	I am aware that I must include only real data and performed activities in the research report, and I must not subsequently modify the results and performed activities.	132	3	5	4.78	0.499
41	I am aware that I must not tailor data and research results to the expectation of the publisher (e.g., journal) where I want to publish them.	132	2	5	4.75	0.558
	3 lowest assessed items					
49	I am aware that I must publish the results of the research only in a journal/publication with an appropriate review process.	132	1	5	4.13	1.029
44	I am aware that as a peer reviewer, I must not share the results of the research I am reviewing with other colleagues before the paper is published.	132	1	5	4.11	1.148
45	I know that as a published author myself, I need to inquire about the different publication procedures of different media/magazines.	132	1	5	4.11	1.009

It is encouraging that in the Publication and Dissemination scale, participants, on average, gave the highest rating for being aware that negative results must also be included in the report. The lowest rating was for knowing that authors themselves are responsible for making inquiries about publication protocols in various journals/media.

Table 5
Three highest and lowest assessed items of the Violations scale

Item no.		N	Min	Max	Mean	Std. Dev.
	3 highest assessed items					
70	I am aware that no matter how many people do it, cheating in research is always just as problematic.	126	2	5	4,80	0,522
69	I am aware that I must not duplicate data/results, even if others do.	126	2	5	4,79	0,546
51	I am aware that I must not adjust the data afterwards in order to achieve desirable results that would confirm my hypotheses.	125	1	5	4,78	0,633
	3 lowest assessed items					
63	I am aware that I must not make the results public before they have been peer-reviewed.	125	1	5	4,13	1,164
58	I am aware that I should not publish the same research reports multiple times in different journals.	126	1	5	3,53	1,355
57	I believe that I should not use the results of one research study for several different publications.	126	1	5	3,30	1,358

The last scale referred to Violations. It is encouraging that students are aware that misconduct in research is always problematic, no matter how many others do it. The lowest mean score was for the assessment that students believe that the results of a research study cannot be used for more than one publication. Interestingly, the lowest scoring items on the Violation scale are those dealing with the 'grey zone' or Questionable Research Practices (QRPs), which was to be expected since QRP issues are not obviously right or wrong but require a subtle awareness of misconduct.

Sub-group differences

To obtain an answer to our second research goal, regarding how students' attitudes, awareness, and opinions about issues of integrity in research differ among BA, MA, and PhD students, we analysed the differences among subgroups in students' ratings of the items.

As can be seen in Table 6, statistically significant differences between

levels of study were seen in 2 of 18 items in the Values and Principles scale, 3 of 17 items in the Research Practice scale, 5 of 15 items in the Publication and Dissemination scale, and 7 of 24 items in the Violations scale.

For Items 2, 27, 28, 40, and 45, 47, the PhD students' assessment on average was higher than those of the other two groups (BA, MA). Most of the items are in the scales Research Practice and Publication and Dissemination; the reason for this could be that PhD students have more knowledge and experience in research and are more competent and confident in methods and publication. In the Violations scale, with the exception of one item, BA students rated their knowledge/awareness/belief lower than the other two groups (MA, PhD). For two items (38, 41), BA students' ratings were lower than those of MA students, and for one (26) they were lower than those of PhD students. The mean rating of Item 1 was highest for PhD students and lowest for BA students.

Furthermore, in assessing other items for which a statistically significant value was not found, there is a trend for higher-level students to show greater awareness or knowledge of the research integrity issues. This result is to be expected as MA students and doctoral students have more research knowledge and experience compared to BA students.

Table 6

Kruskal-Wallis test of between-group comparison on items where statistically significant differences were shown

Item no.		Study level	N	MR	M	SD	$X^2(2)$	
		Values and Principles						
1	I am aware that I must conduct the research according to ethical principles.	BA[2,3*]	115	83.77	4.66	0.62	6.425	.040
		MA[3]	52	95.76	4.87	0.35		
		PhD	9	107.00	5.00	0.000		
		Total	176					
2	I am aware that I must conduct the research objectively, honestly and in a transparent manner.	BA	114	82.17	4.65	0.624	7.791	.020
		MA	51	96.07	4.84	0.464		
		PhD[1,2]	9	106.50	5.00	0.000		
		Total	174					
		Research Practice						
26	I know the research methodology in my field of expertise.	BA	87	65.22	3.67	1.008	6.908	.032
		MA	45	77.00	3.98	0.866		
		PhD[1]	9	96.83	4.44	0.726		
		Total	141					

Item no.		Study level	N	MR	M	SD	X^2(2)	
27	I know different research approaches.	BA	87	67.64	3.76	0.988	7.777	.020
		MA	45	70.56	3.84	0.952		
		PhD[1,2]	9	105.67	4.67	0.500		
		Total	141					
28	I know the appropriate procedures for data collection.	BA	87	67.97	3.86	0.809	7.866	.020
		MA	45	69.92	3.89	0.935		
		PhD[1,2]	9	105.67	4.67	0.500		
		Total	141					
		Publication and Dissemination						
38	I am aware that I must prepare a research report (e.g., a paper) responsibly, regardless of the quality, importance, and reputation of the publication (e.g., journals, monographs, etc.) in which the report will be published.	BA[2]	82	61.15	4.54	0.670	7.122	.028
		MA	41	76.50	4.85	0.358		
		PhD	9	69.72	4.67	0.707		
		Total	132					
40	I am aware that I must also publish negative results in the research report if they occur.	BA	82	61.63	4.68	0.646	8.793	.012
		MA	41	73.93	4.95	0.218		
		PhD[1,2]	9	77.00	5.00	0.000		
		Total	132					
41	I am aware that I must not tailor data and research results to the expectation of the publisher (e.g., journal) where I want to publish them.	BA[2]	82	61.80	4.66	0.633	6.878	.032
		MA	41	74.59	4.90	0.374		
		PhD	9	72.50	4.89	0.333		
		Total	132					
45	I know that as a published author myself, I need to inquire about the different publication procedures of different media/magazines.	BA	82	65.88	4.11	0.981	7.141	.028
		MA	41	61.22	3.95	1.094		
		PhD[1,2]	9	96.17	4.89	0.333		
		Total	132					
47	I understand that the structure and style of a research report may vary by professional field.	BA	81	62.30	4.43	0.724	6.421	.040
		MA	41	67.82	4.49	0.840		
		PhD[1,2]	9	91.00	5.00	0.000		
		Total	131					
		Violations						
51	I am aware that I must not adjust the data afterwards in order to achieve desirable results that would confirm my hypotheses.	BA[2,3]	76	58.86	4.67	0.755	6.950	.031
		MA	41	68.93	4.93	0.346		
		PhD	8	72.00	5.00	0.000		
		Total	125					

Item no.		Study level	N	MR	M	SD	$X^2(2)$	
52	I know that I should not selectively interpret the research results in a way that would better answer my research questions.	BA[2]	76	57.59	4.54	0.807	9.586	.008
		MA	41	72.82	4.88	0.510		
		PhD	9	71.00	4.89	0.333		
		Total	126					
61	I know that I must properly cite (cite or paraphrase) when I summarise other authors.	BA[2,3]	76	59.39	4.66	0.684	5.981	.050
		MA	41	68.70	4.90	0.300		
		PhD	9	74.50	5.00	0.000		
		Total	126					
62	I know that I need to properly reference (cite or paraphrase) when summarising my past research.	BA[2,3]	76	58.32	4.47	0.887	7.706	.021
		MA	41	69.82	4.80	0.558		
		PhD	9	78.50	5.00	0.000		
		Total	126					
71	I am aware that I must avoid conflicts of interest when doing research (e.g., personal - I make a negative review because I don't like someone; financial - I manipulate the results of the drug's effectiveness because I am funded by the company that manufactures the drug; ideological - I disagree with research results because they contradict my beliefs; etc.).	BA[2,3]	76	58.05	4.58	0.753	8.942	.011
		MA	41	70.74	4.90	0.300		
		PhD	9	76.50	5.00	0.000		
		Total	126					
73	I believe that handling violations should be transparent, fair, and confidential/anonymous until the process is officially closed.	BA[2,3]	76	57.99	4.47	0.840	8.227	.016
		MA[3]	41	69.99	4.78	0.525		
		PhD	9	80.50	5.00	0.000		
		Total	126					
74	I believe that if I notice and report a violation, I should be properly protected (by the institution).	BA[2,3]	76	57.81	4.55	0.737	9.143	.010
		MA	41	70.87	4.88	0.331		
		PhD	9	78.00	5.00	0.000		
		Total	126					

*Indicates between groups comparison where Games Howell Post Hoc test showed statistical significance ($p \geq .05$)

Measurement characteristics of the profile

To obtain an answer to our third research goal, which was to empirically validate the competency profile and, if necessary, to modify its categories (competencies), we calculated the measurement characteristics of the questionnaire.

First, we calculated the Cronbach's alpha coefficient to determine the reliability of the questionnaire. As can be seen (Table 7), the reliability coefficients for the four scales and the questionnaire as a whole are all around .900 or higher. Therefore, we can conclude that the overall reliability of the questionnaire and also the reliability of all the individual scales is highly satisfactory and strong, so there is no need for adjustment, which also suggests that the overall structure of the competency profile is good. Since the Research Practice scale deviates slightly in the negative direction of reliability, perhaps some improvements could be made to this scale. The factor analysis we conducted (see Table 8) also suggests that the Research Practice domain of the profile could be reconsidered.

Table 7
Cronbach's Alpha coefficients

Scale	Cronbach's Alpha	N of Items	N of valid cases
Values and Principles	.918	18	171
Research Practice	.898	17	140
Publication and Dissemination	.909	15	131
Violations	.950	24	121
All items	.975	74	119

A factor analysis was then performed to determine the extent to which shared variance existed between the items of the questionnaire. The 74 items of the questionnaire were subjected to principal component analysis (PCA). First, the suitability of the data for factor analysis was checked. A review of the correlation matrix revealed that many coefficients were .3 and above. The Kaiser-Meyer-Olkin value was .766, which is well above the recommended value of .6, and Bartlett's Test of Sphericity reached statistical significance ($p \leq .000$), confirming the factorability of the correlation matrix.

Principal component analysis (Table 8) yielded several possible solutions, but a four-component option was the most robust, explaining a total of 55.84% of the variance, with Component 1 contributing 39.79%, Component 2 7.89%, Component 3 4.43%, and Component 4 3.74% of the variance. A four-component oblimin rotation was performed. Component 1 showed a loading of 28 items, Component 2 of 19 items, Component 3 of 22 items, and Component 4 of 5 items.

Table 8

Principal Component Analysis (PCA)

Item no.	Area in Competency profile	Component			
		1	2	3	4
74	Violations	.855			
70	Violations	.853			
40	Publication and Dissemination	.828			
71	Violations	.822			
67	Violations	.822			
69	Violations	.818			
68	Violations	.815			
61	Violations	.785			
60	Violations	.767			
41	Publication and Dissemination	.755			
66	Violations	.733			
51	Violations	.730			
55	Violations	.721			
38	Publication and Dissemination	.705			
52	Violations	.693			
6	Values and Principles	.686			
39	Publication and Dissemination	.678			
3	Values and Principles	.654			
7	Values and Principles	.650			
59	Violations	.638			
4	Values and Principles	.634			
62	Violations	.626			
33	Research Practice	.620			
65	Violations	.620			
46	Publication and Dissemination	.618			
73	Violations	.615			
25	Research Practice	.583			
72	Violations	.553			
49	Publication and Dissemination		.776		
50	Publication and Dissemination		.766		
45	Publication and Dissemination		.761		
58	Violations		.759		
63	Publication and Dissemination		.704		
28	Research Practice		.674		
57	Violations		.672		
64	Violations		.657		
22	Research Practice		.640		

Item no.	Area in Competency profile	Component			
		1	2	3	4
44	Publication and Dissemination		.633		
27	Research Practice		.602		
47	Publication and Dissemination		.581		
48	Publication and Dissemination		.566		
29	Research Practice		.561		
30	Research Practice		.552		
37	Publication and Dissemination		.549		
26	Research Practice		.548		
43	Publication and Dissemination		.535		
36	Publication and Dissemination		.420		
13	Values and Principles			.770	
14	Values and Principles			.767	
2	Values and Principles			.728	
15	Values and Principles			.715	
23	Research Practice			.699	
5	Values and Principles			.683	
18	Values and Principles			.670	
35	Research Practice			.666	
1	Values and Principles			.636	
21	Research Practice			.633	
31	Research Practice			.620	
17	Values and Principles			.620	
24	Research Practice			.615	
12	Values and Principles			.606	
42	Publication and Dissemination			.592	
11	Values and Principles			.589	
32	Research Practice			.584	
9	Values and Principles			.579	
20	Research Practice			.569	
16	Values and Principles			.552	
10	Values and Principles			.547	
19	Research Practice			.523	
56	Violations				-.727
34	Research Practice				-.647
54	Violations				-.636
8	Values and Principles				-.609
53	Violations				-.603

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalisation.

Discussion

Numerous codes of conduct, policies, guidelines, and manuals on what research integrity encompasses exist. However, our literature review shows that there is no common educational model, no specifically developed competency profile that could address all the drawbacks of current RCR education and thus provide a systematic and all-encompassing RCR education that activates the four levels mentioned above (sensitivity, reasoning, motivation, commitment). A competency profile we developed for teaching and learning research integrity (Selan et al., 2021) responds to the drawbacks that Diaz-Martinez et al. (2019) highlight regarding current research integrity training (1) RCR is mostly taught at the PhD level; 2) RCR training is mostly taught in a stand-alone format that places it outside of the research context; 3) RCR training is mostly designed to address general topics rather than context-specific practices) and, in addition to that, systematically include and address 'grey area' topics or questionable research practices (QRPs) in research integrity education, as emphasised by Hall and Martin (2019) and Butler et al. (2017). Therefore, the critical contribution of our competency profile to RCR education is to 1) progressively increase the complexity of research integrity competencies and enable students at all levels of study (Bachelor (BA), Master (MA), and doctoral (PhD)) to become progressively 'streetwise' about research integrity; 2) integrate RCR into research education itself; 3) provide context-specific behavioural indicators that can be used to address research integrity issues in different professional fields; and 4) pay particular attention not only to overt misconduct (FFPs) but also to more subtle and harmful questionable research practices (QRPs) from which, as pointed out by Steneck (2006, p. 66), the greatest public harm occurs.

Even though competency models are normatively justified and have a conclusive theoretical basis, they are not static, so they need to be validated and updated regularly in the process of gathering and analysing evidence to support the relevance and accuracy of competency models (Schaper, 2017; LinkedIn, 2023). Validation identifies strengths but also gaps and areas for improvement in competency models to determine if they must be updated (revised and refined) and how.

According to Schaper (2017), there are four criteria of validation, which must be met to assume that a competency model generates new insights and can be justifiably used for the intended purpose: for improving teaching quality, whatever the educational context may be. First, the model should be based on proven and evidence-based notions about the structure and ranking of competencies in a field of application. Second, a competency model should be

consistent and generalisable in their descriptions of competencies for a particular professional domain. Third, a competency model should be organised and formulated such that it can be understood by the target groups while making reference to needs and prior conceptions to ensure sufficient acceptance within the target group. Fourth, the practical applicability of a competency model should be based on theoretically and empirically supported evidence and arguments. Different empirical methods can be used to validate competency models, including interviews, surveys, observations, focus groups, and subject matter experts, among others.

In reference to the first criterion, our competency profile is constructed in such a way that it enables RCR education to be all-encompassing and thoroughly integrated into the research education itself, thus enabling students to become 'streetwise' and 'to perform the complex tasks of the discipline with integrity' meaning activating not only ethical sensitivity, reasoning, and judgement, but also commitment: as The US National Research Council (2002, p. 86, 96) emphasises, these are 'survival skills'. Activating the four aspects of RCR education according to Rest's four-component model of morality emphasised by many researchers (Bebeau, 2002b; Bebeau, 2002c; Bebeau & Thoma, 1999; Davis & Riley, 2008: Davis & Feinerman, 2010) is one of the key aspects of our competency profile.

Regarding the second and third criteria, the important aspects of our competency profile are that competencies are conceived and designed as 'intermediate concepts' that link concrete actions (behavioural indicators) to abstract principles and theories (Bebeau & Thoma, 1999). Thus, our competency profile can serve as a list that encompasses and covers all areas of research integrity (similar to Davis and Feinerman's (2010) list for teaching RCR to graduate engineering students; Davis and Feinerman, pp. 354–355, footnote 5) and can be applied to a particular professional domain in a way that it can be understood by the target groups.

However, in light of recent developments and regarding the all-encompassing nature of our competency profile, a highly relevant area is missing from our competency profile and list of intermediate concepts. We developed the competency profile in 2021 (Selan et al., 2021). Although the use of artificial intelligence (AI) in research did not appear out of the blue, and its threat to academic integrity was detected a few years ago (Nanda, 2021), it was not until November 2022, when ChatGPT was launched, and its ability to extract information and generate text was made widely publicly available, that it became an issue to be seriously considered within the research integrity education. Because AI tools can produce seemingly human-written texts by drawing on

knowledge disseminated throughout the internet, their use greatly compromises research integrity. Government institutions, universities, academic journals, and publishers have, therefore, in the past year begun desperately and intensively to implement safeguards to prevent the misuse of AI tools in research and its publication (Bison, 2023; Brent, 2023; Council of Europe, 2023; Eaton, 2023; Hussain, 2023; Ohio State University, 2023; Trachtenberg, 2023; Turnitin, 2023; University of Cambridge, 2023; York University, 2023; Zobel, 2023). The relationship between AI and research integrity has become one of the most active and vital areas of discussion on research integrity in 2023, with many scholarly articles and books already published (Currie, 2023; Dawson, 2023; Eke, 2023; Olatunde Oduoye et al., 2023), and thus the inclusion of this area also requires an improvement of our competency profile.

Regarding the fourth criterion of practical applicability (Schaper (2017), our competency profile has been put into educational use in the courses designed and conducted at the University of Ljubljana, Karlova University, and the University of Utrecht within the project 'INTEGRITY' with the support of the Erasmus+ programme of the European Union, project number: 2018-1-NL01-KA203-038900. Some of these courses are also evaluated in the articles of this special issue of the CEPS Journal (See article Academic Writing in Teaching Research Integrity on pages 129–154). These courses demonstrate and confirm the practicality and usefulness of the competency profile in terms of its all-encompassing nature. Indeed, the courses designed were highly diverse and served students of different levels and different study programmes, from BA, MA, to PhD levels and from humanities and social sciences to natural sciences.

However, to provide empirical validation and empirically assess the validity of the content of our competency profile and to determine whether some adjustments to the profile are needed, we also tested it statistically in a way Hauser, Reuter, Gruber, and Mottok (2018) validated and modified the factor structure of Böttcher and Thiel's (2018) F-Comp questionnaire to measure research competencies. The overall reliability of the questionnaire and the reliability of all the individual scales are shown to be strong; only the Research Practice scale deviates slightly, suggesting some improvements would be possible. In relation to the four-field structure of the competency profile, the factor analysis (i.e., principal component analysis (PCA)) also suggested that a four-component option was the most robust. Based on the PCA, we can thus make the following interpretation about the structure of our original competency profile. The four-component solution we derived from PCA seems to confirm that the four-field structure of the original Competency profile (Values and Principles, Research Practise, Publication and Dissemination, and Violations) is overall sound and firm. However, the

distribution of items in Components 1, 2, 3, and 4 is not as clear-cut as originally defined in the questionnaire (Table 8). Component 1 consists predominantly of Violation items (16 out of 28), Component 2 consists predominantly of items on Publication and Dissemination (10 out of 19), Component 3 consists predominantly of items on Values and Principles (13 out of 22), while Component 4 consists of only five items, most of which are from the Violations domain (3 out of 5). The Research Practice items are not predominant in any of the four components but are most prevalent in Component 2 (6 of 19) and Component 3 (8 of 22). Therefore, the substructure of the components does not fully align with our theoretically defined subdomains and competencies of the competency profile, suggesting that the distribution of subdomains and competencies in the original competency profile could be reconsidered and reorganised. In particular, the Research Practice area could perhaps be reconsidered, as also suggested by its somewhat lower reliability (Table 7). As suggested above, problems regarding AI and research integrity should also be included in the competency profile to keep it up to date with the most contemporary issues and dilemmas in RCR education.

Conclusion

The goal of our research was to develop and validate the competency profile for teaching and learning research integrity. The profile is based on four assumptions: 1) to include all levels of study (BA, MA, and PhD); 2) to integrate RCR education into research education itself; 3) to be specific enough to address research integrity issues in context-specific practices; 4) to pay particular attention to the 'grey zone' or Questionable Research Practices (QRPs).

To test and validate the profile, we developed a questionnaire that allowed us to 1) obtain information about students' attitudes toward research integrity issues, 2) identify differences in these attitudes among BA, MA, and PhD students, and 3) statistically validate the competency profile and suggest possible improvements.

The results showed that:

1. In general, students are well aware of research integrity issues, as the scores were quite high on all items assessed. However, there were some deviations to lower scores on the items in Research Practice and Violations scales. For Research Practice, the lowest score was related to knowledge of methodological procedures, and for Violations, the lowest score was related to the 'grey zone' or QRPs, confirming our assumption that the 'grey zone' issues are precisely the ones that should be addressed and given special attention in present-day research integrity education.

2. The differences in the attitudes of BA, MA, and PhD students indicated that the higher-level students have a significantly stronger awareness of integrity issues than the lower-level students. This suggests that special attention should be paid to addressing integrity issues in research, even at the lowest levels of study, and not only to PhD students. Again, this confirms one of the assumptions on which we based our profile, namely that research integrity should not only be taught to PhD students but that training in research integrity should begin at the BA level and gradually increase in complexity through MA to PhD level.
3. The measurement characteristics have shown that the 'overall reliability of the questionnaire and also the reliability of all individual scales is very high, so an adjustment of the questionnaire and its scales is not necessary, which also indicates a good overall structure of the Competency profile. Only the Research Practice scale deviates slightly in a negative direction, indicating that if improvements to the Competency profile are to be considered, they should be focused on Research Practice. The PCA also points in this direction. The four-component solution confirms that the four-field structure of the original Competency profile (Values and Principles, Research Practise, Publication and Dissemination, and Violations) is overall sound and firm. However, the distribution of items in Components 1, 2, 3, and 4 is not entirely clear, as the items on research practice do not predominate in any of the four components. Therefore, the substructure of the components does not fully match the theoretically defined sub-areas and competencies of the competency profile, suggesting that the distribution of competencies could be reconsidered, especially in the Research Practice area. Recent developments in the field of research integrity also suggest that the competency profile should be expanded to include issues related to the impact of artificial intelligence (AI) on research integrity.

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Appendix 1

Item no.		N	Min (1)	Max (5)	Mean	Std. Dev.
	Values and Principles					
1	I am aware that I must conduct the research according to ethical principles.	176	3	5	4.74	0.545
2	I am aware that I must conduct the research objectively, honestly and in a transparent manner.	174	2	5	4.72	0.573
3	I am aware that as a researcher I am responsible for the credibility of the research results.	176	3	5	4.76	0.513
4	I am aware that participants in the research must participate on a voluntary basis.	176	2	5	4.82	0.521
5	I am aware that I must provide information to research participants in an objective and honest manner.	176	2	5	4.76	0.534
6	I am aware that I must not encourage participants to participate in the research in an inappropriate way (coercion, bribery, etc.).	177	2	5	4.85	0.453
7	I am aware that, as a researcher, my conduct should not affect the judgment, actions, or responses of the participants in the research.	175	2	5	4.82	0.452
8	I am aware that I must allow participants to withdraw from the research at any time.	176	2	5	4.74	0.595
9	I am aware that I must be particularly careful when I intend to include special groups of participants in the research (e.g., persons with special needs, socially vulnerable groups, refugees, etc.).	177	2	5	4.67	0.696
10	I am aware that I can only conduct research with animals if I am properly qualified to do so.	177	1	5	4.40	1.056
11	I am aware that I must treat animals properly in research - in an ethical way (care, nutrition, accommodation, minimisation of pain and suffering, etc.).	177	1	5	4.67	0.822
12	I believe that research on animals should be properly regulated (e.g., by laws, regulations, and codes).	176	1	5	4.68	0.816
13	I am aware that, as a researcher, I must acquire adequate knowledge in the field of research methods before conducting independent research.	176	1	5	4.66	0.647

Item no.		N	Min (1)	Max (5)	Mean	Std. Dev.
14	I am aware that, as a researcher, I must acquire adequate knowledge in the field of research content before conducting independent research.	177	1	5	4.74	0.544
15	I am aware that, as a researcher, before starting the research I must check possible harmful effects or research implications.	177	1	5	4.44	0.909
16	I am aware that for the appropriateness of the quality and integrity of the research, it is not enough to follow only the minimum ethical standards ('what is not allowed according to the rules'), but I must strive to follow the highest possible standards.	177	2	5	4.54	0.691
17	I believe that research must be regulated at the national level with appropriate laws, codes, regulations and, as a result, sanctions for violations.	177	2	5	4.45	0.804
18	I believe that research must be regulated at the level of the institution with appropriate codes, regulations and, as a result, sanctions for violations.	177	2	5	4.59	0.670
	Research Practice					
19	I am aware that as the leader (or will have to as the future leader) of the research group, I have to familiarise younger colleagues with all phases of the research and be a suitable example for them.	142	3	5	4.69	0.535
20	I am aware that in order to carry out the research successfully, I must have appropriate research equipment available.	142	3	5	4.71	0.540
21	I understand that as a researcher I must ensure that the research data is properly archived and protected.	142	2	5	4.49	0.751
22	I am aware that, as a researcher, I must make the raw (unprocessed) research data available (to other subsequent researchers) to verify the relevance of the results.	142	1	5	4.35	0.932
23	I am aware that I have to prepare the research in such a way that other researchers can always check it or repeat (taking into account any new or different circumstances).	142	1	5	4.51	0.805
24	I believe that a research institution should provide adequate mentoring for junior researchers.	142	2	5	4.68	0.612

Item no.		N	Min (1)	Max (5)	Mean	Std. Dev.
25	I believe that older (more experienced) researchers should not abuse their position (e.g., to sign the research as authors, even though they did not participate in it).	140	2	5	4.84	0.517
26	I know the research methodology in my field of expertise.	141	1	5	3.82	0.968
27	I know different research approaches.	141	1	5	3.84	0.973
28	I know the appropriate procedures for data collection.	141	2	5	3.92	0.854
29	I know the appropriate procedures for data processing (e.g., statistics).	141	1	5	3.70	0.941
30	I understand that I must know the relevant statistical procedures and be able to interpret the results, even though data processing may be carried out by other researchers.	141	1	5	4.50	0.780
31	I am aware that without adequate methodological knowledge, I cannot interpret the results of the research.	141	2	5	4.65	0.623
32	Even if we conduct research in a group, I know that I need to know the whole or all phases of the research in which I participate.	141	1	5	4.56	0.740
33	If we are conducting research in a group, I understand that I must share the data I obtain with the other researchers in the research group.	141	3	5	4.82	0.441
34	If we are conducting research in a group, I am aware that everyone who participates in the research is responsible for the proper conduct of the research.	141	2	5	4.73	0.546
35	I believe that the results of the research I obtain should be freely available to the widest possible public (open access).	141	1	5	4.52	0.789
	Publication and Dissemination					
36	I understand that, if there are several authors of the publication, we are all equally responsible for the entire publication (not only for the part that we prepared ourselves).	132	1	5	4.39	0.808
37	I know that I must appropriately acknowledge everyone who, in addition to the authors, contributed to the research (e.g., sponsors, external collaborators, etc.).	132	2	5	4.30	0.906

Item no.		N	Min (1)	Max (5)	Mean	Std. Dev.
38	I am aware that I must prepare a research report (e.g., a paper) responsibly, regardless of the quality, importance, and reputation of the publication (e.g., journals, monographs, etc.) in which the report will be published.	132	3	5	4.64	0.607
39	I am aware that I must include only real data and performed activities in the research report, and I must not subsequently modify the results and performed activities.	132	3	5	4.78	0.499
40	I am aware that I must also publish negative results in the research report if they occur.	132	2	5	4.79	0.539
41	I am aware that I must not tailor data and research results to the expectation of the publisher (e.g., journal) where I want to publish them.	132	2	5	4.75	0.558
42	I am aware that if I discover an error in the results after publication, I must subsequently correct the published research report or withdraw it from publication.	132	1	5	4.42	0.917
43	I understand that when preparing a review (so-called peer reviewing; this also includes providing feedback or evaluating seminar and other assignments), I must not include my personal preferences (e.g., including favourite literature, theories, attitudes, beliefs, etc.).	132	1	5	4.38	0.861
44	I am aware that as a peer reviewer, I must not share the results of the research I am reviewing with other colleagues before the paper is published.	132	1	5	4.11	1.148
45	I know that as a published author myself, I need to inquire about the different publication procedures of different media/magazines.	132	1	5	4.11	1.009
46	I am aware that I must always prepare the review in an objective and transparent manner.	132	3	5	4.61	0.650
47	I understand that the structure and style of a research report may vary by professional field.	131	2	5	4.49	0.748
48	I am aware that I need to know the quality of journals/media that publish results in my field of expertise.	132	2	5	4.47	0.756
49	I am aware that I must publish the results of the research only in a journal/publication with an appropriate review process.	132	1	5	4.13	1.029

Item no.		N	Min (1)	Max (5)	Mean	Std. Dev.
50	I am aware that I may not publish in journals with inappropriate publication practices (so-called predatory journals).	132	1	5	4.40	0.881
	Violations					
51	I am aware that I must not adjust the data afterwards in order to achieve desirable results that would confirm my hypotheses.	125	1	5	4.78	0.633
52	I know that I should not selectively interpret the research results in a way that would better answer my research questions.	126	1	5	4.67	0.714
53	I understand that I must not take data from other research without permission in case I do not have enough of my own data available.	126	1	5	4.56	0.785
54	I am aware that I must not subsequently adjust/change the hypotheses when I see what the results will be.	126	1	5	4.58	0.804
55	I am aware that I must include all results in the report, not just those that I 'like' or provide a desired answer to my research questions.	125	2	5	4.70	0.622
56	I am aware that I must not exclude data that spoils 'good results' from the report.	126	2	5	4.74	0.609
57	I believe that I should not use the results of one research study for several different publications.	126	1	5	3.30	1.358
58	I am aware that I should not publish the same research reports multiple times in different journals.	126	1	5	3.53	1.355
59	I am aware that when preparing the report, I must also take into account sources that oppose or do not confirm the results of my research.	125	1	5	4.38	0.949
60	I understand that I must present the results realistically, without exaggerating their importance.	126	2	5	4.67	0.645
61	I know that I must properly cite (cite or paraphrase) when I summarise other authors.	126	2	5	4.76	0.572
62	I know that I need to properly reference (cite or paraphrase) when summarising my past research.	126	1	5	4.62	0.778
63	I am aware that I must not make the results public before they have been peer-reviewed.	125	1	5	4.13	1.164
64	I am aware that I must not hide the results of the research from the public.	126	1	5	4.39	0.938

Item no.		N	Min (1)	Max (5)	Mean	Std. Dev.
65	I am aware that I must not take advantage of personal acquaintances for the personalised review process.	126	1	5	4.58	0.763
66	I understand that the authors of the paper can only be those who participated in the preparation, execution, and analysis of the research.	125	2	5	4.76	0.614
67	I am aware that the funders/sponsors of the research must not influence the process and results of the research.	125	3	5	4.70	0.609
68	I am aware that ignorance and superficiality are no excuses for inappropriate research (and violation of research integrity).	125	2	5	4.67	0.645
69	I am aware that I must not duplicate data/results, even if others do.	126	2	5	4.79	0.546
70	I am aware that no matter how many people cheat in research, it is always just as problematic.	126	2	5	4.80	0.522
71	I am aware that I must avoid conflicts of interest when doing research (e.g., personal - I make a negative review because I don't like someone; financial - I manipulate the results of the drug's effectiveness because I am funded by the company that manufactures the drug; ideological - I disagree with research results because they contradict my beliefs; etc.).	126	2	5	4.71	0.631
72	I am aware that I must not ignore/be silent if I notice a violation or inappropriate research, but I must report this to the responsible person (at the institution).	126	1	5	4.51	0.807
73	I believe that handling violations should be transparent, fair, and confidential/anonymous until the process is officially closed.	126	1	5	4.61	0.737
74	I believe that if I notice and report a violation, I should be properly protected (by the institution).	126	2	5	4.69	0.626

Biographical note

Jurij Selan, PhD, is an Associate Professor in visual art theory and vice-dean for quality assurance at the Faculty of Education at University of Ljubljana. His research interests include the nature of visual art language and visual art grammar, the role of visual art language in art education, the nature of artistic development in children, the role of colour models in art education, the nature of art hermeneutics and interpretation etc. In recent years, due to his work as vice-dean for quality assurance, his research also extended to the field of academic and research integrity.

Mira Metljak works as a project administrator/manager at the National Institute of Biology. Before, she was working at the University of Ljubljana, Faculty of Education as a project manager and, for some time, as a Teaching Assistant for pedagogical methodology. Her main interests were quality assurance in education, developing research competence of students and professional development of in-service teachers. She was included in many national and international projects in different fields of education (students with special needs, quality assurance, digital competences in education, ...).