The Issue of (Software) Plagiarism: A Student View

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***Abstract*—The issue of plagiarism is discussed in the context of university education in disciplines related to computing. The focus is therefore mainly on software plagiarism. First, however, a case is made for the claim that the most important reason that plagiarism cannot be tolerated lies in the essence of the concept of a university as it is rooted in the Western cultural tradition. The main contribution of this paper is in providing firsthand insight into students' views on some of the delicate questions related to student plagiarism. However, this paper presents views from both sides of the question, including the views of staff members. This paper is quite unique in that it is coauthored by students who provide independent comments and recommendations.**

***Index Terms*—Computer science education, plagiarism, programming, software, text analysis.**

I. Introduction

While this paper is devoted to academic plagiarism, the issue of plagiarism is far more general, has been around for quite a while, and cannot be limited to academic (either by student or professor) cases. One of the reasons for concentrating on academic, and in particular student, plagiarism is that the specificity of this instance does not allow for a direct or mechanistic application of concepts and measures that have been devised to protect work from being plagiarized in general or other contexts. For example, the concepts of intellectual property and copyright are considered by some as partly relevant and potentially useful [1], but by others seen as diverging at best, if not next to irrelevant (for an interesting in-depth analysis, see [2]). Thus, academic plagiarism requires specific approaches pertinent to its nature. The Faculty of Informatics and Information Technologies (FIIT), Slovak University of Technology in Bratislava, Bratislava, Slovakia, offers two Bachelor's-level study programs, in informatics (a.k.a. computer science) and in computer engineering; three Master's-level programs, in computer engineering, software engineering, and information systems; and two doctoral-level programs, in applied informatics and software engineering. Total enrollment in all these programs is approximately 1100.

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It is clear that in such an environment, the particular case of software plagiarism is most relevant. This is thus the focus of this paper.

Many articles have analyzed the phenomenon of student plagiarism [3]–[8] and its detection in student programs and assignments [9]–[13]. The problem can be approached from various angles [4], [14]–[16], investigating both the plagiarism itself and the reasons for it. Perhaps fewer analyses provide a view of the most important *dramatis personae* in the whole affair, namely the students (but see, for example, [7] and [17]–[19]). While there are reasons for this, the approach presented here at least partially overcomes these by involving the students themselves in conducting the research.

The first and second authors are interested in this issue both as a research topic and as a practical problem they face and try to deal with in their classes. The first author succeeded in convincing two students to choose Master's thesis topics relevant to the issue and to the envisaged research. The third and fourth authors contributed as students to the research.

The rest of the paper is structured as follows. An outline of the issue of software plagiarism is given, with reference to the literature. The methodology used is then described. Next, the results of the investigations are presented and commented on. Despite the relative uniqueness of this research, an attempt is made to relate the results of this paper to those of other studies. In conclusion, some hints for possible future research are given.

II. Software Plagiarism in the Academic Setting

The focus of this paper is on a specific class of courses that are quite typical for study programs in fields of computer science and computer engineering. Many courses in such programs are designed to contribute to students developing problem-solving abilities ranging from their acquiring basic skills to their being able to arrive at design solutions expressed as computer programs. In such courses (for example Procedural Programming, Object Oriented Programming, Data Structures and Algorithms, Operating Systems, Artificial Intelligence), students are typically required to present their solutions to assigned problems in the form of computer programs. At a more advanced stage, and definitely in Master's-level study programs in fields such as software engineering, students develop not just pieces of program code, but a piece of software. This is also true for their Bachelor's and Master's theses, which must include a piece of software designed by the student.

Thus, unlike most published work, which concentrates mainly on programming assignments, this research focuses not just on segments of computer code, but more broadly on software, which includes text documentation. The university makes every effort to ensure that only licensed software runs on all computers. While this issue might appear unrelated to plagiarism and will not be dealt with directly here, the improper

use of software has significant implications for managing plagiarism in the academic setting. An academic institution failing to meet all the requirements of properly using its software may find itself severely handicapped when dealing with cases of software plagiarism.

The scope of this paper is restricted to software plagiarism by students. This should not be seen as implying that the research and teaching staff is immune by definition to this transgression, but rather that they are primarily concerned with marking assignments and evaluating projects and not with creating their own software. However, the staff does play an important role. Their views and attitudes toward plagiarism are key. For example, it would be very difficult to impose a strict student plagiarism regime if their prevailing attitude were characterized by leniency and tolerance. Martin [20] goes so far as to identify staff as the true problem in plagiarism. MacDonald Ross also sees the problem in "fellow academics who undermine our efforts to induct students into the core values of higher education, by denying that plagiarism is a crime" [21].

It is essential that any definition of plagiarism covers the (improper) use of not just expressions (words, texts, pictures, etc.), but also ideas. When plagiarizing software, copying or paraphrasing (parts of) the program text is just the simplest way of committing plagiarism. The same algorithm idea can be expressed in various ways or in different programming languages. However, even the simple case of textual paraphrasing happens frequently and is already a serious problem. In textual plagiarism, the problem is not so much that of detecting levels of similarity between texts per se, but rather the scale of the detection effort required. With 300 or so students in a cohort each year, which two programs should be suspected and submitted to the detector tool? Unless there are some clues, each of the 300 programs for each assignment must be tried against each other. A method that works in comparing two programs may not automatically scale to such a prohibitive number of possible pairs of programs. The scope and variability of assignments in an introductory course is limited, so many students in a cohort have the same or similar assignments, and most assignments will be reassigned in the next academic year. Analogously to essay banks, there are servers where a wealth of student programs can be found, often or mostly run by students themselves, whose use is easy for computer science or engineering students.

In addition, the variability of student programs is also limited precisely because the language is a formal one, offering an incomparably lower degree of variability of expression than any natural language. Some believe [22] that detecting plagiarism in computer programs is much easier for just this reason. However, such a simplified view may not consider all the intricacies of the problem. For example, Lancaster and Culwin [23] reason that "it is thought to be easier to detect source code plagiarism than free text plagiarism since the language that can be used is constrained to a set of defined key words and since any plagiarism is most likely intra-corpal in nature. Free text plagiarism contains an effectively unlimited number of possible words that can be used and plagiarism may be intra or extra-corpal." However, they fail to develop an argument, and it is not clear what can actually be inferred from this observation.

As Rosales *et al.* [13] observe, "to develop two identical, or at least very similar, program fragments is much easier than to write two identical or even very similar paragraphs when using natural language. At the same time, whether the cause of the similarity is plagiarism or simply derived from analogous working methods based on the same theoretical knowledge is difficult to distinguish." Mann *et al.* [24] explain that "in free text similarity checking [. . .] 10% similarity is usually considered acceptable to allow for references, quotes, common phrases [. . .]. For code, the situation is more complex." For an extensive study of the proper choice of similarity threshold discriminating cases of software plagiarism by a detection tool, see, for example, Prechelt *et al.* [25]. However, since the perfect automatic detection of software plagiarism is hardly achievable [26], manual checking should be involved.

FIIT follows a rather strict policy regarding student plagiarism. When making a decision on such an allegation, there must be a clear argument. Why is plagiarism wrong? This is important to discuss. For some, plagiarism is not wrong at all. Quite apart from the line of reasoning of typical student excuses such as "we studied/discussed/collaborated together, what's wrong with that?" (for more examples and discussions, see, e.g., [18]), there is a quite fundamental argument used by students coming from different cultural backgrounds [27]–[29]. Sutherland-Smith reports [30] how students coming from some Asian countries were genuinely surprised when they learned that when submitting their work, they were not supposed to reuse (i.e., copy) material they had read, which was written by someone else. They argued that this was how they had been expected to study at their schools. Perhaps the concept of a university is not as universal as it may seem. After all, the concept of a university can be considered an offspring of Western civilization, having been cultivated there for centuries. Most of those who define the concept stress that a university is a community of teachers and students. Another important characteristic is that it is an institution of higher education and research that grants academic degrees. What remains implicit, but equally important, is that a degree is granted based on individual achievement. Therefore, any work submitted to gain some credits toward a degree that is actually someone else's work undermines the very concept of a university as it has developed in the Western tradition. The authors agree with those identifying this as the strongest reason why plagiarism cannot be tolerated [31].

III. Methodology

The aim of this research can be formulated as an enquiry into students' views on the issue of plagiarism. To elicit views of a group of people, the standard methodology is to administer and evaluate a questionnaire. An adequate number of participants are necessary for the questionnaire to yield representative findings. It is not enough to administer the questionnaire to many respondents; a significant number of these must have information or experience pertinent to the study. Similar research often suffers from a relatively low number of appropriate respondents.

An approach to address this fundamental methodological concern has been to involve students not only as participants in the questionnaire, but also as researchers. When students approach other students, asking them to express their views, the chances of getting responses are much higher, especially for a topic as delicate as student plagiarism. However, the approach

presented goes beyond merely using students as questionnaire administrators, but also involves them as researchers. Not only can students be first-class researchers on topics like these; those within this research were the authors of many ideas that emerged.

First and foremost, students were involved in devising the list of questions. Two student coauthors of this paper went through an intensive fortnight of discussions with their thesis supervisor (the first author of this paper), resulting in a list of questions [32], [33] that would give ample room for the participants to express their views.

Another crucial point of the methodology was to survey both students and teachers, with the faculty staff also being approached. A set of six questions (A, B, G–L) was formulated for students, and another set of eight questions (A–F) for staff. Two questions (A and B) were identical for students and staff. The questions were designed as multiple-choice. All participants could add a free text comment, allowing them to express their own opinions on the subject.

With the aim being to enquire into students' views on the issue of plagiarism, why query staff, too? While the research was conducted at a single institution, the intention was to achieve results that would be—at least partially—more generally valid. To this end, information in the form of complementary staff opinions on the students' views was sought so that a reader can put these into context.

The questionnaire was made accessible online, which contributed to higher participation by both students and staff. A Web portal interface was designed, through which participants could make an anonymous one-time submission of their responses. All students and staff of the faculty were invited. Every effort was made to provide a user-friendly interface so that the questionnaire could be completed easily and rapidly. A three-week period was allowed for responses. Taking part were 313 students of a total of 1149 students (thus slightly above 27%) and 25 staff members of a total of 57 research and teaching staff (about 48%).

IV. Results

The results of the research will be presented structured by the particular questions: first for the two questions asked of both students and staff, then for the questions asked only of staff.

A. What Is Plagiarism?

The question asked respondents to identify instances of plagiarism among several kinds of plagiarized material (source code of program, comments of the source program, system design documentation of the program, the user interface of the program, input data of the program). In [34], a similar enquiry into the nature of plagiarized material was made. Here, the aim was to find out how strict was the interpretation of plagiarism across the faculty in general and among the students in particular (Fig. 1).

In total, 100% of staff and 94% of students consider copying, modifying, or presenting another's source code as plagiarism (cf. the first pair of columns in Fig. 1). However, 18 students did not consider this most common case to be plagiarism. For some other options, there was a quite significant difference between

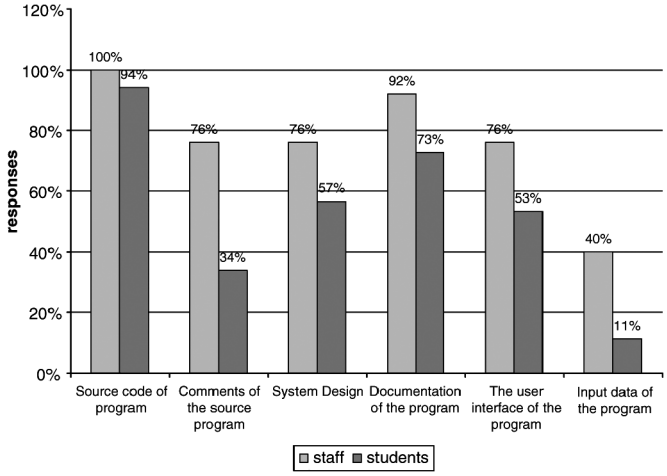

Fig. 1. Responses of students and staff are shown to the question "What is plagiarism?" Note that students do have quite a comprehensive understanding of what plagiarism is.

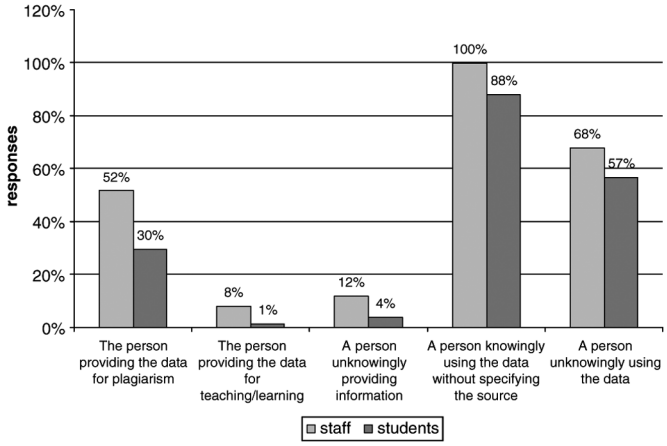

Fig. 2. Who is responsible? Student and staff views are shown side by side.

evaluations by staff and students, with students generally having a softer view of plagiarism than do staff.

This can lead to situations when students may not realize that they are doing something wrong, for which the remedy proposed here is to clearly define the rules for what is considered plagiarism and what is not.

B. Who Is Responsible?

This question seeks to identify those who should be considered responsible in the event of plagiarism, or who is the one actually committing the plagiarism, in the opinion of students and of the staff. The response options provided were: the person providing the data for plagiarism, the person providing the data for teaching/learning, the person unknowingly providing information, the person knowingly using the data without specifying the source, or the person unknowingly using the data. The underlying assumption is that plagiarism involves someone who plagiarizes and someone who has been plagiarized (Fig. 2).

Both students and staff considered a person who uses data without citing the source (regardless of whether the material was provided intentionally or unintentionally) to be guilty of plagiarism. Opinions differ concerning a person who is the source

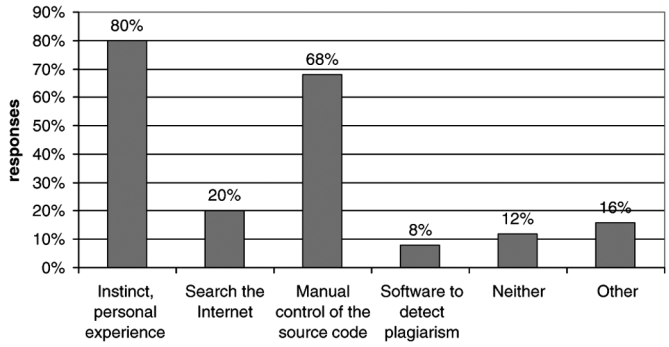

Fig. 3. How to discover it? Staff views are shown.

of plagiarized material. When intentionally providing the material, half of the staff but only one third of students considered that person guilty. A person who is unintentionally the source of some plagiarized material is overwhelmingly considered to be innocent.

C. For Staff Only: What Should Be Done With a Plagiarizing Student?

This question to staff members asked what they would propose as a measure against a student caught plagiarizing. Of the staff, 48% proposed referring the student to the disciplinary committee, 40% would fail the student for that course, and 12% would just give the student a warning. It is perhaps interesting that none of the staff chose the option of immediately expelling the plagiarizing student from the university.

D. For Staff Only: How Often Does Plagiarism Occur at the Faculty?

The intention was to estimate how frequently plagiarism actually takes place at the faculty. The results are alarming. At least once during their academic careers, 64% of staff members have caught a student trying to plagiarize. If staff members who have been told about such cases are also included, the fraction climbs to 84%. Only 12% of the staff had never heard of a case of plagiarism. Exactly when these cases occurred was not made explicit, but from the local context, it can be deduced that they are an ongoing phenomenon, rather than all having taken place in the distant past or just recently. These results bring qualitative information that plagiarism is a persistent phenomenon at the faculty that needs to be addressed with a high priority.

E. For Staff Only: How Should Plagiarism Be Detected?

This question asks staff members which methods and tools they use to search for potential plagiarized works. Respondents could choose between several answers (Fig. 3).

Most of the staff members rely on their instinct or on a manual inspection of source codes. As many as 12% of the staff members do not use any kind of plagiarism checking. This is quite a high number, leaving some opportunity for students to attempt to plagiarize.

F. What is a Significant Level of Similarity?

The intention was to solicit, as an estimated percentage of identical work from two students, what is a high enough level for the teacher to initiate an enquiry into suspected plagiarism. The options were expressed as 10% increments. The average plagiarism sensitivity level is 37.2%.

However, this number does not have much meaning. As some teachers mentioned in their comments, it depends on the length of the program: "10% could be neglected in a 30-line program, but not in software that is part of a Master's thesis." Moreover, it depends how similar the crucial parts of the program are. In general, this cannot be determined exactly. More than a fifth of the staff admitted they did not have the motivation to check plagiarism. Therefore, given that 12% of the staff currently use no method of plagiarism checking, this lack of motivation may lead to an increase in this figure unless something initiates a change in attitude.

However, 72% of the staff declared that automating plagiarism detection by devising an appropriate tool would improve their motivation. The tool should demand as little as possible from the user and should be as precise as possible so that slight imperfections need not be checked by the teacher manually.

Questions C–F served to provide some contextual information for the actual "hard core" student opinions.

G. For Students Only: Is Plagiarism Wrong?

This is the perhaps the crucial question, and one of whose sensitivity the authors were aware. For some students (with all due respect for the presumption of innocence), the question may have brought them very close to a moral conflict. On the other hand, it should not be inferred that those who did not respond to this particular question have committed or knowingly tolerated plagiarism. Of the students, 30% responded that plagiarism is wrong. Only 1% responded that it is not. As many as 69% did not respond. Perhaps the only safe assumption to be made is that they did not possess sufficient information on the phenomenon and, consequently, they were not sure how to answer. Admittedly, despite several occasions during their studies when they are introduced to the proper ways to work with literary sources, a more systematic treatment is desirable of not only how to work with bibliographic references, but more importantly how to properly use another person's work and what is right and what is wrong in this regard.

H. For Students Only: Have You Ever Been a Source for Plagiarism?

This and the subsequent questions aimed at digging out student experiences of plagiarism in either role—either as the one whose work has been (knowingly or unknowingly) plagiarized or as the one who actually commits the act of plagiarism. This question asks the student if her/his work has ever been plagiarized.

Approximately 42% of the students are aware of at least one case when their work has been used in plagiarism, 22% are not aware, and 33% do not know. The question did not enquire whether the work was knowingly offered or it just "fell into wrong hands." Also, the question did not enquire what kind of work was involved (but see the next question). Approximately one third of the students were not able to tell if their work had ever been plagiarized.

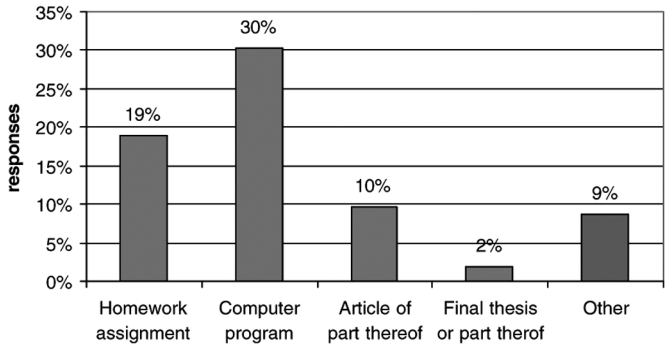

Fig. 4. What was the source document? Results show students' experience.

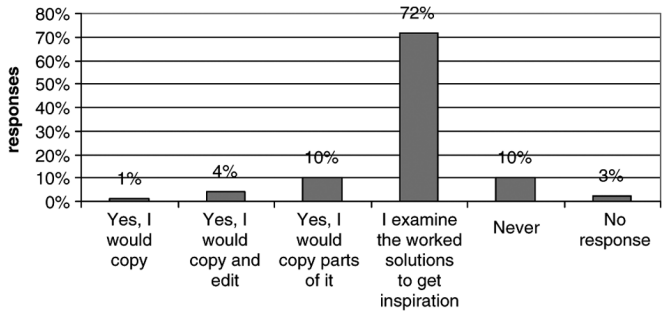

Fig. 5. Is it acceptable for you to plagiarize when you have the opportunity? Results show students' experience.

I. For Students Only: If Yes, What Was the Source Document?

This question is crucial in recognizing the similarity or difference between general cases of plagiarism in most fields, and the special case of disciplines where designing a computer program is an essential part of the study. It should be noted that most discussions on plagiarism generally cite the final thesis as the most frequently plagiarized source document.

For this question, the options were the following: homework assignment, computer program, article or part thereof, final thesis or part thereof, other (Fig. 4).

Computer science and computer engineering students mostly plagiarize computer programs and homework assignments.

The final thesis, or part of this, was plagiarized only in 2% of cases.

J. For Students Only: Have You Ever Plagiarized at the Faculty

The questionnaire continues with even harder and more delicate questions. An honest answer to this question may effectively amount to an (anonymous) confession of having committed plagiarism.

Of the students participating in the questionnaire, 33% admitted plagiarism; 63% declared that they had never plagiarized. The authors of this paper (including student coauthors) see the presence of one third of plagiarism-positive students as negative and alarming. The authors call for actions to remedy this, such as doing a better job of informing students as to what is wrong, taking other actions to increase understanding of why it is wrong, stricter checking, and tougher sanctions. Other remedies will be suggested later in this paper.

K. For Students Only: Have You Ever Given Your Work for Others to Plagiarize at the Faculty?

This question asks about the other side of the story, since without those who give their work to others to be plagiarized, there would be no plagiarism.

As many as 63% of the students have given their work to others. This does not seem to be consistent with the results for question H, where only 42% of the students responded that they were aware that their work had been plagiarized. According to comments submitted with responses to this question, students also included cases when they gave their own work "for inspiration" and not directly for copying. The large number of "don't know" responses to question H should be noted. A better or just a different wording of the question reduced this fraction dramatically. Taking 63% to be closer to the truth, this is a very large number indeed. According to half of the staff (cf. question B), these individuals also are responsible for plagiarism. This raises the question of whether the other half of the staff is also part of the problem.

L. For Students Only: Is It Acceptable for You to Plagiarize When You Have the Opportunity?

The last question investigated the motivation of students to plagiarize works of others. The question was: Is it acceptable for you to copy (plagiarize) someone else's work or submit someone else's program when you know your assignment had been assigned before (perhaps in previous years) and you are able to get hold of the elaborated solution (Web, dedicated student server, friend,...) (Fig. 5)?

Approximately 15% of the students do not feel motivated to work on an assignment identical to one assigned in previous years. If they have access to the solution, they copy or reuse it (this includes possible modifications of the work). As many as 72% of the students take a look at such solutions "to get inspiration" and elaborate their own solution (but mostly based on the same idea as the original one). Generally, of course, plagiarism means the improper use of not only expressions, but also ideas. Specifically, much depends on the nature of the assignment and how original the plagiarized solution actually is. In any case, only 10% of the students do their work without looking at the work of others (Fig. 5).

Section V is based on the reflections and conclusions of the first student coauthor. This should not be taken to imply that she does not agree with any of the statements in the rest of the paper or that the other authors do not share her views expressed in the next section. Rather, the intention is to communicate the students' views to the reader as faithfully as possible.

V. Commentary by Students: Votum Separatum of the Third Author

The comments that students added to their responses were very interesting and motivating. A large part of the students admitted that they regularly take "inspiration" from works submitted in previous years. There are various reasons for this:

- time pressure;
- an uninteresting course;
- a poor attitude from the teacher.

Whether such an approach is plagiarism is questionable. These cases should be judged individually according to the assignment.

Students criticized some courses and their teachers in this regard. How far their criticism is correct could only be justified by a more detailed investigation. Even if students are motivated to learn something new, the wrong approach by the teacher can cause them to copy and modify someone else's work, allowing them to use this free time in another way. Students consider a wrong approach by the teacher to include the following.

- Open tolerance of, or little checking for, plagiarism. Too much latitude toward attempts to tamper with the rules. When even a few students plagiarize without being detected, others feel demotivated.
- Lack of opportunities for individual presentation by the student of her/his work to show how much she/he actually understands of what she/he submitted.
- Mild penalties. These do not have sufficient deterrent effect. Students take the risk, plagiarize, and win extra free time that would be needed to study.
- Insufficient volume of study material provided by teachers to help in explaining assignments.
- Insufficiently precise or understandable assignments.
- Student overload with too many or too challenging assignments.

If the institution wants to reduce the number of cases of plagiarism, these could serve as implicit suggestions for possible remedies. Plagiarism cannot be prevented completely. There will always be some students, seeking a degree for the qualification rather than for the knowledge itself, who will always take the path of least resistance. With the right approach, however, their number can become negligible.

One student attempted to estimate the fraction of homework assignments that are plagiarized, depending on the specific course. For the courses he listed, the fraction was between 30% and 80%.

It was interesting to note that copiers and cheaters were not popular among students, which echoes this author's student perspective. Another comment is while detecting plagiarism is necessary and important, there are too many students and too few staff members to make this easy. Automating plagiarism detection would help very much.

VI. Conclusion

In this paper, an attempt has been made to present students' views on the issue of plagiarism, with a special emphasis on software plagiarism. The approach was to involve students as researchers. While students at many universities, including the FIIT, perform research, it may be seen as unusual or even pioneering to involve students as front line researchers in a topic that is very delicate and that concerns them directly. The novelty of the approach is not in involving students in devising new methods of detecting the similarity of programs (e.g., [34]) and detecting the similarity of natural texts (e.g., [35]), but in researching students' views on plagiarism.

The idea of involving students in the research of student plagiarism was based on the firm conviction of the authors that they know their students and can rely on their adherence to the academic principle of seeking truth. Based on their experience, as reported in this paper, the authors venture to generalize. The message is not to hesitate to involve students in actively researching and even seeking proposals for possible remedies to any problem, even such a delicate one as student plagiarism.

This is not to rephrase the results of the reported research in this conclusion. However, the very critical and constructive contribution of students should be emphasized. It should also be noted that the study programs and courses that were the focus of this research are very standard ones, offered by many universities, whatever the country. Thus, the findings and experience reported here are relevant and of interest to anyone teaching courses in software development.

The findings of the questionnaire are consistent with the experience at the FIIT. When a comprehensive plagiarism detecting process was introduced in one of the courses in 2009, dozens of cases were detected, involving approximately one fifth of the students. After a subsequent manual inspection, most of these were found to be grave enough to result in failure of the course and referral to the disciplinary committee. More generally, the authors of [36] report on academic plagiarism in Europe, describing it as a serious problem. The authors are not in a position to make any exact comparisons to situation in other parts of the world, but are aware of papers dealing with this phenomenon in the U.S. or Australia, for instance. In [22], the authors admit that "statistics on the frequency of plagiarism within universities are rare." One such set of statistics is given in [37], where some recommendations are also made, among them that students should subscribe to rules of ethical conduct or that a detection tool such as turnitin should be used.

For the future, a continuation of the study is planned to see how student perception of plagiarism changes over a period of time. It will be interesting to learn of similar studies at other institutions so that the students' views presented here can be contrasted with others.

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