IT Employers' Expectations from their Employees Regarding Java Programming Language

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***Abstract*—In this paper, the authors strive to set out a methodology for the learning outcomes revaluation using object-oriented programming higher education courses regarding JAVA™ programming language as a pilot sample in the evaluation and adjustment process that needs to be done periodically. For that purpose, authors analyze learning outcomes and hourly rate of the teaching subjects in the JAVA™ courses (EQF/CROQF level 6 and 7) at different higher education institutions with an aim to set out a solid base for employers in the IT industry to provide feedback from the labor market and suggest the segments for further improvement. Employers were asked to fill out a survey in which they needed to assess (on a scale from 1 to 5) how much their employees knew about each of the segments, i.e., for each learning outcome or content topic that was covered by the JAVA™ programming language in the class. According to the employers and in relation to the defined learning outcomes, their employees needed additional education in almost all segments of object-oriented JAVA programming, especially in two segments. In this paper, the authors present in detail the obtained analysis and the results of the conducted survey regarding IT employees with guidelines that should be considered in the revision of existing syllabuses and curriculums.**

Keywords—JAVA™, IT employers, syllabus & curriculum revision, employees

I. INTRODUCTION

This paper aims to analyze and synchronize subjects and learning outcomes according to the employers' revision from the conducted survey. The proposed revision of the object-oriented course content was carried out based on the standards and guidelines of obtaining objective indicators in the revision of the teaching within the recommended European framework. The ESG [1] provides guidance, covering the areas vital for the successful quality provision and learning environments in higher education i.e.,, standard 1.2 *Design and approval of programmes* describes guidelines for designing study programmes by involving students and other stakeholders in work. Stakeholders are understood to cover all actors within an institution, including students and staff, as well as external stakeholders, such as employers and external partners. At the center of this research are the study programs and courses with related subjects. To describe types and levels of study programs, we need to describe the Croatian qualification framework in the European context.

The European Qualification Framework (EQF) aims to make possible the comparison of qualifications levels amongst national qualification systems in Europe. The Croatian Qualifications Framework (CROQF) coordinates and integrates all stakeholders in the qualifications system, paying attention to the needs of the labor market, individuals, and society [2]. The CROQF defines basic (complete and independent) characteristics/properties of qualifications and units/modules of learning outcomes as profile; workload/volume; reference level; and quality, as an implicit part of qualifications and units/modules, denoting the reliability and credibility of the statement made by the official certificate (and/or other documents) about learning outcomes. For is paper, we have asked the employers to distinguish type and year of study of their employees, whether they're still students or already have graduated at the EQF/CROQF level 6 or 7. Levels 6 and 7 have their diversities as follows[2]:

- *Undergraduate university degrees* correspond to the first cycle of QF-EHEA and level 6 of CROQF. These degrees are awarded following the completion of accredited programmes lasting three to four years and students are required to earn minimum of 180 or 240 ECTS credits.
- *Graduate university degrees* correspond to the second cycle of QF-EHEA and level 7 of the CROQF. These degrees are awarded after completing accredited programmes lasting one to two years, and students are required to earn a minimum of 60 or 120 ECTS credits. In addition, some graduate programmes are integrated, and students are required to earn a minimum of 300 ECTS.
- *Professional undergraduate degrees* correspond to the first cycle of the QF-EHEA and level 6 of the CROQF. These degrees are awarded following completion of accredited programmes lasting two to three years, and students are required to earn 120 or 180 ECTS.
- *Specialist professional graduate degrees* are awarded following the completion of accredited one or two-year programmes, and students are required to earn a minimum of 60 or 120 ECTS credits, respectively. They correspond to the level 7 of the CROQF if students are required to

earn a minimum of 300 ECTS credits within the first and second cycle qualification of the QF-EHEA, specifically with a minimum of 180 credits at level 6 or higher of the CROQF including a minimum of 60 credits at level 7 or higher of the CROQF.

The approach towards IT employers was segmented to obtain the most relevant information regarding the specific knowledge from object-oriented programming, which, if possible, should be more extensively processed in the higher education curricula. In addition, employers' were asked to fill out a survey in which they needed to assess on a scale from 1 to 5 (5 being the highest grade), how much their employees knew about each of the segments, i.e. for each learning outcome or content topic that is covered by the JAVA™ programming language in the class; have their employees needed an additional education (the minimum entry level of employees/students was HKO/EQF levels 6 and 7). Considering the scarcity of programmers in the labor market, employers often hire students, and that is why student employees were taken as a separate population segment to avoid biases in the result interpretation.

Even though the analyzed sample of the employers' N: 9 could be qualified as a small one, on the other hand, each one of the employers' representatives employs from 20 to more than 50 employers (programmers), which puts the observed secondary sample in this survey much bigger than the actual N is. It is also important to note that when conducting the survey, authors deliberately haven't asked employers which higher education institutions their employees are from since that would change the context of the research objectives. The institutions from which authors come invest exceptional efforts in achieving quality which, among other things, proves the research subject itself, whose purpose is to revise the syllabuses and foster quality in teaching with the better achievement of learning outcomes.

II. JAVA IN THE OBJECT-ORIENTED PROGRAMMING COURSES

The programming language Java was first released on May 23, 1995, by Sun Microsystems [3], and since the 1990s, it has been one of the most successful object-oriented languages [4]. After that, in 2009, the Oracle company bought Sun Microsystems [3], and managed to reorganize the release cycle of new Java versions every six months [5], which makes it suitable to be introduced to Object-oriented programming classes before every semester during the academic year on computer science colleges. As a result, the latest version of Java™ SE was version 19 released in September 2022.

Java is among the most popular introductory teaching programming languages at many universities [6] because of its versatility and object-oriented paradigm. It offers students to gain experience in modeling data based on inheritance, abstraction, and encapsulation, which are essential concepts used in software modeling and development in general. Furthermore, Java does not represent only the programming language but also a whole platform for developing desktop, web, and mobile applications. Based on the skills acquired on courses related to object-oriented programming related to Java programming, students can switch to many other programming languages like Kotlin, Scala, Groovy, and Clojure, also based on Java Virtual Machine (JVM).

Java uses the JavaFX platform [7] for desktop, mobile, and embedded systems built on Java and represents an optimal baseline for mastering the MVC (Model-View-Controller) architectural pattern. Because of that, JavaFX is also an integral part of object-oriented programming courses based on Java. Moreover, it represents a good start for studying web applications development because its architecture is also based on MVC architectural patterns, among the other Java-based programming frameworks like Spring and Hibernate. All that makes Java suitable to meet all requirements to be the main object-oriented programming course in computer science education programmes.

III. IT INDUSTRY NEEDS REGARDING JAVA

Java has had a significant role in the IT industry for the last two decades because of its popularity and demand [8-11]. European public services continue to increase their use of open-source software [12] based on technologies like Java, so it is expected that the popularity of Java technologies will remain. Because of that, software engineers with Java skills are in high demand, especially skills related to Spring Framework and Spring boot, REST API, Microservices, Hibernate framework, and Cloud Computing [13]. The interoperability of the Java frameworks and libraries with the other technologies and many options related to the choice of IDE (Integrated development environment), among which many are free and support community editions, makes Java desirable in large companies as well as in smaller companies to avoid high initial costs before starting a business or a new project. The large community of around 9.4 million developers worldwide [14] created a large set of online information sources that are very valuable for developers when solving problems and collaborating with other developers, making the Java platform even more popular.

Java certification [15] also gives developers and companies a comparative advantage over competitors in applications for tenders, if required, besides formal education level. Each certified developer in a software company brings a certain number of additional points to the application and improves the chances of winning the tender and getting a change to work on the project and increase the company's profit and visibility on the market.

Because of the high demand for software developers to attract and keep new talents [16], companies are interested in presenting themselves to students through visiting local Java conferences, organizing guest lectures at colleges, organizing hackathon competitions, meetups, and co-op opportunities for students during the summer period.

Software companies expect new junior employees and students to be familiar with technologies they will use on their projects, so they don't need to educate them about the basics of programming languages, development frameworks, and object-oriented aspects. To reduce the "time to market" of their solutions, the software companies optimize the onboarding process of new junior employees and assign them a mentor to join them in development teams and projects as soon as

possible. The higher level of programming skills and experience with software frameworks, the shorter time is needed to join the project and start to be productive. Besides just writing code, the Java developer skills that are important are also related to using specific development tools, familiarity with software development methodologies, teamwork, critical thinking, problem-solving, and conflict resolution.

The aim of the research is this paper is to analyze the feedback from employers regarding the programming skills of undergraduate and graduate students. Based on the feedback, syllabus shortcomings will be addressed and improved, so the next generations can better answer on the job market demand.

IV. Methodology, Conducted Survey and Results

A. Methodology

This research was conducted through a questionnaire in which employers were asked six questions, of which questions 5 and 6 had 13 and 12 sub-questions regarding the JAVA knowledge and skills of their employees. In the first four questions, employers were asked basic questions related to the number of students they employ, what is the approximate study year of the students they hire (student contract), whether they come from state or privately founded studies/higher education institutions and have the students they hire already passed final exam regarded JAVA programming language (whether this has any significance in their selection process).

In question number 5 (in each of 13 sub-questions), the employers were asked to estimate the level of learning outcomes achievement regarding JAVA acquired by the students during their studies on a grade scale from 1 (weak, learning outcome have been achieved less than acceptable) to 5 (excellent, learning outcome have been achieved much more than acceptable). Based on the employer's answer to question number 5 from the questionnaire, the hypothesis was tested that the students they employed on part-time basis achieved above-average learning outcomes in the Java programming language during their studies.

In question number 6, employers were asked to assess the level of competence and generally acquired knowledge of students during their studies, with a score from 1 (the student's knowledge is insufficient) to 5 (the student's knowledge is excellent), for each of the 12 topics covered by the JAVA programming language course. Based on the employer's answer to question number 6, the hypothesis was tested: the knowledge and competencies in programming and general application development students acquired during their studies are at least average, which basically for the needs of the labor market in the IT sector means that student's level of competences meets at least the minimum of labor market needs.

The corresponding hypotheses were tested using a t-test with a significance level of 5%.

B. Conducted Survey and Results

Regarding the observed sample N: 9, it's evident that employers equally hire students from both state and private studies, regardless of whether they are currently attending undergraduate or graduate studies. However, there is still a visible trend of hiring students from the dominantly final year of undergraduate studies and graduate studies.

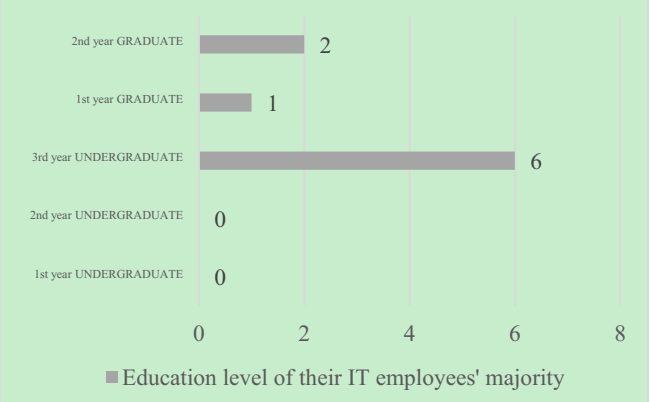

Fig. 1. Employers' answers from the survey on the education level they prefer to employ regarding JAVA (EQF/CROQF levels 6 and 7).

Also, among part-time employed students, there is a noticeable difference in the number of students who passed the course related to the JAVA programming language compared to students who did not pass the corresponding course.

On 13 sub-questions (Table I.) from question number 5 of the survey questionnaire, on the observed sample N: 9, the average answers of employers were obtained, by sub-questions, in the range of the minimum average of 2.67 on two sub-questions sub-question 8: "*To sketch conceptual application solution before the implementation phase*." and sub-question 12: "*To develop a multilingual Java web application*", and up to a maximum average of 3.67 on sub-question 10: "*To choose the option Spring boot framework for optimizing Java web application development* ".

TABLE I. Employers' Assessment of Learning Outcomes Achievement during Employees' Study

Q. 5	Learning outcomes in JAVA (EQF levels 6 & 7)	$\bar{x}$	SD
1.	To write the programming code for Java web application that runs on the server and can be used in a browser.	3.44	0.73
2.	Design a Java web application using a three-layer (MVC) architecture.	3.56	0.53
3.	Organize web application components into a graphical interface that uses business logic and data layer.	3.33	0.71
4.	To extend existing modules of the application with other open-source libraries.	3.22	0.83
5.	To develop components based on object-oriented concepts that can be reused.	3.00	1.32
6.	To configure IntelliJ integrated developing environment for efficient development of Java web applications.	3.44	0.88
7.	To integrate Java web applications with different frameworks to improve the quality of the development process.	3.11	0.78
8.	To sketch conceptual application solution before the implementation phase.	2.67	1.00
9.	To compare the development of JAVA web applications with the development of JavaFX applications.	2.78	1.09
10.	To choose the option Spring boot framework	3.67	0.71

Q. 5	Learning outcomes in JAVA (EQF levels 6 & 7)	$\bar{x}$	SD
	for optimizing Java web application development.		
11.	To choose Angular for graphical interface application design.	3.00	0.50
12.	To develop multilanguage (i18n) Java web applications.	2.67	0.71
13.	To integrate scheduled jobs into a Java web application.	3.00	1.00

It is significant that on 10 out of 13 sub-questions, the average answer of employers was more significant than or equal to 3.00. All this leads to hypothesis X: employers employed part-time by employers achieved above-average learning outcomes in the Java programming language during their studies.

Hypothesis X can be written as $\mu > \mu_0 = 3$. More precisely, the hypotheses are

$$\text{H0: } \mu \leq \mu_0$$
$$\text{H1: } \mu > \mu_0.$$

We will test the corresponding hypothesis based on the average of the answers from 13 sub-questions from question 5 of the survey questionnaire, using the t-test with a significance level, i.e., the probability of a wrong conclusion, of 5%. As it is a small, analyzed sample (N: 9 < 30), we will take the limit of the critical area from the student's t-distribution [17].

The mean value of all averages of employers' answers to the given 13 sub-questions from question 5 was $\bar{x}$ = 3.15, with the average corresponding standard deviation of s = 0.8298. Since it is

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} = \frac{3.15 - 3}{0.8298/\sqrt{9}} = 0.54 \not> 1.86 = t_\alpha,$$

we cannot reject hypothesis H0, i.e., we accept hypothesis H0. Therefore, with a significance level of 5%, we conclude that the students employed on part-time basis by employers achieved average or below-average learning outcomes in the Java programming language during their studies. Hence, we have not confirmed the expected hypothesis X. Although we did not confirm hypothesis X, it is to be expected that the following hypothesis will be confirmed:

Hypothesis Y: Students' competencies and knowledge acquired during studies in the programming language JAVA are at least at an average level.

Hypothesis Y can be written as $\mu \geq \mu_0 = 3$. More precisely, the hypotheses are

$$\text{H0: } \mu \geq \mu_0$$
$$\text{H1: } \mu < \mu_0.$$

We will test the corresponding hypothesis based on the average of the answers from 12 sub-questions from question 6 of the survey questionnaire, using the t-test with a significance level, i.e., the probability of a wrong conclusion, of 5%. The corresponding boundary of the critical area, as in the case of testing hypothesis X, will be taken from the student's t-distribution [17].

On the given 12 sub-questions (Table II.) of question number 6 from the survey questionnaire, on the observed sample N: 9, the average answers of employers were obtained, by sub-questions, in the range of the minimum average of 1.67 on 2 sub-questions. Sub-question 6: "*Spring Security*." and sub-question 11: "*Spring Boot and multilanguage support in Java web applications*." up to a maximum average of 3.00 employers' answers to sub-question 1: "*Basics of Java web application*.". In the segment of education that refers to programming courses in general, it is not encouraging that even 6 out of 12 sub-questions were answered by employers with an average rating no higher than 2.11.

TABLE II. EMPLOYERS' ASSESSMENT OF EMPLOYEES' KNOWLEDGE REGARDING JAVA

Q. 6	IT employers' assessment of JAVA subjects	$\bar{x}$	SD
1.	Basics of Java web application.	3.00	1.41
2.	Introduction to the Spring framework.	2.33	1.00
3.	Spring MVC REST services.	2.11	1.05
4.	Validating REST API.	2.11	1.05
5.	Angular routing and connection to the REST services.	2.11	1.05
6.	Spring Security.	1.67	1.00
7.	Web applications and databases.	2.78	1.20
8.	Spring Data JPA.	2.78	1.56
9.	Hibernate.	2.33	1.41
10.	Spring MVC REST and Quartz scheduler.	3.22	1.20
11.	Spring Boot and multilanguage support (i18n) in Java web applications.	1.67	1.00
12.	jUnit testing.	1.89	1.05

The mean value of all averages of employers' answers to the given 12 sub-questions from question 6 was $\bar{x}$ = 2.33, with the average corresponding standard deviation of s = 1.1677. Since it is

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} = \frac{2.33 - 3}{1.1677/\sqrt{9}} = -1.72 \not< -1.86 = -t_\alpha,$$

we cannot reject hypothesis H0, i.e., we accept hypothesis H0. Therefore, with a significance level of 5%, we conclude that the competencies, that is, the knowledge of the students acquired during studies in the programming language JAVA are at least at an average level, which confirms the expected hypothesis Y.

V. CONCLUSION

Based on the conducted research and the unconfirmed hypothesis X, it is evident that students, for the needs of the labor market in the IT sector regarding programming and general application development, did not master the expected learning outcomes of the JAVA programming language satisfactorily. This has been supported by the fact that hypothesis Y is almost borderline accepted and by the fact that for 50% of JAVA programming language topics, employers declared students' knowledge as devastating (average grade 2.11 or less).

All this indicates [18] [19] that most studies, whether public or private, should revise the implementation plans of programming courses, especially those based on object-oriented programming.

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