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E-ASSESSMENT WITH OPEN BADGES

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Abstract: *This paper focuses on using Open Badges in e-assessment. Open Badges have evolved as a novel means of assessing, recognizing, and credentialing skills, competences, knowledge, and achievements in various learning settings (formal or informal, online or traditional classroom). Viewed as e-assessment systems, Open Badges systems can be used to support assessment and recognition of a variety of skills, including both hard and soft skills. A case study presented in this paper illustrates all the necessary strategies, design decisions, and practical steps in assessing hard and soft skills with Open Badges.*

Keywords: *E-Assessment, Open Badges, learning recognition*

1. INTRODUCTION

In e-assessment, information technology and different software applications are used to support assessment processes. These processes include testing, test generation, assessment of cognitive and practical abilities, assessment of practical abilities, achievements, accomplishments, etc. [1].

If an e-assessment software application is designed as an e-testing system, it typically has two components: an assessment engine, and a database of assessment items/questions themselves that the engine uses generate a test.

If, on the other hand, an e-assessment system is designed to support more sophisticated forms of assessment, it typically supports some sort of interactive activity, enables students to reason and solve problems around that activity, and includes means of estimating students' understanding of the particular domain.

When used as e-assessment systems, Open Badges systems belong to the latter of the two kinds of e-assessment. Open Badges, http://openbadges.org/, are a widely used form of digital badges. A *digital badge* is a validated indicator of accomplishment, skill, quality or interest that can be earned in various learning environments [2]. In other words, it is an online representation of one's skill, knowledge, or achievement, such as those shown in Fig.1.

Open Badges (OBs), take that concept one step further, and allow learners to verify their skills, interests and achievements through credible organizations. "An OB attaches that information to the badge image file, hard-coding the metadata for future access and review. Because the system is based on an open standard, earners can combine multiple badges from different issuers to tell the complete story of their achievements — both online and off. Badges can be displayed wherever earners want them on the Web, and share them for employment, education or lifelong learning" [3].

Figure 1: Digital badges awarded to learners for their accomplishments in learning by means of various digital assets available at the Smithsonian's museum (figure taken from: http://naskun.dvrlists.com/smithsonian-insider-smithsonian-insider.html)

OBs greatly contribute to the general trend of open education by enforcing an open approach to recognition of learning achievements, by providing open evidence of learning accomplishments, by open criteria for credentialing learning no matter where, when, and how it happens, by being based on an open technical standard and free software, as well as by enabling open displaying and sharing of one's achievements [4]. The practical meaning of these open features is that OBs are "clickable at several points", Fig.2. One can click the badge issuer link to find out more about the authority who has issued the badge, or can find out more about the criteria used to issue the badge to the earner. Most importantly, one can also click the evidence link to see a digital evidence of the achievement.

2. THE GRASS PROJECT

OBs have entered The University of Belgrade as a means of supporting e-assessment through the GRASS project (http://grass.fon.bg.ac.rs). GRASS stands for GRAding Soft Skills. It is a 3-year European project, coordinated by

The University of Belgrade, being developed with the support of the Lifelong Learning Programme (LLP) of the European Commission. Eight educational institutions from four different European countries focus on how OBs can be used as means of grading learners' achievements in developing and demonstrating their soft skills (such as effective communication, collaboration, leadership, problem solving, and the like). The partner institutions come from different educational levels (secondary, upper secondary, and higher education) and their students' age spans from 12 to 26.

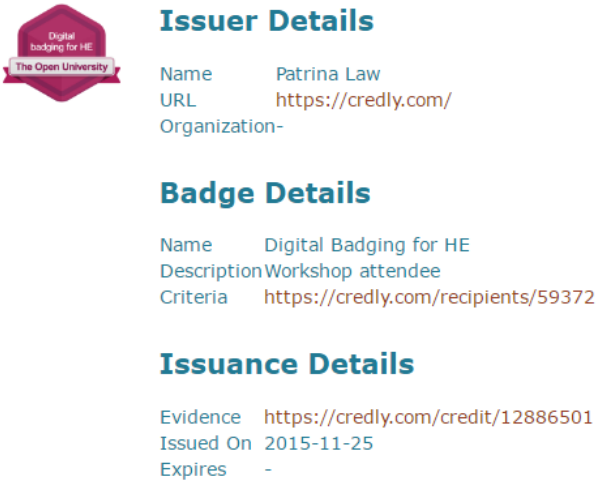

Figure 2: An Open Badge

Most researchers and teachers from these institutions do not explicitly teach soft skills to their students as specific courses. They typically explain the importance of soft skills and incite students to develop some of these skills as a side effect of regular courses. A set of a few dozens of soft skills (problem solving, emotional awareness, visual communication, summation, self-regulation, assertive behavior, creativity, critical thinking, communication, collaboration, etc.) is covered in the project activities, each partner institution typically focusing on a subset of 5-6 soft skills in the courses they teach. In about a dozen of application cases (ACs), the project partners award their students OBs for development and demonstration of different soft skills.

All project results are reported at the project Website (https://sites.google.com/site/llpgrassproject/results) and are already available for use by any interested institution or individual. They include:

- the GRASS pedagogical rubrics (links and interdependence between the critical elements that could influence learning activities and ultimately the development of soft skills), https://docs.google.com/spreadsheets/d/14Nk9OEw1UCg0s_RCctVQIXrTfPW7w-IFQGvdwVqeOm8/edit#gid=809795435
- various didactic materials
- a number of video tutorials for teachers, available through the project YouTube channel
- detailed descriptions of all project applications (ACs)
- detailed presentations and Websites of the Open Badge awarding platforms used by the partner institutions in different ACs

All of these products/results are already disseminated in more than a dozen of publications in international academic journals and conferences, the most comprehensive one to date being [5]; for other most important publications, see https://sites.google.com/site/llpgrassproject/publications). The project also maintains intensive contacts and exchanges experiences with other relevant European projects, networks and communities (see https://sites.google.com/site/llpgrassproject/links).

3. E-ASSESSMENT WITH OPEN BADGES – A CASE STUDY FROM THE GRASS PROJECT

The importance of soft skills in all educational and work settings is growing rapidly. However, such skills are easy to notice, but hard to measure. Defining metrics for soft skills, collecting measurements, and setting up the reference frameworks and measurement environments is extremely challenging – how can one, for instance, objectively measure and score a student's critical thinking?

In practice, metrics do exist (e.g., [6], [7]), but vary from one case to another, and are often rather implicit and vague. Contrary to that, the GRASS project use precisely specified, measurable factors, criteria, or functions to assess each soft skill. Although these GRASS metrics are not as general as those proposed in [6] and [7], they still have the advantages of being based on carefully developed GRASS pedagogical rubrics, being tested in the GRASS ACs, and being easy to reuse in practice with slight modification. In addition, GRASS has developed:

- a related new model and ICT framework for measuring, assessing, benchmarking, and evaluating learners' soft skills used in their activities, and generating appropriate feedback
- related sets of OBs (one per AC) for acknowledging, grading, awarding and recognizing learners' achievements in developing their soft skills, clearly reflecting their different education levels

SAGRADA model

The GRASS project team has developed the SAGRADA model that identifies a cyclic nature of development, measurement/assessment, displaying and recognizing students' soft skills by OBs, Fig.3. SAGRADA stands for SAmpling, GRAding, Displaying and Acknowledging. Using OB platforms and other ICT tools and services, students can submit digital artefacts representing their individual and/or work (sampling). These artefacts very often include traces of students' soft skills, and the teachers (as well as peer learners) can recommend awarding appropriate OBs for these skills (grading). Badge earners can then display the OBs they have earned on their Webpages or social network profiles (displaying), and employers and other stakeholders can click them and check the evidence of the accomplishments that led to the award of badges (acknowledging).

GRASS metrics

In GRASS, the development of soft skills is measured differently in each specific AC (i.e., in a specific course in a partner institution). To this end, the project has developed rich, AC-specific, structured sets of soft skill metrics to serve as dynamic indicators of the learners' ability to apply, develop and improve their soft skills in different ACs. These sets are all available online from the project results page for each specific AC (https://sites.google.com/site/llpgrassproject/results). They are based on well-known pedagogical approaches, such as constructivist alignment [8] and the cyclical model of experiential learning [9]. Starting from these approaches, each partner institution has elaborated a set of metrics to suit their specific learning settings. These sets of metrics look like the one shown in Table 1.

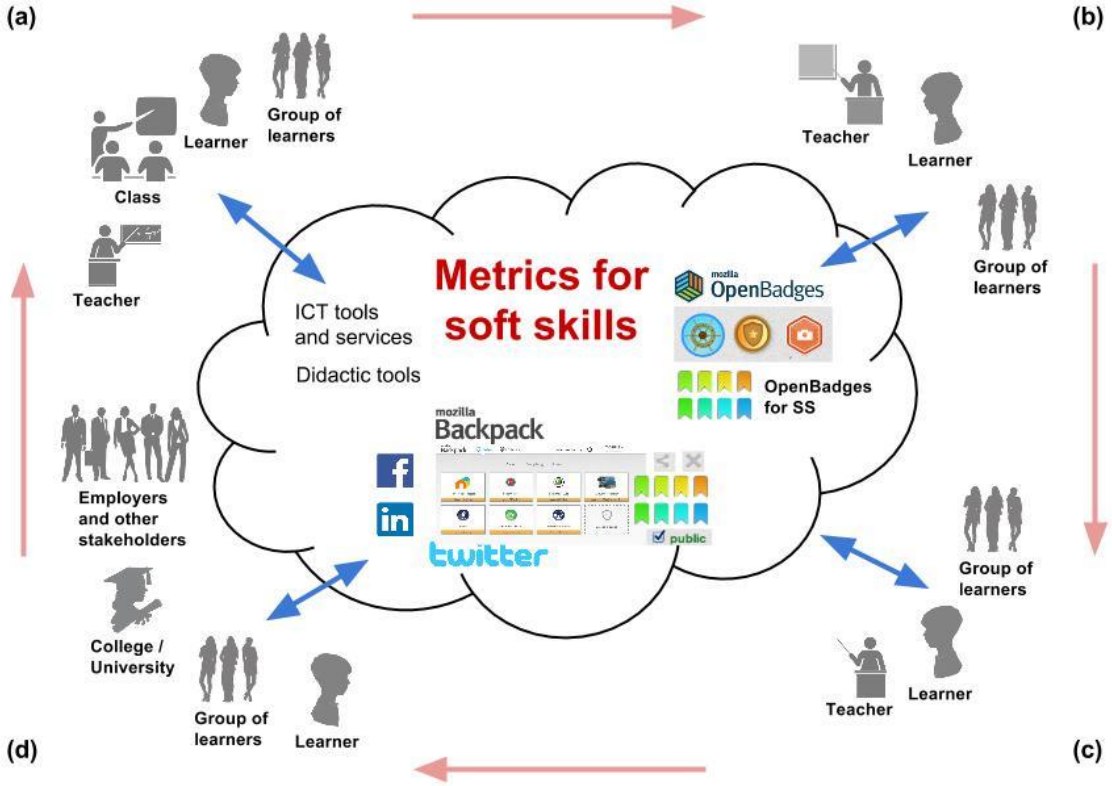

Figure 3: SAGRADA model (a) Sampling (observing, measuring) soft skills (b) Grading (assessing, awarding) soft skills (c) Displaying (sharing) soft skills (d) Acknowledging (recognizing, credentialing) soft skills

Table 1: Examples of soft skill metrics used in the UB application case. Soft skill: collaboration. See https://sites.google.com/site/llpgrassproject/results for all metrics.

Soft skill	Soft skill Quality/Criteria	Key indicator	Performance measure	Performance standard
Collaboration	Collaboration effort - behavior during 1.5-hour labs	Student displays collaborative behavior during labs	Live observation by tutor/peer (team member) during the labs	Tutor/peers notice that student engages in collaborative activities (Likert scale: No collaboration - Low Collaboration - Average Collaboration - High Collaboration Threshold[1]: Average Collaboration)
Collaboration	Collaboration effort - code (evidence) being produced	Student produces significant code improvements[2]	Code review - number of non-empty lines of code (per team member)	Student produces a significant number of non-empty lines of code (Scale: Less than 20 lines - 20-25 lines - 26-30 lines - more than 30 lines Threshold[1]: 26 lines)

[1] With that metric value (or higher), the student is a candidate for a badge in the corresponding achievement category.

For example, The University of Belgrade (UB) as a partner in GRASS has developed its AC for badging development of soft skills of entry-to-mid level Java programmers (BSc and MSc students learning Java in different courses taught at UB). Experienced teachers have identified a set of soft skills important for such programmers (collaboration, skilled communication, real-world problem solving, innovation, enthusiasm, initiative, critical thinking). For each soft skill in the set, the teachers have specified: a corresponding importance statement (e.g., for collaboration: "Most programming and software engineering nowadays is conducted in small teams..."); the pedagogical approach to incite, monitor and measure the skill development (for collaboration: the programming problem(s) that students work on in small teams, the role of the tutor, the roles of the peers, the level of contribution, and so on); and the context of the skill development (lab, assignment, presentation, etc.). Based on this, the teachers have defined several specific metrics for each soft skill. Descriptions of the metrics currently used in the UB application case are available online from the project results page, and an excerpt of these descriptions is shown in Table 1. The first row of the table exemplifies a metric that is derived from the tutor's online journal of students' collaborative activities, while the second row illustrate a metric that is based on the data collected from log files and students' submissions when working with specific ICT tools (e.g., programming code commits to code repositories).

The assessment process

In the AC implemented at The University of Belgrade, students work on simple programming problems and are guided by the teachers/tutors. They also get programming assignments to complete out of the regular classes. Parts of the assignments always include incentives to demonstrate one or more soft skills. If, for example, the point is to develop collaboration as an important soft skill, they get group assignments – a group of 3-4 students is assigned a collaborative project. When they are ready, they can submit their project through a dedicated BadgeOS badging platform called JGRASS, http://jgrass.fon.bg.ac.rs/. BadgeOS (http://badgeos.org/) is a WordPress-based software that enables users to design, develop, and organize badging process on their WordPress-powered Website (such as JGRASS).

Fig.4 shows a page from the JGRASS Website. It includes 2 badges (out of a dozen) that students can earn in this AC for their Java programming skills. For example, if they demonstrate a good command of the Git software versioning system, they can earn the *GIT Apprentice* badge. Similarly, if they demonstrate that they have mastered JUnit testing, they can earn the *JUnit Tester* badge. To apply for a badge, a student has to log in to JGRASS, complete the related programming assignment created by the teacher/tutor, and submit the program to the GitHub repository (https://github.com/) for review, Fig.5.

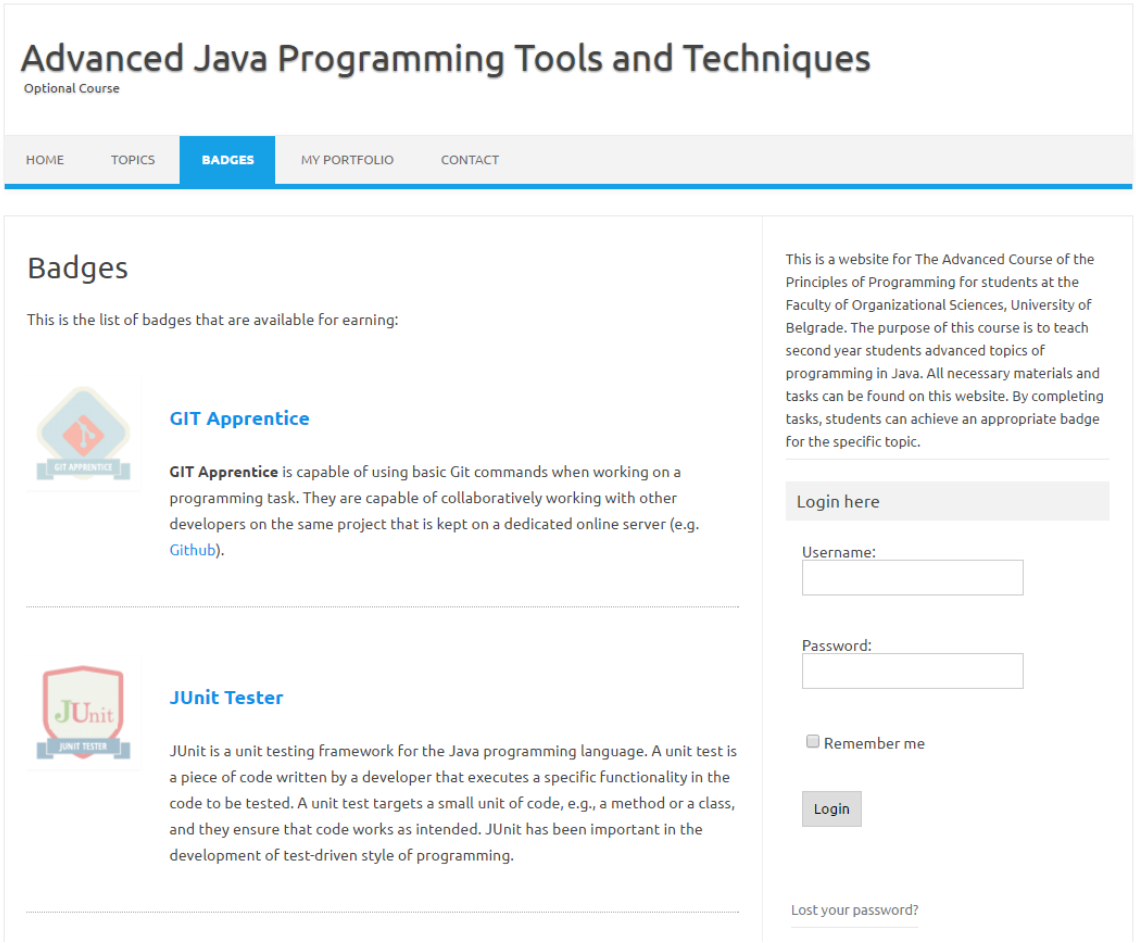

Figure 4: Some of the badges that students can earn from the JGRASS Website

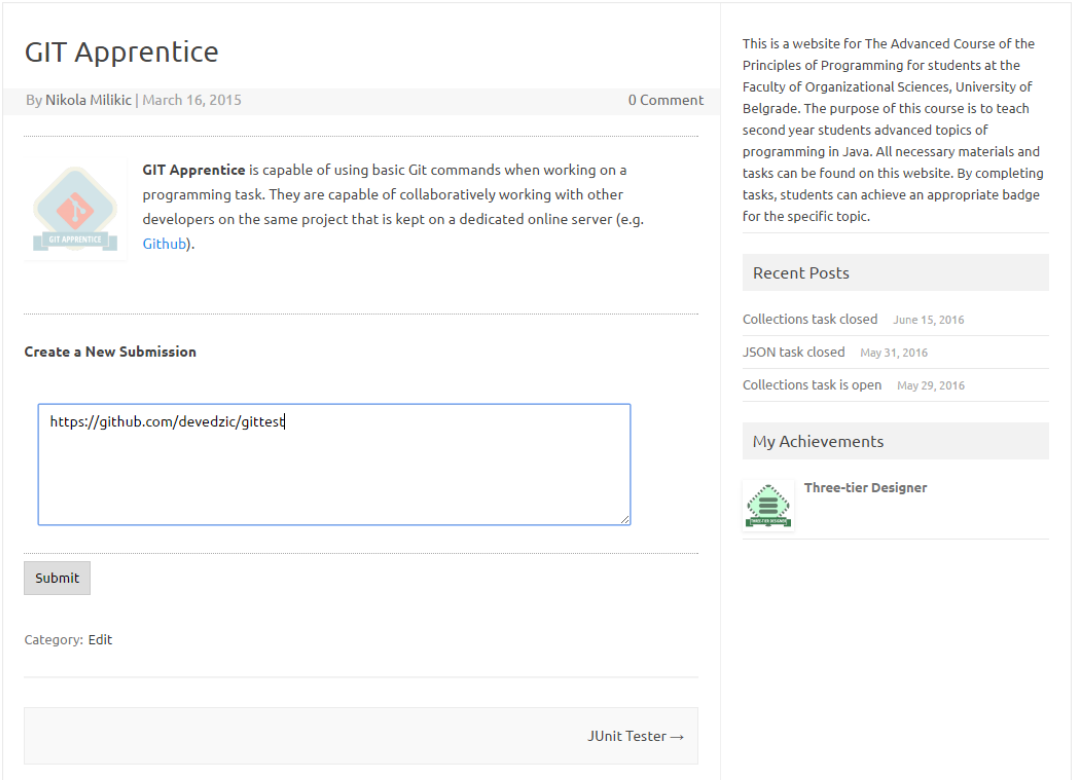

Figure 4: Applying for a badge on the JGRASS Website

More specifically, through the Create a New Submission box (see the lower part of Fig.5), the student submits a link to their project (Java program) stored in the GitHub software repository. The teacher(s)/tutor(s) responsible for assessing their project and the level of mastery of the related Java skill reviews the project and can award the related badge to the student.

If a student is awarded a badge, he/she gets an email notification of the achievement and can accept or discard the badge awarded. If the student accepts it, the badge is automatically stored on the Credly badge displayer platform (https://credly.com/), from which he/she can easily share it on his/her LinkedIn profile, on Facebook, on Twitter, or on another relevant Web page, Fig.5. This is typically very important – when seen, e.g., on LinkedIn, the badge can be clicked for evidence (the View evidence link in Fig.5), which takes the viewer to the digital evidence of the achievement (in this case, the Java program developed to demonstrate the mastery of Git). This can be essential for recruiting job candidates. As with all OBs, the digital evidence is an unambiguous testimony of one's demonstrated skill, knowledge and effort. If, in addition, the badge is awarded by a trusted issuer (the upper left corner in Fig.5), it can be a great advantage for the job candidate.

If during the work on an assignment the students have demonstrated not only their hard programming skills, but also some soft skills, they can be awarded some of the GRASS badges for soft skills. For example, working on a group assignment and demonstrating good collaboration, they can earn one of the GRASS collaboration badges – the *Collaborator BRONZE*, *Collaborator GOLD*, and *Collaborator GOLD* badges. There are also *Communicator SILVER* and *Communicator GOLD* badges for acknowledging demonstrated communication skills, as well as *Problem Solver BRONZE*, *Problem Solver SILVER*, and *Problem Solver GOLD* (for skilful problem solving abilities), and *Enthusiast SILVER* and *Enthusiast GOLD* awarded for recognizing enthusiasm of student programmers.

Obviously, GRASS soft skills badges acknowledge different "levels" in demonstrating soft skills. For example:

- *Collaborator BRONZE* badge (shared responsibility) is awarded if code commits come from all team members and contain significant code improvements (empty commits or commits that fix typos don't count)
- *Collaborator SILVER* badge is awarded if code commits clearly identify that certain tasks were done by certain people (evidence of decisions made regarding roles/responsibilities for each team member) and that roles/responsibilities were divided among the team members
- *Collaborator GOLD* badge is awarded if code commits clearly identify that all team members' work is interdependent and that it is equally divided

The teachers/tutors evaluate the students' soft skills in two ways. For example, when it comes to collaboration when working on the project, the teachers/tutors observe their activities when they work in the lab, but also use data and figures collected automatically by the GitInspector tool (https://github.com/ejwa/gitinspector), Fig.6. Both the live observations and the GitInspector data are used when judging how intensive their collaboration was. The indicators from the GitInspector tool visualize when, how often, and to what extent each team member has

contributed to the Java program developed (how many times they have committed (uploaded) new program code to the repository, how often they have done so, how many times they have made changes to the existing program code, when they have done it, etc.). Thus the reviewers have a pretty good picture of how much has each team member really contributed to the project.

With all these indicators and observations, the reviewers consult the reference metrics table developed and evolved over time for this AC, and can decide to award (or not) a collaboration-related OB to the team members. There are three such badges in this AC:

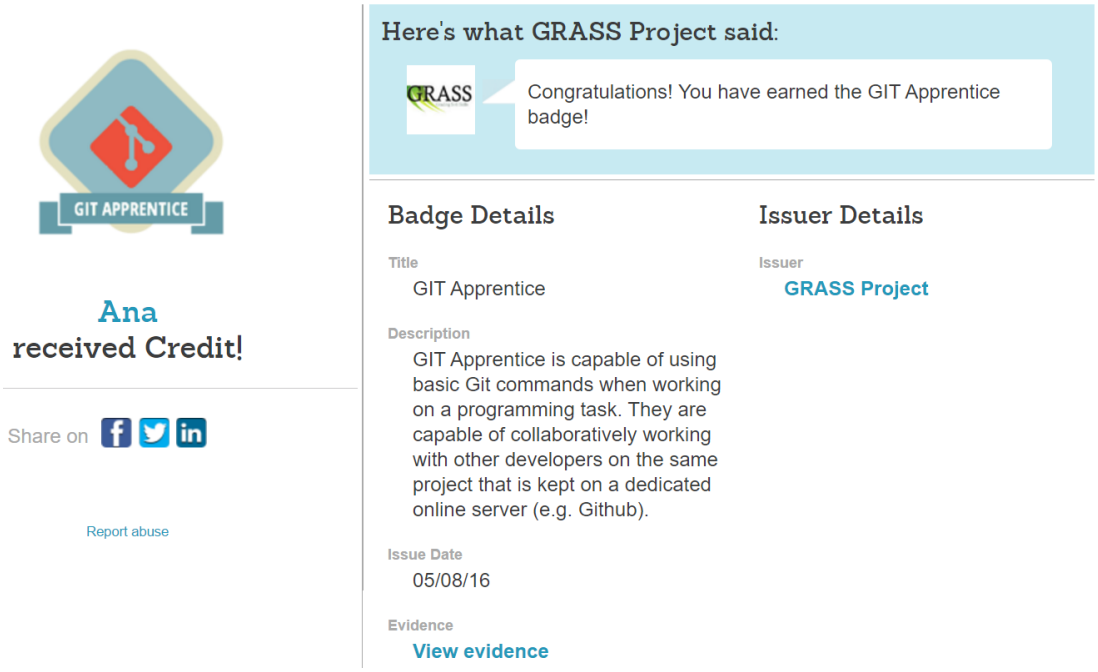

Figure 5: A student (Ana) has been awarded the *GIT Apprentice* badge

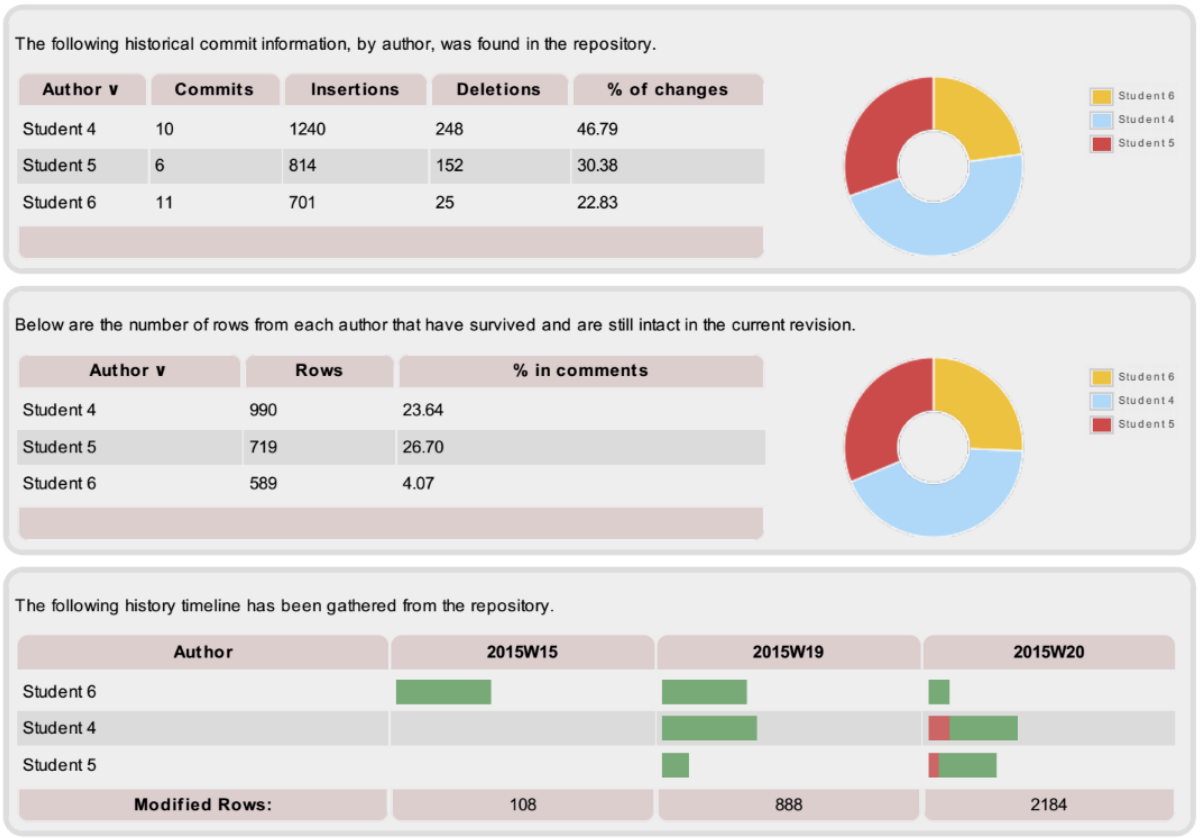

Figure 6: Indicators of collaboration generated by the GitInspector tool

4. EVALUATION AND LESSONS LEARNED

The course on Java programming implemented in this course was organized in the summer semesters of two consecutive academic years: 2014/2015 and 2015/2016. The course is an extracurricular one (not for credits), but attracts good students with high GPAs. In the first year (2014/2015), 56 second-year BSc students attended the course; in the second year (2015/2016), 64 second-year BSc students attended.

In the final week of the course, in class, the attending students were asked to fill out a questionnaire and state their opinion about OBs as a motivational mechanism, about soft skills, and about the course in general.

A subsequent analysis of the students' responses has revealed the following:

- Students generally like the idea of e-assessment with OBs and like getting OBs for their achievements. It indicates that OBs in e-assessment can be an interesting alternative to traditional test scoring. Still, creative work on real-world problems is a prerequisite for using OBs in e-assessment successfully.
- However, students do not perceive OBs as a crucial motivational mechanism for completing their assignments. This is in line with [4], where it has been discussed that OBs in assessment do not work as badges in gaming.
- Not all students understand the value of displaying the OBs earned in public; although most of them have displayed their OBs on Credly, not all of those have shared them on LinkedIn. This calls for a more thorough explanation of the benefits of OBs in the beginning of each course.

There are many more details related to this analysis. They are all publicly available in [10] and [11].

5. STEPS IN ORGANIZING E-ASSESSMENT WITH OPEN BADGES

In summary, if a teacher wants to organize e-assessment using OBs, she/he should make some strategic decisions first. These decisions have been made in GRASS starting from adaptations of the steps proposed in [12]:

- step 1: inform stakeholders about the importance of OBs
- step 2: explain all students the achievement standards and expectations
- step 3: identify partners to support e-assessment with OBs
- step 4: decide how students will participate in e-assessments with OBs (individually, collaboratively, as peer assessors, and the like)
- step 5: when possible, integrate performance observations with automatically collected data
- step 6: use a variety of e-assessment approaches; for instance, OBs can accumulate in formative assessment in a variety of ways and help decide on the final grade
- step 7: score the OBs earned, report results, and use the data for course improvement
- step 8: evaluate the e-assessment with OBs

In addition to these steps, one should be aware of different perspectives of using OBs for assessment: learners, teachers, schools, employers and other stakeholders all have different interests in e-assessment with Obs and perceive that process differently. The details of these different perspectives are beyond the scope of this paper, but are discussed thoroughly in [5].

6. CONCLUSION

Open Badges are an effective mechanism that can be used to support e-assessment. The emphasis here is on *support* – there is very little (if any) automatic assessment test scoring with OBs. They are rather a mechanism that can be used to capture the results of students' activities, the overall learning accomplishments, the levels of learning achievements, a variety of knowledge, skills and competences, and, most importantly, the evidence of these accomplishments, skills, competences, etc. As the experience from the GRASS project shows, OBs are somewhere midway between quantitative and qualitative assessment support. If used in a sophisticated way, scoring with OBs is also possible (guided by human judgement and with careful design of the underlying OB system), augmented with a strong digital evidence of the learning achievement (hard-coded in the badge itself).

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