

An automated and scalable solution for anonymous written exams realized by web services and smart card systems

Tor Fridell ¹, Suzanne Svensson ²

¹The LADOK consortium and Linköping university, Linköping university, SE-581 83 Linköping, Sweden, tor.fridell@liu.se, ²Linköping university, SE-581 83 Linköping, Sweden, suzanne.svensson@liu.se

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1. EXECUTIVE SUMMARY

1.1. Background

There is at least in Sweden a general equal opportunity trend. You should have the same possibilities regardless of gender, race, handicap and more. One demand in that direction has been that written exams should be corrected anonymously. There have been schemes in operation for a long time but all of them have been in a small scale and highly manual.

With the help of a web service for correcting exams supplied by the Ladok consortium, Linköping university has developed an IT-system for an automated process for this.

1.2. Prerequisites

There are three things that set the stage for the solution. Most universities in Sweden use the same student information system, Ladok. It is developed jointly and lately the development has led to several web services, one of them offers the possibility for teachers to correct exams.

At Linköping University, as well as many other institutions, it is mandatory for the students to register for each exam. This is done in a web system by the students themselves.

Linköping University has a campus card system for all students. This includes photo ID and is the only identification needed for the students.

1.3. The solution

The system is based on three pillars:

-The students receive an anonymous identification number, AID, (a serial number) when they register for the exam.

-At the exam only the AID is written on the exam papers. The students swipe their campus card in a PDA (personal Digital Assistant) with a card reader which the exam guards carry. This signifies attendance and links the identity to the AID. The exam guards then check the identification number and photo on the campus card and link the actual person to the AID.

-The teacher corrects the exam in a web service where only the AID is displayed. When the correction is done the system translates this to the personal identification number used in Ladok. Once in the student information system the anonymity is broken. Thus, the anonymity is not complete but the correction of the exam is anonymous.

2. INTRODUCTION

There is at least in Sweden a general equal opportunity trend. You should have the same possibilities regardless of gender, race, handicap and more. One demand in that direction has been that written exams should be corrected anonymously. The demand for anonymous exams originates from the student unions. The teacher should not at the time of correction know which student he is setting a grade on.

There have in fact been schemes in operation for a long time running anonymous exams but all of them have been in a small scale and highly manual. Either the student simply put their name on a paper with codes and remember this code at the exam or the administrator assigns anonymous codes in for instance an Excel-sheet and hands out at the exam. Obviously this way would not work when the number of students increase. The workload increases unproportionally and the risk for human errors make it hazardous. The decision in Linköping was that all written exams should be anonymous which means it concerns approximately 120 000 exams per year.

Since the university supports the notion of equal opportunity it was with only a minor study decided to go ahead with the project. The project started more or less with a blank paper and went to work. The main objective was at first only to create the anonymity. In the early stages simple solutions such as putting a semi-glued sticker over the name, which could be torn off when entering grades into the Student Information System, SIS, were discussed. All of these were abandoned since they do not scale well. It is easy with five students but not with five hundred. An automatic solution was needed.

After an inventory it was clear that the systems most likely to contribute to the solution was the SIS Ladok¹, the exam registration system and the campus card system. At this stage we identified substantial side benefits. Attendance control was until then done manually with paper lists but is done with just little interaction with the use of the campus card. Attendance lists used in the correction process could now be produced electronically and automatically. The ID-number facilitates random seating.

The project was nevertheless redefined along the way. The part with the teachers correcting exams on the internet was added halfway. The reason for this was that the teachers protested against the increased workload. With the first solutions minor extra work was anticipated, but even a small amount of extra work adds up to a big sum when you have a thousand students and ten days to complete the correction. It is a valuable lesson that it is absolutely necessary to involve faculty early in the project! Linköping University acts as a pilot for this application. The web service will later be offered as a part of the national Ladok system.

3. THE SYSTEM

There are three things that set the stage for the solution. First is the student information system (SIS), Ladok, used by most universities in Sweden. It is developed jointly by a consortium² and lately the development has led to several web services, one of them offering the possibility for teachers to correct exams.

Secondly, at Linköping University, as well as many other institutions, it is mandatory for the students to register for each exam. This is done in a web system by the students themselves in the university student portal³.

Finally Linköping University has a campus card system for all students. This includes photo ID and is the only identification needed for the students. It has been used for exams for several years. The campus card includes a contact less chip, a Mifare® 1K chip.

¹ The Ladok system, <http://www.ladok.se/en>

² The Ladok consortium, <http://www.ladok.se>

³ The Linköping university student portal, <http://www.student.liu.se/en>

In order to understand the system we first need to examine the exam process. In the following chapter we go through the process as it works with this new system.

4. THE EXAM PROCESS

The exam process with this new routines is as follows:

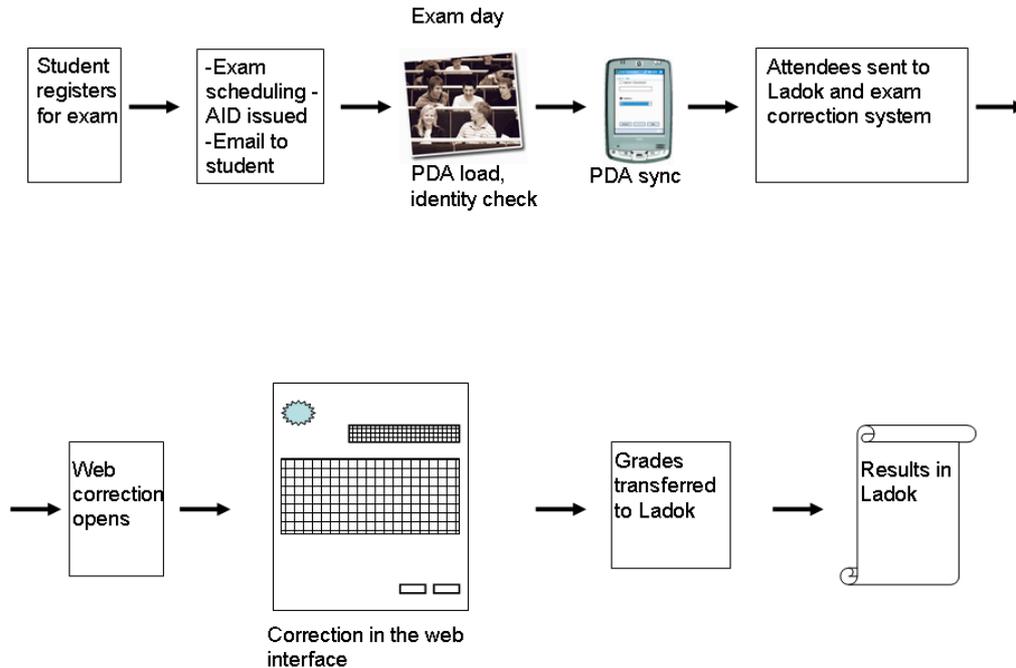


Figure 1 The exam process

1. The students register for the exam.
2. The administration assigns rooms for all exams ten days before the exam.
3. An email is sent to the student with a reminder of the exam and the room where it takes place.

4. At the exam only the AID is written on the exam papers. The exam guard reads each student's campus card in a PDA (Personal Digital Assistant) with a contact less card reader, which they carry. This signifies attendance and links the identity to the AID. The exam guards then check the card itself; identification number and photo on the campus card and link the actual person sitting in the room.

A HP iPAQ with a Mifare® reader (ISO 14443) was chosen as the mobile equipment.



Figure 2. Exam guard checks the Liu Card

5. The attendees of this day's exams are sent to Ladok and the exam correction system, sometime in the evening after all exams are done. The correction is now open.

6. The teacher corrects the exam in a web service where only the AID is displayed. When the correction is done a conversion engine translates this to the personal identification number used in the SIS Ladok. Once in Ladok the anonymity is broken. Thus, the anonymity is not complete but the **correction** of the exam is anonymous.
7. The administrator now acknowledges the grades in Ladok, possibly corrects problem for instance students without registration, and then prints the list of grades.
8. The teacher signs the list of grades. This document is still the legal binding document of the exam results.
9. When administrator receives the signed list the results are finally recorded in Ladok.

5. TECHNICAL DETAILS OF THE SYSTEM

The Student Information System

Ladok is a national Swedish Student Information System and it is developed jointly. It is at the moment only available in Swedish. Ladok is used to store all study results and is also in this new order the end station for all grades. According to Swedish legislation it is not possible to set a grade on an unknown person. When the results are transferred to Ladok they are therefore decoded and the personal identification number is used. As a security measure, to register a result in Ladok **two** persons must interact. The teacher corrects the exams and set grades (today usually on paper). A Ladok administrator then enters the grades into Ladok and prints a report. This report is signed by the teacher and then the administrator finally validates the grades. This two-fold system is maintained and the only difference is that the teacher fills in the grades in a web interface and the administrator thus doesn't need to do this.

The exam registration system

The exam registration system is of own brand. It serves both students and all administration about exams. The exam occasions are imported from planning systems well in advance.

The student registers for exams, usually from 20 to 10 days before the exam.

When registration is closed the administration selects room for the exam and assigns exam guards.

Finally the AID is generated and an email is sent to the students with a reminder of the exam and also with what room the student is located in. This system lastly feeds the PDAs with data about the next days exams. All data of the current days exams are exported to each PDA. You can use anyone of them at any given time.

The equipment at the exam event.

PDA

A HP iPAQ 214 was selected as the PDA (personal Digital Assistant) to be used in the rooms. We also considered a Palm Tungsten and found them more or less equal. The main reason for choosing the Ipaq was that our developers had knowledge of the operating system, windows Mobile 6.0.

We tried different IPAQ models. The decision was a balance between the screen size, weight and battery capacity and this model seemed like a good choice. An application was developed for the user interface. The PDA communicates with wireless internet (IEEE802.1b) which means you have to have wireless internet coverage but since all PDAs have information of the whole day you only need internet connection when you synchronize, in the morning and after the exam. The university nevertheless has coverage on most



Figure 3. IPAQ 214

places on campus.

We use up to fifty PDAs at the same time. We needed to consider where to keep them to protect from theft. We equipped one room in each campus area with access control and alarm system. We also equipped these rooms with electricity outlets so that the PDAs are put in the charger each night to be fully charged each morning. The data load is done by the exam guard when they check out the PDA in the morning. It takes only seconds.

Card Reader

In the analysis phase we tested readers of different types. We tried a bar code reader but the reading was not reliable and quick enough.

We then tried magnetic stripe readers who performed very well but you have the hassle that the guards must take the card and swipe it.

Finally we tested a RFID (Radio frequency Identification) solution. Since all LiU-cards include a Mifare[®] 1K chip (ISO 14443) we found a reader to the PDA where you just hold the PDA near the card. We choose a PROMAG[®] MFR 135 reader.

All card readers beep when they make a successful read. This is ordinarily desired but it is not so in an exam situation. We therefore had to make a special order without beep.



Figure 4. Card reader MFR 135

The Exam Correction System

The exam correction system starts to work on the exam day. As soon as all PDAs have synchronized their data about an exam the web interface for correcting exams is open for authorized users. The teacher now sees only the AID for each student. Several variations where more teachers can take part and both students and parts of the exam can be divided amongst them.

When the correction is done the responsible teacher sends the data to Ladok. At this point the anonymity is broken. A conversion engine translates all anonymous IDs (AID) to the personal identification number used ordinarily in Ladok. It is not much of an engine to be precise, we keep both name, identification number and AID in the database for each student and exam so we just fetch different fields. The correcting teacher can both see and print lists of students with AID and name. Now the two-fold security system kicks in. A Ladok administrator must confirm the grades in Ladok and print a report. The report is signed by the teacher and then the administrator finally validates the grades. Of course all actions in the system are logged so if a grade is changed after the anonymity is broken then we will know this (and there better be a reason for it).

6. RELEVANCE TO OTHERS

The system described integrates three systems in an **exam process**. Although the systems are very specific they are not interesting at all. We believe that the basic ideas could be generalized to any campus.

The Student Information System (SIS) used, Ladok, could be replaced with any SIS. It would not even be a necessity that the SIS be involved at all. You could use this system and produce paper lists as output for an administrator to enter into the SIS in the ordinary way.

Any campus card system could be used and if such does not exist then any form of identification could be used, for instance driver's license or biometrics. The only purpose of the campus card is to establish a strong identity connection between the person and the anonymous ID. It adds convenience without doubt but it is not a requirement.

Instead, the interesting thing and the relevance to others is the impact on the campus! How do we get this accepted by the faculty? How do the students react?

The change in how both teachers and administrators work is a major one. It affects all teaching staff and therefore you need to have a solid information plan. We involved faculty early and have distributed information in many ways; meetings, email, web pages and printed information. You can never give too much information!

The exam correction web page required extra design attention. It as, and must be, very simple in its basics. Only one startup choice is necessary, the name of the correcting teacher. Yet it must be possible to divide students and parts of the exam in a variety of ways if needed.

One thing discovered during the way is that there exists lots of different “bonus systems”. One example of this is that if you have passed an earlier voluntary exam you get three extra points on this exam. The reasons for all of them are pedagogic and there are many variations. In a regular exam this is no problem, you just check the qualifications but when it is anonymous you can't do that. You don't know who the student is! This caused us to include a function that fetches previous study results from Ladok and presents them in the interface when correcting the exam.

Since this system must be fail proof, both a backup plan and a disaster plan also had to be designed. No event at all must crack the system. We have written instructions to the exam guards for all possible events. If a PDA is broken, you simply get a new one and continue. If the PDAs don't synchronize correctly the exam administration has a routine. If the worst possible case occurs, that the whole system fails, the worst possible effect is that the exams that day are not anonymous. We can always instruct the students to write their personal identification number on the exam instead. By this we have eliminated the strong dependency on the technical systems.

How do the students react then? Since the demand emanates from them the system has been received well. Nevertheless we have from the start of the project made sure that the student wishes has been fulfilled. We have student representatives in the project itself, which we feel has improved the quality of the project.

The system is when writing this not in full scale production. The final results will therefore not be present until fall-08.

7. REFERENCES

The Ladok consortium Located [26.4.2008] on World Wide Web: <http://www.ladok.se>

The Ladok system, short description in English Located [10.5.2008] on World Wide Web at <http://www.ladok.se/en>

The Linkoping university student portal. Located [10.5.2008] on World Wide Web at <http://www.student.liu.se/en>