

12/2 (2014), 241–250

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**Teaching**  
Mathematics and  
Computer Science

## Radio Frequency Identification from the viewpoint of students of computer science

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*Abstract.* This paper aims at creating the right pedagogical attitudes in term of teaching a new technology, Radio Frequency Identification (RFID) by evaluating the social acceptance of this new method. Survey of future teachers, students of teacher master studies and students from informatics oriented secondary schools were surveyed comparing their attitudes in terms of RFID to other recent technologies. Consequences of this survey are incorporated into the curriculum of the new RFID course at our institution.

*Key words and phrases:* Radio Frequency identification, social acceptance, curriculum.

*ZDM Subject Classification:* P70, Q20, Q40, Q80.

### 1. Introduction

Teaching of any fields of computer science requires continuous update of curriculum and content, due to the rapidly developing technologies. One of the newly emerged method in data transfer is Radio Frequency Identification (RFID), and there is a solid demand of teaching RFID techniques for students in computer

This research was supported by the European Union and the Government of Hungary, co-financed by the European Social Fund in the framework of TÁMOP-4.2.2.C-11/1/KONV-2012-0014 FutureRFID - Az RFID/NFC technológia továbbfejlesztési lehetőségei az “Internet of Things” koncepció mentén.

science, even if they have no prior knowledge of its physical or information background. A complete RFID security course with new learning materials and teaching strategies is presented in [3], while further aspects are discussed e.g. in [4, 5]. RFID also recently appeared in the curriculum of informatics teacher Master in Eszterházy College, Eger [6]. The theoretical, technical and informatical aspects of this curriculum have already been developed, but it was uncertain to what extent social questions should be incorporated to the curriculum, since it is – as we will see in Section 2 – a crucial point of the widespread application of this technology.

For a teacher of computer science, it is of central importance to be aware of the prior knowledge and attitude of the students in the subject. Thus our aim was to assess and evaluate this knowledge and suppositions of recent and future students of informatics in terms of radio frequency identification. Moreover, it is extremely important to gain knowledge about possible RFID-specific fears, if any, and attitudes of these students. This survey provides us information in adapting the curriculum, but also helps us handling the somewhat crucial pedagogical questions in terms of social acceptance of this new technique – the final aim is to bring up a new generation of teachers who consider (and teach) RFID as a natural and effective way of information transfer.

## 2. RFID – new opportunities and fears

Radio frequency identification is already present in everyday life, although its use only ranges to industrial and commercial networks, storages, and the controlling of work processes. The appearance of this technology is a revolutionary breakthrough in automatic identification: the data stored on RFID transponders attached to objects or living entities can be read even from greater distances with the help of radio waves, and can be forwarded to a data-processing computer without human interference. This ability has inevitable advances, albeit it enables identification of persons by their objects tagged with RFID transponders, and an observation of their movements and habits. From this aspect, unlike an RFID tag attached to a piece of furniture, tags placed on an object which is permanently held by the user (e.g. glasses, telephones, personal documents, or a device for controlling certain illnesses) can be especially alarming. Data-reading is noiseless and invisible, and can be done without the knowledge of the transponder’s owner, even behind closed doors and windows. Consequently, the RFID’s breaking out from the business sphere and its widespread unfolding means a new level and

further problems, primarily from the aspect of social acceptance or rejection. Due to the supposedly positive effect of the technology on Europe’s industry the European Union is constantly working on providing the appropriate legal, ethical and commercial framework: having recognized the fears, and admitting their validity, EU has already made a recommendation for the controlling of the use of RFID devices [1]. Collecting private-considered data for mainly commercial reasons had already existed long before the emergence of RFID [2]. The users (consumers) usually regard it as necessary evil, but accept it to a certain limit, since it is clear for them that this is partly for their own benefit. In earlier surveys among adults, fears about RFID-based technology was higher than about ICT in general (cf. [8], [9]). Some groups, however, especially in countries where the use of RFID technology is widespread, still have doubts on privacy and security issues [9, 10, 11, 12]. Through social media these doubts have also reached the Hungarian audience but no survey has been made in order to clarify its effects. Thus in our research it was of utmost importance to gain knowledge about the attitudes of our future and present students – the next generation – in terms of these questions.

Another important question is how the information is used after having been collected. Some of the concerns are identical with those we can experience in similar cases, e.g. handing the data over to a third institute or person – the user favours to have the information connected to him/her and the use of it within certain barriers. From this aspect, the object of observation can be the question of how much more the user should be concerned about RFID, than about other information-collecting of similar types and interests. Beyond pedagogical issues mentioned above, our survey aims at providing a guideline for the companies and projects that are willing to introduce the RFID technology regarding social expectations and opinions.

### 3. The survey

In 2013 we carried out a survey measuring opinions and habits regarding the individual uses of electric devices, and we also compared them to similar questions in connection with RFID. Our primary aim was to assess whether there are RFID-specific fears, concerns, and how the future, or already existing applications where RFID tags store personal data and thus enable possible misuses, are accepted by our present and future students, who form the younger part of society being more educated in terms of informatics.

The online questionnaire was filled by more than 500 people, thus became representative enough and suitable for statistical analysis. Those, who filled the questionnaire were primarily students of informatics-oriented secondary schools and college students of informatics. The distribution of responders according to age and place of residence can be seen on Figure 1. Responders who are mostly under the age of 30, proportionately map the distribution of applicants to this field of study to our institution according to their place of residence [7], thus the survey can be considered representative in this term.

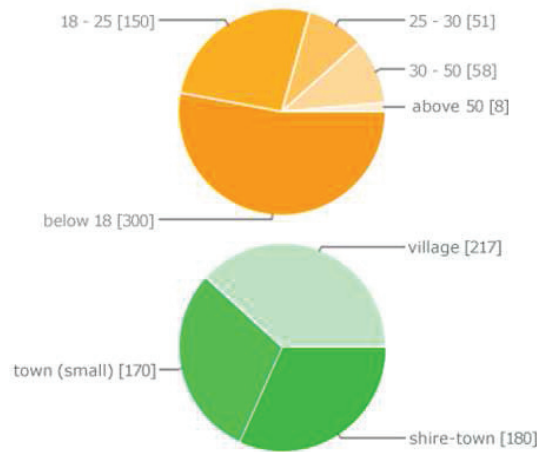


Figure 1. The distribution of responders according to age and place of residence

#### 4. Views regarding known channels of observing and collecting data

With the first circle of questions we were looking for an answer to the question of to what extent is the use of electronic data-traffic a part of the responders' everyday life, namely, how often they use mobile phones and internet. According to the results, 70 percent uses the mobile for at least 30 minutes a day, 54 percent of them arrange “possibly everything” by mobile, 97 percent use the internet every day, and 40 percent of them are “almost always” online – we can regard the responders as digital natives. It has also turned out clearly that the vast majority of the responders are aware of the danger of gathering personal data

by these channels. The next group of questions was expected an answer to how much this danger and the fact of collecting personal data bother the responders, or whether they consider collecting data as a useful act. The opinions regarding collecting data are summarized on Figure 2. As it can be seen, the responders are aware of collecting data, but this age-group are not particularly bothered by that, for instance, because they do not think these data are so important as to be worth misusing.

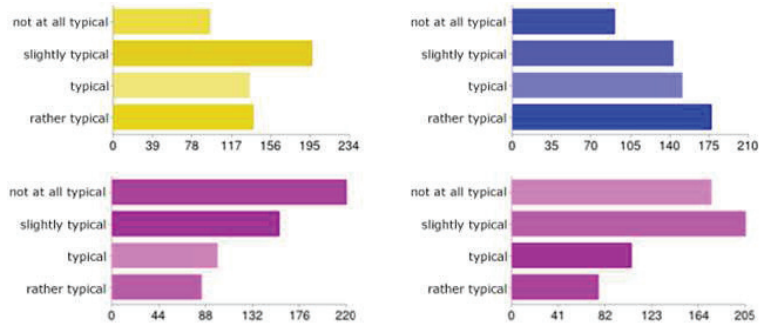


Figure 2. Answers to: “Does it bother me that my personal data are accessible?” on the internet, with data provided by browsers (upper left), by reading my e-mails (upper right), with shopping rewards cards (lower left), and by tracking my mobile (lower right)

The same potential data-collecting and observing possibilities evoke much more definite reactions in connection with whether the responders regard the collecting as a useful act (Figure 3).

The users definitely refuse that these data-collecting would be useful for them, they simply co-exist with them as a “necessary evil” which are thus inevitable, if we want to use the given channels of communication. There is only one, but significant exception – the question regarding mobile phones emphasized that tracking a mobile can be useful when searching for criminals. As it can be seen on the lower left graph of Figure 3 this purpose made tracking and collecting data much more acceptable than pay per click advertisements and personal offers.

In summary we can state about observing and collecting data that:

- The responders are aware of the various possibilities of observing and gaining information.
- The fact of being observed does not particularly bother them.
- The vast majority of them do not regard any form of it as useful.

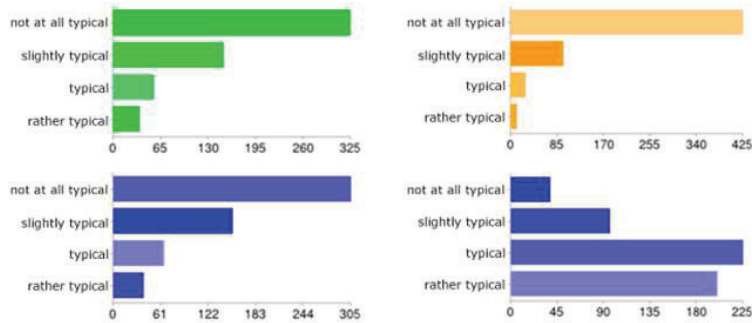


Figure 3. Answers to: “Do you think it is useful that the data are accessible?” regarding internet browsers (upper left), by reading my e-mails (upper right), with shopping rewards cards (lower left), and by tracking my mobile (lower right)

- In the case of a particular purpose (tracking down criminals) their judgement on usefulness may change to a positive direction.

## 5. Views regarding RFID

In the next segment of the questionnaire we asked the responders about their views regarding RFID. As we were not sure whether all the responders had heard about RFID-technology, we included a short neutral guide before these questions. As Figure 4 shows, when defining concrete aims, the responders of the questionnaire do not reject the use of RFID and the observing that goes along with it to the extent that we have seen with those devices mentioned above. The identification of dogs with RFID-chips this was announced in the press at the beginning of launching the survey, this is why it is included here, or the RFID-passport already in existence abroad, proved to be much more useful according to the responders than the previous observation situations (apart from the mobile-based tracking of criminals).

These charts also show that the opinions on RFID are still quite diverse, indicating a certain uncertainty. This can be useful, for it means that with good communication and well-defined aims RFID can be made acceptable, and the majority of society can be convinced about its usefulness.

At certain points of the questionnaire we also asked identical questions to investigate whether there are differences in the fears connected to RFID and

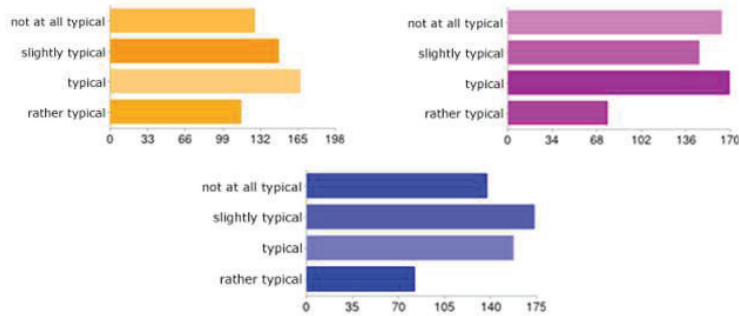


Figure 4. Answers to the statement regarding the views on the usefulness of RFID: the chip required for dogs (upper left), the passport with RFID chip (upper right), and their usefulness. At the bottom, in the middle: reactions to the statement: “I would buy a device containing an RFID tag if it helps with further servicing an identification.”

other devices. Our experiences are definitely positive from the aspect, that there are no extra fears connected to RFID, as it is shown on Figures 5 and 6, almost identical statistical results came up to those identical questions in connection with RFID and other devices.

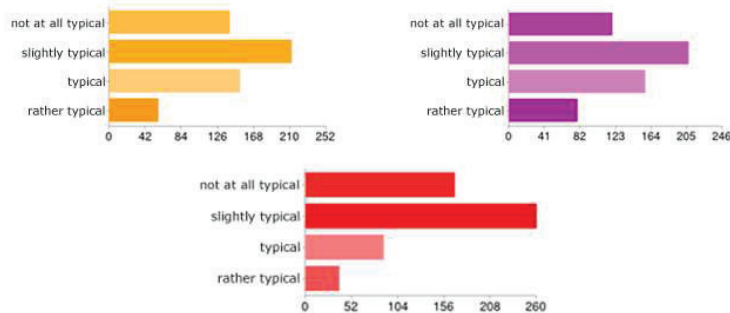


Figure 5. The judgement of the statement: “The electromagnetic radiation of the device is hazardous to our health” in the case of mobile phones (upper left), microwave ovens (upper right), and RFID gates (at the bottom, in the middle)

Although it is not shown by the graphs, this identical judgement is valid for each individual one by one: the one concerned about the electromagnetic radiation of microwave ovens is also concerned about the radiation of RFID gates, whereas,

the one not concerned about all the above is not concerned about RFID as well. Similarly, the judgement of each channel from the aspect of misusing the data is also analogue (Figure 6).

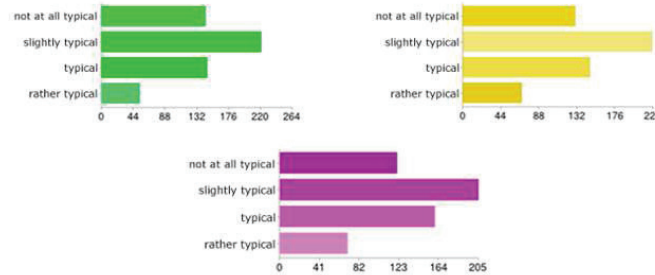


Figure 6. The judgement of the statement: “I do not think that I can be a target of the misuse of information obtained this way” in the case of e-mails (upper left), the internet (upper right), and RFID (at the bottom, in the middle)

The judgement of how much the channels can be controlled is also identical. The graphs of Figure 7 show a high accordance, furthermore, they show the fact that there is a high demand for controllability – this could be vindicated at the new generation of RFID chips at a standard level, thus making its social acceptance easier.

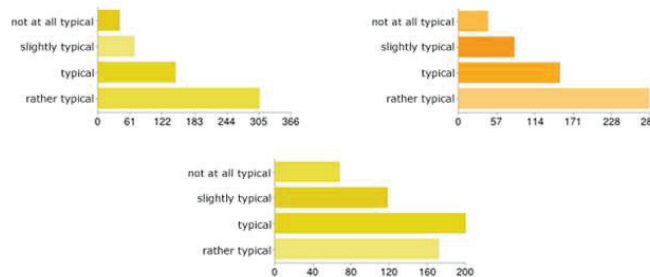


Figure 7. Answers to the statement: “It would be good if I could give permission for reading/tracking the data” in the case of e-mails (upper left), the internet (upper right), and RFID chips (at the bottom, in the middle)

The survey is available (in Hungarian) at <http://goo.gl/y2C7x>.



## 6. Summary

The results of our research can be summarized as follows:

- In the survey we could not trace particularly RFID-specific fears.
- At the questions regarding RFID, there are few extremities and more uncertainties, which can even be positive, with a good pedagogical strategy and with concrete aims acceptance can be increased.
- The students can be best convinced about the usefulness of the technology through concrete examples.
- There is a strong demand to personally control the reading/tracking of data – this brings up the need for introducing an independent school object dealing with security issues when regarding the curriculum, as it is suggested by international examples [3].

As a consequence of this survey, lessons learnt in terms of teaching of RFID for informatics teachers. During the RFID course in our institution we strongly emphasize to our students that – in spite of some warnings – our society has a basically positive attitude in terms of RFID applications. Future teachers of informatics have to be aware of this attitude, since they will bring up the next generation of users. In the RFID course, beside theoretical foundations and computer-related tasks

- one lecture is dedicated to the social circumstances and related issues,
- two lectures are dedicated to practical, existing and possible applications.

It is of great importance that teachers have to provide best practices in terms of RFID applications, since – due to our survey and observations – these practical and useful examples can improve the level of acceptance. Consequences of this survey are successfully incorporated into the new curriculum of our RFID course.

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(Received March, 2014)