

# **International Baccalaureate**

## **Extended Essay**

**Due Date:** June 2007

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**An analysis and comparison of the use of RFID tags for monitoring in  
Schools and Hospitals: do the benefits outweigh the risks?**

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**Subject:** Information Technology in a Global Society (ITGS)

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**Supervisor:** Mrs Wheaton

**School:** Tintern Girls Grammar School

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

## **Abstract**

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This essay compares and analyses the use of RFID technology to monitor people in two situations: Schools and Hospitals, weighing up the benefits against the risks in each situation.

It covers the technological and historical background of RFID technology and its use in schools and hospitals. It shows how the technology can be used to assist attendance taking in schools, increasing student safety, and how it is used to monitor the movements of patients within a hospital ensuring maximum patient safety.

It explores the social, economic and ethical impacts of the technology on various stakeholders, and how these have impacted the trials leading to their success or failure. The economic implications are discussed in regards to the cost of each system to each organisation. The legal implications for both schools and hospitals have been closely analysed, particularly the issue of data security within the system. If schools and hospitals are collecting and storing data about the movements of people, they would have to ensure the data was sufficiently secure to prevent unauthorised access. Individual's privacy, the main ethical concern discussed, could be breached, leading to greater implications if the security was inadequate. Two possible solutions of data security are suggested, using a combination of encryption and user accounts.

On evaluation of the two systems, using RFID to monitor students is not efficient, as the high risk of the breach of privacy outweighs only the minor benefit of taking attendance faster. However, in the hospital situation, patients are hoping for maximum safety and care, therefore are 'glad' they are being more closely monitored, taking less regard to the breach of privacy. Therefore, in hospitals, the benefits of patient safety outweigh the risks.

**Word Count: 281**



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An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

## Introduction

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My research question is:

***“An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?”***

I have written my extended essay in the subject of Information Technology in a Global Society (ITGS). I am currently studying it and I have a keen interest in the area, and the way our developing technology has an effect on society.

I was first interested in the area of RFID technology and how it could be used within schools. However, through secondary research on the internet, I found that the issue was limited in schools due to privacy implications ceasing the school trials. I researched further and found a useful comparison where hospitals use RFID technology to monitor patients. Comparing the two, I chose to analyse the differences between monitoring students at school, and patients in hospitals and why one system was successful compared to the other.

My essay covers the economic, legal and privacy impacts of the implementation of RFID technology in schools and hospitals: whether the benefits outweigh the risks in both situations.

I surveyed 30 students from year 9-12 at my school about the implementation of RFID technology to automatically take attendance<sup>1</sup>. I contacted and interviewed various knowledgeable stakeholders: David Straitiff, president and chief officer at Intuitek, supplier of the technology at Brittan Elementary School<sup>2</sup>, Mark Walter, Chief Information Officer at Enterprise Charter School and principal developer of the system<sup>3</sup> and Simon Richardson, ICT

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<sup>1</sup> Appendix E – Survey of 30 Students  
Date Conducted: 12<sup>th</sup> June 2007

<sup>2</sup> Appendix A – Email Interview with David Straitiff  
President and CEO Founder of Intuitek, New York.  
Date of Interview: 18<sup>th</sup> April 2007

<sup>3</sup> Appendix D – Email Interview with Mark Walter

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Operations manager at Health and Aged care at Werribee Mercy Hospital in Australia<sup>4</sup>. I also managed to find and transcribe an interview with David Morgan, an Ear, Nose and Throat surgeon at a hospital in England, who instigated the use of the system<sup>5</sup>. I used a combination of primary and secondary resources to investigate RFID technology in schools and hospitals.

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Chief Information officer at Enterprise Charter School, New York  
Date of Interview: 12<sup>th</sup> April 2007

<sup>4</sup>Appendix C – Email Interview with Simon Richardson  
ICT Operations Manager at Heath & Aged Care – Werribee Mercy Hospital, Australia  
Date of Interview: 31<sup>st</sup> May 2007

<sup>5</sup> Appendix B – Interview via Podcast with David Morgan  
Ear, Nose and Throat Surgeon at Birmingham Heartland's Hospital, UK  
Date of Interview: 22<sup>nd</sup> March 2006

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## Chapter 1: IT and historical background of RFID Technology.

### 1.1 General Background

RFID (Radio Frequency Identification) Technology uses electronic tags to replace conventional barcodes enabling machines to identify objects. The RFID system consists of a microchip (see Figure 1<sup>6</sup>), connected to an antenna (forming the RFID tag), sending out a signal received by a reader<sup>7</sup>. It uses radio waves to communicate between devices<sup>8</sup>.

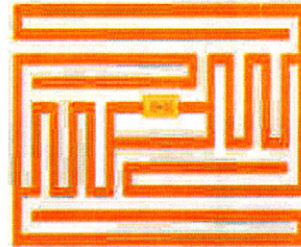


Figure 1: An enlarged microchip found in an RFID tag.

RFID was first used in World War Two where British aircraft needed to be distinguished from other objects on their radars<sup>9</sup>. Scottish physicist, Sir Robert Watson-Watt developed a transmitter to be attached to British planes which first picked up radar signals then sent its own return signal<sup>10</sup>. Essentially, Watson-Watt created the first basic RFID system.

Today, RFID has widespread uses. Tags have been used to track goods within a supply chain; ensuring items are delivered from their manufacture site to their point of sale or to their planned destination<sup>11</sup>. RFID has also been used in tracking livestock: for example Lobsters in the Gulf of Maine have been tagged for conservation research<sup>12</sup>, whilst farmers in Australia are required by law to tag their cattle to enable tracking in case of disease and to boost Australia's

<sup>6</sup> 'Radio Frequency Identification', 2007, *Wikipedia, the free encyclopedia* [Online], Available: <http://en.wikipedia.org/wiki/RFID> [2006, November 21].

<sup>7</sup> 'RFID FAQs' 2007, Available: <http://www.rfidjournal.com/faq> [2007, April 18].

<sup>8</sup> 'Presence Awareness: Optimizing the Marketplace', 2006, *Diamond Cluster* [Online], Available: [www.diamondcluster.com/ideas/viewpoint/wppresenceawareness.asp](http://www.diamondcluster.com/ideas/viewpoint/wppresenceawareness.asp) [2007, April 24].

<sup>9</sup> 'The Basics of RFID Technology', 2006, *RFID Journal* [Online], Available: <http://www.rfidjournal.com/article/articleview/1337/1/129/> [2007, April 18]

<sup>10</sup> *Ibid.*

<sup>11</sup> 'RFID Technology: Readers, Tags, Systems' 2006, Nov. 10 Available: <http://www.electronics-manufacturers.com/info/rf/microwave-electronics/rfid-technology-readers-tags-systems.html> [2007, April 19].

<sup>12</sup> Cowan, Dianna 2003, June, 'Identifying Lobsters using Passive Integrated Transponder (PIT) Tags' Available: <http://www.maine.gov/newsletter/june2003/Lobsters%20PIT%20tag.htm> [2007, April 18].

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cattle exports<sup>13</sup>. Countries, such as the US and Australia, are now embedding RFID tags in passports to create “e-passports”<sup>14</sup>.

In the future, RFID technology will become smaller, cheaper and more advanced<sup>15</sup>. As the ability of RFID implants into the human skin becomes more realistic, so does our ability to track the individual<sup>16</sup>.

The RFID system relies on interaction between tags and readers. Present-day tags often use a silicon microchip able to store a unique serial number including additional information such as batch numbers, point of origin and destination when used to track exports<sup>17</sup>. Tags are either passive or active<sup>18</sup>. Passive tags do not contain a battery or power source, therefore cannot broadcast their own signal independently; however, radio waves are reflected by the antenna to the reader, receiving the signal<sup>19</sup>. Active tags, on the other hand, use their power source to broadcast a signal containing the information stored on its microchip<sup>20</sup>. This allows tags to transmit radio signals at higher power levels, coping in environments such as water or at longer distances<sup>21</sup>. Active tags due to their battery are more expensive, therefore less common, however are more reliable<sup>22</sup>.

<sup>13</sup> **'RFID Tagging of Cattle by Law in Australia'**, 2005, Jul. 4 *IDTechEx* [Online], Available: <http://www.idtechex.com/products/en/articles/00000201.asp> [2007, April 18].

<sup>14</sup> Gilbert, Alorie 2004, Oct. 25, **'U.S. moves closer to e-passports'**, CNet News [Online], Available: [http://news.com.com/U.S.+moves+closer+to+e-passports/2100-1012\\_3-5425314.html](http://news.com.com/U.S.+moves+closer+to+e-passports/2100-1012_3-5425314.html) [2007, April 19].

<sup>15</sup> **'Radio Frequency Identification (RFID) Systems'**, 2006, *EPIC* [Online], Available: <http://www.epic.org/privacy/rfid/> [2007, April 19].

<sup>16</sup> Ibid.

<sup>17</sup> Op. Cit. **'The Basics of RFID Technology'**

<sup>18</sup> Ibid.

<sup>19</sup> Ibid.

<sup>20</sup> Ibid.

<sup>21</sup> **'RFID Solutions for Hospitals'** 2006, Available: [http://www.activewaveinc.com/applications\\_hospitals.html](http://www.activewaveinc.com/applications_hospitals.html) [2007, May 18].

<sup>22</sup> Ibid.



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RFID tags with low radio frequencies can be read from short distances (twelve inches) whilst higher frequencies allow tags and readers to communicate over three feet<sup>23</sup>. Each tag broadcasts its own unique number to identify the tag. The reader is often connected to a database which can link this number to other corresponding information<sup>24</sup>.

Software is used in the readers allowing the information to be connected to databases or applications on a network<sup>25</sup>. Most new readers have network connections through Ethernet, WiFi or USB ports<sup>26</sup>.

RFID tags do not need line-of-sight to connect with a reader<sup>27</sup>. They can work in environments with dirt, dust, moisture or poor visibility<sup>28</sup>. The signal can be encoded, securing data transmission<sup>29</sup>. This is particularly important when carrying sensitive information, an issue when monitoring people.

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<sup>23</sup> Op. Cit. **'The Basics of RFID Technology'**

<sup>24</sup> **'Intuitek: RFID'** 2007, Available: <http://www.intuitek.com/Home/RFID> [2007, April 18].

<sup>25</sup> Ibid.

<sup>26</sup> Op. Cit. **'The Basics of RFID Technology'**

<sup>27</sup> Op. cit. **'Presence Awareness: Optimizing the Marketplace'**

<sup>28</sup> Ibid.

<sup>29</sup> Op. Cit. **'RFID Technology: Readers, Tags, Systems'**

## Chapter 2: Uses of RFID Technology.

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### 2.1 RFID Tags in Schools

Some schools are using RFID to monitor students. Several US schools have trialed systems to monitor attendance. They were initiated for a faster, more accurate method of taking attendance improving students' safety<sup>30</sup>.

Students and staff at Enterprise Charter School (ECS) in New York, USA were issued passive RFID badges (embedded with their 9-digit student ID number<sup>31</sup>) with their photo and homeroom/staff position printed on it<sup>32</sup>. On each floor, when entering the school, students and staff were required to stop and 'wave' their card at the screen (passing the reader), recording their attendance for the day<sup>33</sup>. The data was then transmitted wirelessly to a central server, running a custom application<sup>34</sup>.

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<sup>30</sup> Leff, Lisa 2005, Feb. 9, '**Students ordered to wear tracking tags**', *Tech, News and Reviews*, MSNBC, [Online], Available: <http://www.msnbc.msn.com/id/6942751/> [2007, March 29].

<sup>31</sup> Op. Cit. Mark Walter: Q6

<sup>32</sup> Ibid: Q2

<sup>33</sup> Ibid: Q2

<sup>34</sup> Scheeres, Julia 2003, Oct. 24, '**Three R's: Reading, Writing, RFID**', *WIRED* [Online], Available: <http://www.wired.com/science/discoveries/news/2003/10/60898?printable=true> [2007, March 29].



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Brittan Elementary School (BES) in California, USA, introduced a similar system where their RFID tag (containing a unique 15-digit number) displayed their name, picture and grade, affixed to a lanyard and worn around the neck<sup>35</sup>. The system was similar to ECS's system but students had to simply walk under readers located above classroom doors<sup>36</sup>. At BES attendance lists are then sent wirelessly to the teacher's PDA (Personal Digital Assistant) where the teacher can visually verify the student's presence<sup>37</sup> (see Figure 2<sup>38</sup>).

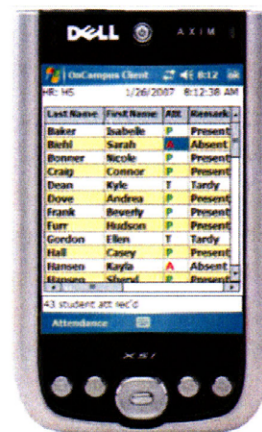


Figure 2: Teacher's PDA showing their students' attendance record.

## 2.2 RFID Tags in Hospitals.

Some hospitals are now using RFID tags to monitor their patients. Patients are 'tagged' upon arrival monitoring them to ensure they receive the correct treatment. Several hospitals in the UK have adopted this system<sup>39</sup>.

The Birmingham Heartlands Hospital (BHH), in the UK, have successfully trialled an RFID tagging system for over a year on their patients to "mistake-proof their surgical processes," according to David Morgan - an Ear, Nose and Throat Consultant surgeon at the hospital<sup>40</sup>. The tags improve theatre efficiency, identifying patients, and ensuring they are delivered to the correct

<sup>35</sup> Zetter, Kim 2005, Oct. 2, 'School RFID Plan Gets an F', *WIRED* [Online], Available: <http://www.wired.com/print/politics/security/news/2005/02/66554> [2007, April 18].

<sup>36</sup> Ibid.

<sup>37</sup> Ibid.

<sup>38</sup> 'InClass and OnCampus' 2005, Available: <http://www.incomcorporation.com/product1.htm> [2007, April 19].

<sup>39</sup> 'RFID in Healthcare' 2006, Available: [http://www.electronics.ca/reports/rfid/rfid\\_healthcare.html](http://www.electronics.ca/reports/rfid/rfid_healthcare.html) [2007, May 27].

<sup>40</sup> Op Cit. David Morgan.

theatre on time and returning them back to the ward<sup>41</sup>. It does not replace manual checking of patients, but verifies that doctors and nurses have done their job.<sup>42</sup>

When a patient books in for surgery, they have a digital photograph taken and are assigned a unique identification number (stored on the electronic patient records) held on a secure server in the hospital<sup>43</sup>. They are then allocated a 13.56 MHz passive RFID tag which is embedded into the traditional hospital wristband (see Figure 3<sup>44</sup>).



**Figure 3:** An RFID tag is embedded in the traditional patient wristband.

Authorised nurses, surgeons and anaesthetists can view the electronic records via a PDA designed to communicate exclusively with the mainframe computer<sup>45</sup>. The operation list can be viewed or altered digitally<sup>46</sup>. PDAs have their own RFID software and readers which can read tags 4-5 inches away, sending that information wirelessly (using the hospital's WiFi network) to the hospital database<sup>47</sup>. RFID readers are also located at the entrances and exits of the wards, the anaesthetic room and surgical theatre where Visual Display Units connected to the hospital's electronic record show the digital operation list<sup>48</sup>.

<sup>41</sup> Op. Cit. David Morgan: Q2

<sup>42</sup> Ibid: Q6

<sup>43</sup> Ibid: Q7

<sup>44</sup> 'Medical Errors - RFID to the rescue' 2006, Available: [http://asianhbm.com/magazine/previous\\_issue/medical\\_errors\\_rfid.htm](http://asianhbm.com/magazine/previous_issue/medical_errors_rfid.htm) [2007, May 27].

<sup>45</sup> Op Cit. David Morgan:Q7

<sup>46</sup> Ibid. Q:7

<sup>47</sup> 'Birmingham Heartlands RFID-tags patients to avoid litigation' 2005, Feb. 18 Available: <http://www.bjhc.co.uk/news/1/2005/n502016.htm> [2007, May 18].

<sup>48</sup> Op. Cit. David Morgan:Q7

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A 'traffic light' system is used to monitor the stages of the patient's surgical journey and various checks are done to correctly identify the patient and to ensure protocols have been followed<sup>49</sup>. A green light is then showed on the operating list showing that the patient is ready to go<sup>50</sup>.

The Aged Care department at Werribee Mercy Hospital in Australia is also looking at implementing tags to track patients with dementia, alerting the staff to abnormal patient behaviour, for example: disorientation<sup>51</sup>.

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<sup>49</sup> Parkinson, Caroline 2007, Feb. 16, '**Tagging improves patient safety**', *BBC News* [Online], Available: <http://news.bbc.co.uk/2/hi/health/6358697.stm> [2007, May 27].

<sup>50</sup> Op. Cit. David Morgan: Q7

<sup>51</sup> Op. Cit. Simon Richardson: Q7

## Chapter 3: Legal implications of RFID Technology

Legal implications arise from the collection of data, namely the information that is stored on a central database gained from the information supplied by the RFID tag.

### 3.1 Legal implications in Schools.

The information linked with the ID number on the RFID tag may include the student's full name, age, sex, class or other personal information<sup>52</sup>. The time and place of arrival is also stored on the database<sup>53</sup>. Therefore, movements of each student can be found in one location in the school system. This raises the legal responsibility of the school to maintain the security of this information.

The school must make decisions about who can access the information, and must consider security measures to stop unauthorised access. At BES, the RFID system was ceased after parents sent an official letter to the board of trustees regarding the "safety and civil liberties implications"<sup>54</sup>. The letter also outlined how the tags "jeopardize the safety and security of the students by broadcasting identity and location information to anyone with a chip reader."<sup>55</sup> Parents were concerned that their child could be intercepted by anyone. The school would have to ensure that their network security was impenetrable, or would risk the safety of their students, their reputation or even litigation.

At BES, the information was also relayed to teacher's PDAs<sup>56</sup>. Wireless transmissions should have sufficient encryption and limited access to teachers only. These PDAs could easily fall into

<sup>52</sup> **'Concern Grows Over ID Data Systems and Tracking'**, 2006, Feb. *Education Reporter* [Online], Available: <http://www.eagleforum.org/educate/2006/feb06/id-data.html> [2007, March 29].

<sup>53</sup> Op. Cit. Mark Walter: Q2

<sup>54</sup> **'Safety and civil liberties implications of including Radio Frequency Identification tags in student identity badges [letter]'**, 2005, Feb. 7 *EPIC* [Online], Available: <http://www.epic.org/privacy/rfid/brittan-letter.pdf> [2007, May 17].

<sup>55</sup> Ibid.

<sup>56</sup> Op. cit. **'Concern Grows Over ID Data Systems and Tracking'**



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the ‘wrong hands’ such creating legal consequences for the school if the information was broadcasted.

The school must also consider how long the data is stored. At ECS, law requires attendance to be stored for five years after the student graduates<sup>57</sup>. From my survey (see Figure 4<sup>58</sup>), only a subtle majority opposed this idea. It would be breaching their legal responsibility if the school released details after a student had graduated especially if the information was published – say in the case of a celebrity. Also, does the student, or their parents, have the right to view their own data? At ECS, the answer was no<sup>59</sup>.

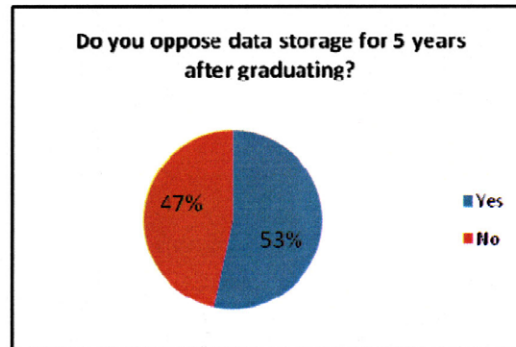


Figure 4: Survey Result

Who owns the data? The school collects the information, but specific details belong to the students – can the school refuse students the right to access their own information? Do they have the right to divulge the information to other sources? For example, the school might distribute student’s statistics to employers highlighting those who were consistently punctual or late - creating serious legal issues: as students could be deprived of equal employment opportunity.

### 3.2 Legal implications in Hospitals.

The legal implications in hospitals would share some of the same issues as those found in schools.

Hospitals would have to ensure that all patient data was secure and encrypted to maintain doctor/patient confidentiality – especially as hospitals deal with the general public.

<sup>57</sup> Op. Cit. Mark Walter:Q9

<sup>58</sup> Op. Cit. Survey of 30 Students: Data storage for five years.

<sup>59</sup> Op. Cit. Mark Walter: Q10

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Hospitals would also have to ensure that only those authorised to see the information had access. At BHH, staff had PDAs allowing direct access to the patient information<sup>60</sup>. The hospital would have to ensure that no PDAs were misused or lost to guarantee maximum patient safety.

Reliability of the information is another issue. It is vital that the wristband does not mistake the patient's identity. At BHH, the system was introduced to reduce these mistakes<sup>61</sup>, however, if the information provided by the wristbands was incorrect, the same problem would arise making the new system redundant. The hospital would have to ensure the validity of all the information or a patient scheduled for an x-ray could have a limb amputation – creating serious legal implications for the hospital.

Hospitals would face the same issue regarding how long they keep the data. Most hospital visits are over within days, yet the patient records could be kept for years. The question of data ownership also arises – does the hospital have the right to release information? For example – a well known person may have been scheduled for surgery: does the hospital have the right to release to the press that this person has entered the operating theatre at 2:13pm, for a specific operation? All legal implications must be considered.

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<sup>60</sup> Op. cit. **'Tagging improves patient safety'**

<sup>61</sup> Op. cit. David Morgan: Q1

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## Chapter 4: Economic implications of RFID Technology

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All new technology comes with a cost. RFID technology would have an economic impact on any organisation.

### 4.1 Economic implications in Schools.

Schools must examine both initial and long term costs. At ECS, the initial cost was \$35000 USD<sup>62</sup> – each kiosk costing \$4000 and each tag \$3.50 USD<sup>63</sup>. Schools must weigh up the advantages of the new versus the old system including the cost. For some schools it is not worthwhile when they cannot afford equipment in other areas of the school. At ECS, tag costs became “prohibitive” when the student population rose<sup>64</sup>.

The ‘digital divide’ issue arises – whilst the richer schools advance with technology, the poorer schools recede. This would show differences in safety, as the RFID technology is aimed at improving the levels of student safety. It would imply that poorer schools were viewed as ‘less safe’ than richer schools, because they did not have a ‘tagging’ system. This could, in turn, affect student intake and enrolment numbers.

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<sup>62</sup>Op. Cit. Mark Walter: Q4

<sup>63</sup> Murray, Corey 2003, Nov. 18, '**Controversial radio ID tags keep track of kids**', *eSchool News online* [Online], Available: <http://www.eschoolnews.com/news/showstory.cfm?ArticleID=4770> [2007, April 18].

<sup>64</sup>Op. Cit. Mark Walter: Q3



Maintenance would also be costly. Schools would have to ensure that each reader was functioning every day and repair or replace faulty items. Vandalism could also be prevalent in a school. Schools would have to secure readers to prevent them from being stolen or damaged, yet remain accessible for students. Broken tags would have to be issued immediately at a cost to the school. My survey shows that students prefer the school to pay for replacement cards (see Figure 5<sup>65</sup>). ECS decided to cease its trial – whilst “effective, it was cost prohibitive.”<sup>66</sup>

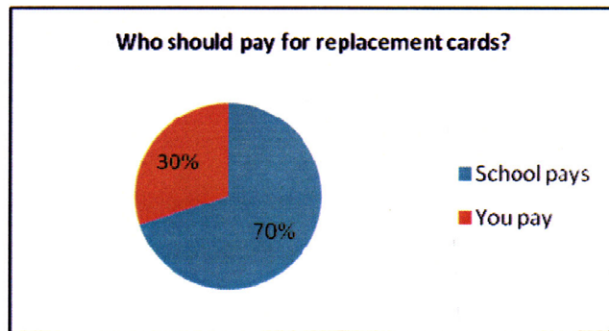


Figure 5: Survey Result

#### 4.1 Economic implications in Hospitals.

When implementing RFID technology to monitor their patients, the hospital would have to consider the benefits of using the technology versus the costs involved.

At BHH, the total cost was £75 000 however the costs of the tags themselves dropped about 200% in the last 9 months to 30-50 pence each<sup>67</sup>. The pilot study at BHH showed improved efficiency allowed one extra minor operation to be carried out per day, saving the hospital £260000 a year<sup>68</sup>, allowing for the system to extend to other hospitals<sup>69</sup>.

<sup>65</sup> Op. Cit. Survey of 30 Students: Who should pay for replacement cards?

<sup>66</sup> Op. Cit. Mark Walter: Q13

<sup>67</sup> Op. Cit. David Morgan: Q2.

<sup>68</sup> Op. cit. 'Tagging improves patient safety.'

<sup>69</sup> Op. Cit. David Morgan: Q3

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However, Simon Richardson, ICT Operations Manager at Werribee Mercy Hospital, Australia, acknowledges that an RFID system that monitored babies within their nurseries “was not implemented as the staff within the area did not feel the risk [of abduction] warranted the cost of the installation.”<sup>70</sup> However, the overwhelming majority (93%) of students surveyed supported the use of RFID to monitor patients (see Figure 6<sup>71</sup>).

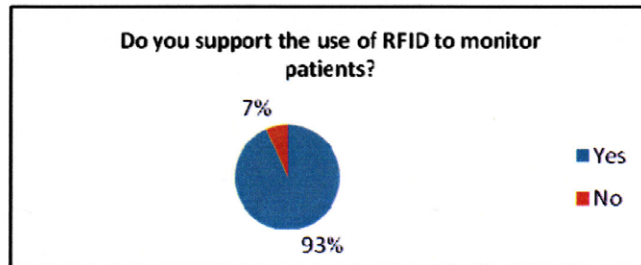


Figure 6: Survey Result

Similarly, this could create another ‘digital divide’, where privately funded hospitals would advance due to a superior patient monitoring system, as opposed to public, or government funded hospitals who could not afford it. Akin to the school scenario, this could affect admissions to certain hospitals as those with RFID monitoring would be considered as ‘safer’ as there was less risk to the patient<sup>72</sup>.

Maintenance of the RFID technology in the hospital would be less of an issue compared to schools. The equipment in a hospital environment would be ‘safer’ and the issue of vandalism would be minimal as only staff and visitors are permitted in wards.

It seems as though RFID monitoring systems would be a greater advantage in hospitals than schools, because their benefits outweigh the costs involved. In schools however, it seems as though the RFID system has no significant advantages over the old system, whilst costing much more.

<sup>70</sup> Op. Cit. Simon Richardson: Q7

<sup>71</sup> Op. Cit. Survey of 30 Students: Do you support the use of RFID to monitor patients?

<sup>72</sup> Op. Cit. David Morgan: Q3

## Chapter 5: Ethical Implications of RFID in Schools and Hospitals

When using RFID technology to track and monitor people, privacy and the ‘big brother’ issue arises.

### 5.1 Privacy in Schools

At both ECS and BES, the privacy debate has caused both schools to reconsider their program<sup>73</sup> - the intrusion of privacy did not warrant the benefits the system offered. Both students and parents were outraged at this “big brother style system.”<sup>74</sup>

Monitoring and the invasion of privacy are major issues. Parents at BES expressed their rage at this “intrusive new technology,”<sup>75</sup> which “puts its children at risk...rather than making the schools more secure.”<sup>76</sup> Ascertaining the exact time of a person in a certain place restricts the individual’s right to freedom. This is especially concerning in the case of ‘hacking’ into the system, or if the data was to ‘fall into the wrong hands’, questioning data security.

Parents are most concerned about the invasion of privacy<sup>77</sup>. However, my survey showed that the majority of students thought that RFID tags in schools were not a breach of privacy (see Figure 7<sup>78</sup>).

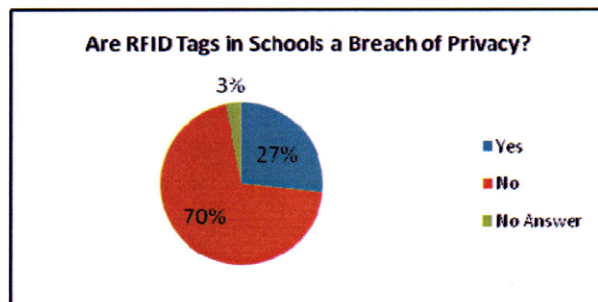


Figure 7: Survey Result

<sup>73</sup> Op. Cit. 'School RFID Plan Gets an F'

<sup>74</sup> Op. Cit. Mark Walter: Q5

<sup>75</sup> Op. cit. 'Safety and civil liberties implications of including Radio Frequency Identification tags in student identity badges [letter]'

<sup>76</sup> Ibid.

<sup>77</sup> 'Mandatory Student ID Cards Contain RFIDs', 2005, Feb. 8 *EPIC* [Online], Available: [http://www.epic.org/privacy/rfid/prs\\_rls-020705.html](http://www.epic.org/privacy/rfid/prs_rls-020705.html) [2007, May 17].

<sup>78</sup> Op. Cit. Survey of 30 Students: Are RFID Tags in Schools a Breach of Privacy?

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The invasion of privacy can have a detrimental psychological effect on an individual. A student at ECS described his concerns: "Something about the school wanting to know the exact place and time makes me feel like kind of an animal."<sup>79</sup> Students may feel constantly uncomfortable during school knowing their movements are monitored, may be unnecessarily self-conscious and could also be a form of distraction.

Whilst students may feel anxious from being so closely monitored, it could possibly have positive effects for the parents – peace of mind. At ECS, parents "absolutely loved it, as it would notify them when their child was not in school."<sup>80</sup>

## 5.2 Privacy in Hospitals

The privacy debate is less prevalent in hospitals because it is in their best interest to maintain the highest quality of patient safety<sup>81</sup>.

As with schools, the main concern for patients is constant monitoring. However it seems as though patients would prefer 'over-monitoring' rather than inattention, especially in regards to their health. It was suggested that at BHH "tags themselves are actually widely accepted by patients."<sup>82</sup> A patient actually rang up "asking if they could be tagged because they were worried about having the wrong operation."<sup>83</sup> Patients are "pleased" as it shows the "hospital is taking that little bit of extra care."<sup>84</sup>

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<sup>79</sup> Richtel, Matt 2004, Nov. 17, 'In Texas, 28000 Students Test an Electronic Eye', *The New York Times* [Online], Available: <http://www.nytimes.com/2004/11/17/technology/17tag.html?ex=1258434000&en=50d7082241e1c3bfe1=5088&partner=rssnyt&pagewanted=print&position=> [2007, March 29].

<sup>80</sup> Op. Cit. Mark Walter: Q5

<sup>81</sup> Op. Cit. David Morgan: Q1

<sup>82</sup> Ibid. Q2

<sup>83</sup> Ibid. Q2

<sup>84</sup> Ibid. Q2

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Hospitals face the same problem as schools in regards to who has access to the data, and whether this could invade one's privacy. The hospitals would have to ensure the data was adequately encrypted and also limit the access to information. If the information was unlawfully released or used, this could create large privacy issues for the individual and breach hospital legal standards.

When comparing the privacy issue in both schools and hospitals, we see that it is more a concern in the school system. This is mainly because the hospitals have a need for ensuring patient safety and improving these standards at whatever cost, but schools have an adequate attendance system, and do not need the risk of invading one's privacy to only marginally increase the safety of their students.



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## Chapter 6: Solutions to the problem of data security

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In both schools and hospitals, the issue of data security arises – who can access the data and what levels of encryption are present to guarantee a system which cannot be intruded. The main problem is that security is often overlooked, having the opposite effect - threatening the safety and privacy of the people.

### 6.1 Encryption

One solution to the problem is that both hospitals and schools should ensure their data is sufficiently encrypted. Encryption is the coding of information, transforming it to make it unreadable to anyone who does not have the decryption key<sup>85</sup>. There are several different levels of encryption, ranging from 40-bit (considered weak) to 128-bit, which is considerably higher<sup>86</sup>.

At Enterprise Charter, the network was on SSL (secure socket layer) and 128 bit encryption<sup>87</sup>. 128 bit encryption is considered high for websites<sup>88</sup>, however stronger encryption could be used, such as 192 or 256-bit encryption<sup>89</sup> as the school (or hospital) system could contain extremely sensitive information causing legal implications previously discussed. The Bank of New Zealand currently uses 256-bit encryption to secure their information<sup>90</sup>.

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<sup>85</sup> **'Encryption'**, 2007, *Wikipedia, the free encyclopedia* [Online], Available: <http://en.wikipedia.org/wiki/Encryption> [2007, June 2].

<sup>86</sup> **'Levels of encryption - how browsers decide'**, 2004, May. 10 *Thawte* [Online], Available: <http://www.herald.co.uk/thawte/browserlevel.html> [2007, June 2].

<sup>87</sup> Op. Cit. Mark Walter: Q8

<sup>88</sup> Op. Cit. **'Levels of encryption - how browsers decide'**

<sup>89</sup> **'Advanced Encryption Standard'**, 2007, *Wikipedia, the free encyclopedia* [Online], Available: [http://en.wikipedia.org/wiki/Advanced\\_Encryption\\_Standard](http://en.wikipedia.org/wiki/Advanced_Encryption_Standard) [2007, June 2].

<sup>90</sup> **'Technical Requirements'**, 2006, *Bank of New Zealand* [Online], Available: [https://www.bnz.co.nz/Internet\\_Banking/1,1184,10-225-601-2820,00.htm](https://www.bnz.co.nz/Internet_Banking/1,1184,10-225-601-2820,00.htm) [2007, June 2].

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An advantage to this solution is that organisations can choose to use stronger encryption if they felt as though their protection could be jeopardised. This is one of the benefits of encryption – its levels can be as high as they want – only the creator of the encryption code would know the key to decrypt it.

Manufacturers could also include levels of encryption in their equipment before selling it to organisations to make sure there is a set benchmark of security, and that no organisation goes without encryption. The technology used in schools supplied by Intuitek used an ISO15693 encryption standard which, according to David Straitiff, “lack[ed] in security.”<sup>91</sup> The system was based on the premise that only manufacturers could create the tags; however “it is easy to emulate a tag.”<sup>92</sup> Although this could be potentially problematic, Straitiff noted that each tag has its own unique ID number, so only those corresponding to the numbers in the database would work<sup>93</sup>. Schools and hospitals wouldn’t have to worry about people buying readers and connecting to their system because the readers cannot work by themselves if it is not connected to or authorised by the software that is controlling the system<sup>94</sup>.

However, with any type of encryption, it can be ‘hacked into’ or cracked; therefore schools and hospitals should not rely on simply encryption to protect their data.

## 6.2 User Accounts

A second solution is to form user accounts and passwords for access to both the database and each PDA. Each user would have their own account and password, so only ‘authorised’ people could view the information. The system could also track who was accessing the information at specific times, to avoid abuse of accounts. There could also be varying levels of access and read-write permissions, depending on your role in the system. If the PDAs had a login, then unauthorised users would not be able to use its functions and features. Users would also need to login again if the account had not been used for a certain time; ensuring accounts aren’t

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<sup>91</sup> Op. Cit. David Straitiff: Q3

<sup>92</sup> Ibid. Q3

<sup>93</sup> Ibid. Q5

<sup>94</sup> Ibid. Q6



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simply 'left on'. The school or hospital could closely monitor movements to ensure there were no unauthorised accesses or abuse within the system itself.

Overall, it seems that only encryption over the system would not be enough to ensure sufficient data security as it may be 'hacked' into. Encryption provides an initial barrier to intruders, but once cracked, no longer serves any purpose. It would be effective as part of a security system, but not used by itself.

Similarly, user accounts are an effective form of data security; however it cannot be used solely as security. The data being transmitted could be intercepted if not encrypted, thus rendering the function of separate user accounts pointless. However, user accounts would be effective, allowing for different levels of access for each authorised user, and monitoring the access and use of each account.

Schools and hospitals should use a combination of high encryption and user accounts to minimise the risks and problems of data security.

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## Conclusion

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After looking at the benefits and risks of using RFID technology in both schools and hospitals, it seems as though the monitoring of people is more useful when safety is the highest priority.

Within the school system, it was seen that the benefits of the technology, mainly time and accuracy, did not outweigh the risks that arose concerning privacy. However, in hospitals, the main concern is patient safety, so it seems as though patients are willing to sacrifice their privacy in order to maintain a higher level of monitoring, ensuring their safety.

From school trials conducted in the past, it would be suggested that the system is not efficient, hindering implementation in other schools. On the other hand, David Morgan from BHH suggests that the RFID system and technology will spread to the other hospitals in the area<sup>95</sup>.

In conclusion, it is apparent that the benefits outweigh the risks in hospitals when using RFID technology; however the benefits do not outweigh the risks in schools, highlighting the reasons why school trials have failed.

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<sup>95</sup> Op. Cit. David Morgan: Q3

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## Bibliography

---

### Primary Sources:

#### Email Interview with David Straitiff

President and CEO Founder of Intuitek, New York.

Date of Interview: 18<sup>th</sup> April 2007

#### Email Interview with Mark Walter

Chief Information officer at Enterprise Charter School, New York

Date of Interview: 12<sup>th</sup> April 2007

#### Email Interview with Simon Richardson

ICT Operations Manager at Heath & Aged Care – Werribee Mercy Hospital, Australia

Date of Interview: 31<sup>st</sup> May 2007

### Secondary Sources:

#### Interview via Podcast with David Morgan

Ear, Nose and Throat Surgeon at Birmingham Heartland's Hospital, UK

Date of Interview: 22<sup>nd</sup> March 2006

Available: <http://www.e-health-insider.com/podcast/index.cfm?ID=6> [2006, March 22]

'**Advanced Encryption Standard**', 2007, *Wikipedia, the free encyclopedia* [Online],

Available: [http://en.wikipedia.org/wiki/Advanced\\_Encryption\\_Standard](http://en.wikipedia.org/wiki/Advanced_Encryption_Standard) [2007, June 2].

'**Birmingham Heartlands RFID-tags patients to avoid litigation**' 2005, Feb. 18 Available:

<http://www.bjhc.co.uk/news/1/2005/n502016.htm> [2007, May 18].

'**Concern Grows Over ID Data Systems and Tracking**', 2006, Feb. *Education Reporter*

[Online], Available: <http://www.eagleforum.org/educate/2006/feb06/id-data.html> [2007, March 29].

Cowan, Dianna 2003, June, 'Identifying **Lobsters using Passive Integrated Transponder (PIT) Tags**' Available:

<http://www.maine.gov/newsletter/june2003/Lobsters%20PIT%20tag.htm> [2007, April 18].

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

'**Encryption**', 2007, *Wikipedia, the free Encyclopedia* [Online], Available:  
<http://en.wikipedia.org/wiki/Encryption> [2007, June 2].

Gilbert, Alorie 2004, Oct. 25, '**U.S. moves closer to e-passports**', *CNet News* [Online],  
 Available: [http://news.com.com/U.S.+moves+closer+to+e-passports/2100-1012\\_3-5425314.html](http://news.com.com/U.S.+moves+closer+to+e-passports/2100-1012_3-5425314.html) [2007, April 19].

'**InClass and OnCampus**' 2005, Available:  
<http://www.incomcorporation.com/product1.htm> [2007, April 19].

'**Intuitek: RFID**' 2007, Available: <http://www.intuitek.com/Home/RFID> [2007, April 18].

Leff, Lisa 2005, Feb. 9, '**Students ordered to wear tracking tags**', *Tech, News and Reviews*,  
 MSNBC, [Online], Available: <http://www.msnbc.msn.com/id/6942751/> [2007,  
 March 29].

'**Levels of encryption - how browsers decide**', 2004, May. 10 *Thawte* [Online], Available:  
<http://www.herald.co.uk/thawte/browserlevel.html> [2007, June 2].

'**Mandatory Student ID Cards Contain RFIDs**', 2005, Feb. 8 *EPIC* [Online], Available:  
[http://www.epic.org/privacy/rfid/prs\\_rls-020705.html](http://www.epic.org/privacy/rfid/prs_rls-020705.html) [2007, May 17].

'**Medical Errors - RFID to the rescue**' 2006, Available:  
[http://asianhnm.com/magazine/previous\\_issue/medical\\_errors\\_rfid.htm](http://asianhnm.com/magazine/previous_issue/medical_errors_rfid.htm) [2007,  
 May 27].

Murray, Corey 2003, Nov. 18, '**Controversial radio ID tags keep track of kids**', *eSchool  
 News online* [Online], Available:  
<http://www.eschoolnews.com/news/showstory.cfm?ArticleID=4770> [2007, April  
 18].

Parkinson, Caroline 2007, Feb. 16, '**Tagging improves patient safety**', *BBC News* [Online],  
 Available: <http://news.bbc.co.uk/2/hi/health/6358697.stm> [2007, May 27].

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**'Presence Awareness: Optimizing the Marketplace'**, 2006, *Diamond Cluster* [Online], Available: [www.diamondcluster.com/ideas/viewpoint/wppresenceawareness.asp](http://www.diamondcluster.com/ideas/viewpoint/wppresenceawareness.asp) [2007, April 24 ].

**'RFID Solutions for Hospitals'** 2006, Available: [http://www.activewaveinc.com/applications\\_hospitals.html](http://www.activewaveinc.com/applications_hospitals.html) [2007, May 18].

**'RFID Tagging of Cattle by Law in Australia'**, 2005, Jul. 4 *IDTechEx* [Online], Available: <http://www.idtechex.com/products/en/articles/00000201.asp> [2007, April 18].

**'RFID Technology: Readers, Tags, Systems'** 2006, Nov. 10 Available: <http://www.electronics-manufacturers.com/info/rf/microwave-electronics/rfid-technology-readers-tags-systems.html> [2007, April 19].

**'RFID in Healthcare'** 2006, Available: [http://www.electronics.ca/reports/rfid/rfid\\_healthcare.html](http://www.electronics.ca/reports/rfid/rfid_healthcare.html) [2007, May 27].

**'Radio Frequency Identification (RFID) Systems'**, 2006, *EPIC* [Online], Available: <http://www.epic.org/privacy/rfid/> [2007, April 19].

**'Radio Frequency Identification'**, 2007, *Wikipedia, the free encyclopedia* [Online], Available: <http://en.wikipedia.org/wiki/RFID> [2006, November 21].

Richtel, Matt 2004, Nov. 17, **'In Texas, 28000 Students Test an Electronic Eye'**, *The New York Times* [Online], Available: <http://www.nytimes.com/2004/11/17/technology/17tag.html?ex=1258434000&en=50d7082241e1c3bfe1=5088partner=rssnyt&pagewanted=print&position=> [2007, March 29].

**'Safety and civil liberties implications of including Radio Frequency Identification tags in student identity badges [letter]'**, 2005, Feb. 7 *EPIC* [Online], Available: <http://www.epic.org/privacy/rfid/brittan-letter.pdf> [2007, May 17].

---

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

Scheeres, Julia 2003, Oct. 24, '**Three R's: Reading, Writing, RFID**', *WIRED* [Online], Available:  
<http://www.wired.com/science/discoveries/news/2003/10/60898?printable=true>  
[2007, March 29].

'**Technical Requirements**', 2006, *Bank of New Zealand* [Online], Available:  
[https://www.bnz.co.nz/Internet\\_Banking/1,1184,10-225-601-2820,00.htm](https://www.bnz.co.nz/Internet_Banking/1,1184,10-225-601-2820,00.htm) [2007, June 2].

'**The Basics of RFID Technology**', 2006, *RFID Journal* [Online], Available:  
<http://www.rfidjournal.com/article/articleview/1337/1/129/> [2007, April 18]

Zetter, Kim 2005, Oct. 2, '**School RFID Plan Gets an F**', *WIRED* [Online], Available:  
<http://www.wired.com/print/politics/security/news/2005/02/66554> [2007, April 18].



## Appendix A

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### Email Interview

**Date:** 18<sup>th</sup> April 2007

**Interviewee:** David Straitiff, President and CEO Founder of Intuitek (RFID Systems Supplier based in New York.)

**1. How have you been involved with RFID in Schools?**

We did an RFID demonstration project at a school several years ago but we did not pursue it further. RFID in schools often faces some major privacy concerns that I believe are misguided but a real issue for anyone developing solutions in that space. I know there were some additional projects in Texas and California that you may want to google for supporting material.

**2. How does the technology work?**

Most RFID applications use one of three frequency ranges 125khz, 13.56Mhz, and 900Mhz. There are variations on that due to technology and regulations but generally these are the big ones. 125Khz is used mostly in animal tracking and speed pass applications. 13.56Mhz is dominant in ID, access control, credit cards, etc. 900Mhz is dominant in longer range inventory applications and is seldom used for ID. We chose 13.56Mhz and used the ISO15693 standard. Our Kiosk was at the highest power legal in the US, about 1 Watt, and had a range of about 2ft. The antenna was custom and the full size of the Kiosk for maximum range. The controller was Windows based with a Kiosk application that talked to a database over the network.

We also developed a card issuing system that printed and inventoried the ID cards RFID number in the database. All the reporting was done with MS SQL and some .NET applications.

**3. Does the equipment (readers and tags) come with any encryption built in? (Is it base/standard level - can it be easily 'hacked'?)**

ISO1443 RFID is very secure and the basis of most credit card and payment applications. ISO15693 and most other standards are pretty lacking in security. They were originally based on the premise that only the manufacturers could create tags and put an ID in them but it is easy to emulate a tag.



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**4. Can the organisation (who buys it) upgrade or improve levels of encryption?**

There are a number of ways to improve security by writing a security code to the card or a two step authentication like a card and a PIN. All balance between security and convenience. At the end of the day, anyone could physically steal a card and use it.

**5. Is the encryption specific for a 'set' of equipment? (Say, one school gets a different code compared to another school)**

As far as code between schools, each ID tag is unique, so only ones that are in a database will work. That actually has the advantage that in the future one card could work on several systems like home, work and school.

**6. Can a person buy readers (separately) to 'hack' in other RFID systems?**

Anyone can buy a reader or tag but without it connected to whatever is controlling access like a door lock and the software that authorizes it nothing could be done with it.

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## Appendix B

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### Interview via Podcast.

**Date:** 22<sup>nd</sup> March 2006

**Interviewee:** David Morgan, Ear, Nose and Throat surgeon at Birmingham Heartlands Hospital (began patient tagging trials in 2006.)

**Site:** <http://www.e-health-insider.com/podcast/index.cfm?ID=6>

**Q1 Interviewer:** I'm here with David Morgan who is ENT Consultant surgeon at Birmingham Heartlands NHS Trust. David's going to tell us a little bit about how he's begun using RFID tags with patients at his trust. Perhaps you could give us a bit of background.

**David Morgan:** I first became interested in trying to mistake-proof the surgical process or surgical journey, when about eight or nine years ago a colleague of mine unfortunately operated on the wrong patient due to a mistake in the ordering and process within the surgical theatre. It then got me thinking that there must be way that computers can be used to verify that all the checks have been completed. In a chance meeting with in fact the IT director of Tesco about four years ago led me into the sphere of RFID and its use, and it just seemed a magic combination of computers and RFID. We've been working on this for now about 3 years. We've had a pilot project running at Heartlands for over a year and a half which has shown the efficacy of using RFID to mistake-proof surgical processes. We're also looking at other areas such as blood transfusion and safe patient handover between junior doctors - which is a great cause of concern. I'm surgical advisor to national patient safety agency so the agency were very concerned regarding misidentification within the sphere of hospitals and it seems to me that RFID is the ubiquitous device that will help prevent mistakes which have only become apparent in the last week with the poor unfortunate patient in Scotland who had the wrong kidney removed.

**Q2 I:** In terms of kind of RFID is it a technology that patients are aware of? Or is it sort of more pervasive and simply happening in the background? Do you have patients that go – Ahh! Yes, I understand what this is. Again, also I'm intrigued by the connection with Tesco, perhaps you could tell us a little bit more about that.

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**DM:** Yeah, Colin Cobain, who is the IT director for Tesco was telling me about how they are using RFID tags to prevent shop lifting. And obviously tagging in the community has always been associated with people on parole while we are using it in a completely different way to mistake-proof medical processes. Interestingly, we are asked about 2 or three years ago, patient's perceptions about what they are most worried about in hospitals – the top 3, not surprisingly were hospital acquired infection, having the wrong operation performed by the wrong surgeon, and also being awake during anaesthetics. Now RFID will help to a certain extent in mitigating the wrong operation and also helping to control hospital acquired infections. The tags themselves are actually widely accepted by patients, in fact we had a patient phone up the other day asking if they could be tagged because they were worried about having the wrong operation and within the health care environment, patients actually are very pleased they are going through a tagging system because it shows that the hospital is taking that little bit of extra care in ensuring their safety. And Heartlands England NHS Trust has always been very forward thinking in improving patient care and this is one of the technologies which seems to be working well at the moment. Originally people were worried about the costs, but the costs have tumbled down by about 200% in the last 6 to 9 months. Currently the tags are between 30p and 50p, which is not too bad compared to bar-coding and obviously RFID has a much wider application than bar-coding in terms of its flexibility and its use within the hospital environment.

**Q3 I: And I understand that your hospital is upgrading now to a wider procurement and is this to introduce RFID tagging across the entire trust? Perhaps you could give us an indication to what time scales that will be introduced.**

**DM:** Although I am not involved in the procurement process, Heartlands England is being pretty sensible about this with the new technologies as it's worked in the pilot study, they're now wanting to roll it out over a three month period between two other surgical disciplines. They will then look at the results and if those results show they improve safety and improved efficiency then it will be rolled across the two trust sites which are Heartlands and Sullihill, which have around about ten to fifteen theatres and about thirty wards. So if the project goes well the hopefully within about two years we'll have all the patients on RFID in Heartlands and then obviously there are other applications they will be looking into at the moment.

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**Q4 I: In terms of this becoming a common place technology, presumably this is clearly the way ahead in terms of ensuring safe patient care particularly in surgical context.**

**DM:** Yeah I think the two reasons, in fact three reasons for using RFID. One is it obviously mistakes-proofs. Two, it actually improves theatre efficiency because it actually processes and manages what can be a haphazard arrangement in operating theatres in terms of delivering patients to the theatre on time and getting them back to the ward. And the pilot study would suggest that you can get one to two extra patients on your lists because of increased productivity without compromising patient safety. The other thing is that using RFID with wireless networks and PDAs does save health care people a lot of time. For example, the surgeons now using Digital Photographs so patients can be found in a ward without scratching around asking every individual patient who they are. And that in itself can save about half an hour at the beginning of a theatre list.

**Q5 I: Perhaps you could tell us about your other work with the National Patient Safety Agency?**

**DM:** National Patient Safety Agency was set up to improve safety of patients and NHS trusts and they've been particularly interested in patient misidentification and in fact have a whole program directed at improving not only using technology but also traditional methods of validating the right patients as having the right pattern of care. They've been able to look at the safe surgery system, of course no national body can actually endorse a commercial system but it's been subjected to MPSA connecting to health risk assessment and has been shown to improve patient safety. And the National Patient Safety is online with any type of technology, old or new, which will improve the safety of patients within the NHS.

**Q6 I: And presumably, a technology which can demonstrate improvements in patient safety is one that you'd hope would be widely adopted as quickly as possible.**

**DM:** Absolutely, there's nothing so valuable as a patient in the NHS or in life in general and I think it beholds to us all to help our patients and using technology which does not replace manual checking but actually verifies that doctors and nurses have done their job. Seems to me



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a no-brainer especially as the implementation of such a system delivers cost efficiency savings anyway to justify the return on investment.

**Q7 I: And finally Mr. Morgan, could you describe for us both from the clinicians and the patients perspective, how the technology is currently working in practice at your hospital.**

**DM:** When a patient books in for surgery, they have a digital photograph which is stored on the electronic patient record and they are allocated a 13.56 RFID tag which is embedded in a normal wristband. On that wristband has the normal patient demographics printed in a legible form which is quite unusual in the NHS. They are then put into a bed. The surgeon and the anaesthetist who are doing the pre-op ward rounds have a PDA which acts as a dumb terminal from which they can view the electronic patient records stored on a secure server. So instead of having a written operation list they actually have a digital form. The digital photographs allow them to identify the patients. They then go through the nationally agreed checklist to prevent wrong site surgery and that's been put together by National Patient safety agency in accordance with the Royal Colleges. One can also do, which I think is quite important, to make sure that every one that is having surgery goes through DVT prophylaxis tool to ensure that patients are protected against getting pulmonary emboli which is a common cause of unexplained and unexpected death in surgical procedures. Now within the ward and anaesthetic room and theatre, instead of having a printed list, we have visual display units from which the operating lists can be reordered if there is a delay. It also allows you to do messaging to the nurse who is told when to bring the next patient to theatre. So the actual whole process is more controlled and more process managed and that means that you can predict when delays are going to occur, if some of the checks haven't been done, and automatically reorder the list with minimal fuss and every one in the team knows exactly what's going on. Before the patient can go through any stage of the surgical journey, various checks are measured to make sure that the patient is correctly identified and all the protocols have been followed and then a green light on the operating list then shows the patient is ready and so the whole process is more managed a safely and more efficient manner.

**Q8 I: And does the system currently extend to tray tracking, obviously variance in CJD being particularly an important issue within operating environments.**



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**DM:** Tracking and ordering would be in version 2 of the application, that's very important, not only for CJD but as yet we're not really sure whether there is a real risk or not. There's obviously a theoretical risk, but more importantly ensuring that the correct tray is ready for the surgeon when he's doing his operation. So once again there is minimal delay in the operative process.

**I:** Excellent, well many thanks for taking the time to explain the work you're doing in Heartlands and wish you every success in the future with it. Thanks.

**DM:** Thanks.

## Appendix C

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### Email Interview

**Date:** 31<sup>st</sup> May 2007

**Interviewee:** Simon Richardson, ICT Operations Manager at Health & Aged Care – Werribee Mercy Hospital, Australia.

**1. How does the hospital currently utilise RFID technology?**

The hospital uses RFID in the Central Sterilising Department for tracking the cleaning and use of medical instruments. Instruments used in operating theatres are tracked so we can relate when they were cleaned and who they were used on etc...

**2. How does the system function in the hospital, what other technology is used?**

Instruments are stored in trays which have RFID tags. The tags are scanned when cleaned and scanned when they are sent to a theatre. I believe the operation/patient ID is recorded in the system once the tray is used in theatre.

When the tray is returned for cleaning the process starts again.

**3. Who has access to the information that the technology provides?**

CSD (Central Sterilising Department)

**4. What were the costs in implementing the system?**

Not sure.

**5. What are the benefits over previous systems?**

Risk reduction/Quality control. We know who instruments were used on, if there was a chance of an infection, all patients could be tested. It also enables the tracking of instruments to ensure all are returned (ie: not left behind in a patient)

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**6. Are there any disadvantages?**

None

**7. Has the hospital ever considered using RFID in hospital wristbands to monitor patients, newborn babies or aged care? Why/why not?**

Yes,

- Tracking of new born babies within nurseries and their mothers. The goal was to relate the mothers tag to the babies tag, if the mother picked up the wrong baby an alarm would sound. This was aimed at stopping a mother leaving with the wrong child and also to stop a mother breast feeding the wrong child. This was not implemented as the staff within the area did not feel the risk warranted the cost of installation.
- Within our Aged Care areas we are still looking at implementing tags to track patients with dementia. These patients can become disorientated and cause injury to themselves. The tags would track the patients and alert staff of abnormal behaviour. They would also act as a door lock to prevent these patients from leaving the building/grounds while allowing others to come and go as they please. We are still looking into this one, the costs are still fairly high.

**8. What are the issues that need to be considered?**

- Cost
- Type of RFID tags used (Active vs Passive) the passive are fine for close proximity to readers and last a long time however they are unreliable within large areas.
- Privacy – People generally don't like being tracked.

**9. Do you think the advantages outweigh the disadvantages? Why/why not?**

At this point in time I don't believe the cost is low enough to reap the benefits. Where large companies such as WallMart in the United States can force their suppliers to provide tags on stock, we are not in that situation. However I think that quality control, safety and risk management will drive the need for the technology and we will see it in areas such as patient wrist bands and medical records to ensure medication is given to the right person etc...

**10. What do you think patients' reaction will be? Would they accept or embrace the technology?**

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An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

If the right message is communicated and patients understand the benefits, the majority will embrace. If it is improving their safety and their experience (be it from faster service or value added things like the ability to purchase a news paper and have it added to their account) rather than being seen as a “Big Brother” approach.

**11. How would cost affect this system hypothetically?**

Most of these ideas are fairly large projects and would be tackled separately so in theory, the first few implementations would be funding the whole base infrastructure. Where these costs are high, the likelihood of a successful business case is low.

**12. Have you ever heard of any other hospitals using RFID technology? If so, how and where?**

Yes however most of these are in either the UK or the US. The main areas are patient/patient record tracking and asset tracking. Some of these systems are linked to personal communicators allowing staff to ask the system where a particular piece of equipment is and then getting an answer of where it actually is rather than where it was or should be.

**13. Do you think other hospitals will consider using RFID for either equipment tracking or for patient monitoring?**

Yes, as soon as it is used for one thing widely (ie patient tracking) medical records and equipment would be an easy, cheap and quick win.

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

## Appendix D

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### Email Interview

**Date:** 12<sup>th</sup> April 2007

**Interviewee:** Mark Walter, Chief Information Officer at Enterprise Charter School, New York.  
(Principal Developer and Architect of the school's RFID system)

**1. When was the school RFID Attendance-taking system implemented in the school – how long did it last for?**

The school began using RFID in August, 2003 and continued through July of 2006.

**2. How did the system work?**

Each student/staff was issued a passive RFID badge with their photo and homeroom/staff position printed upon it. On each floor was a kiosk that, when entering the school in the morning, each student/staff was required to stop at and wave their card at the screen. This recorded their attendance for the day. This data was transmitted to a server running a custom app running under Server 2003 written in SQL.

**3. Why was the system stopped?**

With a student/staff population close to one thousand in number, the \$3.50 USD to replace the cards when they were lost/damaged became prohibitive.

**4. What were the economical implications - how much did it cost to establish the system, including tags and readers?**

Initial cost outlay was \$35,000 USD.

**5. What were the legal implications of the system?**

While in the mainstream press we were taken to task for implementing what was perceived to be a 'big brother' style system, all of the parents of our students signed off on the system and absolutely loved it, as it would notify them when their child was not in school. No legal challenges were issued.

**6. What types of data were collected about each student – what information about the student was linked to their ID number?**



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An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

Each card id was linked to RGN table that then held a key to the student's 9 digit Student Information ID number.

**7. Who had access to the data? How and where was it stored?**

Myself, the principal and the attendance officer had access. It was store on a Dell 8000 series blade server housed in the secure sever room of the school.

**8. Did you have any security on the data or the system? Was it encrypted?**

The data was transmitted via 10base T copper category 5 ethernet cables, on a SSL with 128 bit encryption.

**9. How long was the data stored for?**

State law dictates that attendance as well as transcripts for all students are housed for 5 years after the student graduates.

**10. Was the student or their parents able to view or access their own data?**

No.

**11. What was the reaction of the parents and students?**

Again, the parents adored the system and the kids loved having ID badges and were especially enthralled when checking in, as their photo popped up on the kiosk screen, along with a personalized greeting.

**12. What were the privacy implications?**

Insofar as an independent audit ruled, no compromises were discovered.

**13. What is your overall opinion on using RFID for school attendance?**

Effective, if cost prohibitive.

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## Appendix E

### Survey of 30 Students

Date: 12th June 2007

#### Raw Statistics

Year Level	Number of Students Surveyed
------------	-----------------------------

12	9
11	1
10	11
9	9

**Total Students Surveyed 30**

#### Do students carry ID with them always?

Yes	15
No	15

**Total 30**

#### Do students oppose taking attendance with it?

Yes	7
No	23

**Total 30**

#### Advantages

Easier Roll (quicker, accurate)	7
No need for Roll	18
Tracked (emergency, wagging)	4
No Advantages	5

**Total 34**

#### Problems

Use other people's cards	9
Privacy	5
Swap Cards	2
Malfunction	3
Losing/Forgetting Card	6
No Disadvantages	6

**Total 31**

42.

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**Is it a breach of privacy**

Yes	8
No	21
No Answer	1

**Total** **30**

**Oppose Data Storage for 5 Years**

Yes	16
No	14

**Total** **30**

**Who pays for replacement cards?**

School pays	21
You pay	9

**Total** **30**

**Support other uses of RFID in schools? (tuckshop, library)**

Yes	20
No	10

**Total** **30**

**Advantages of other uses (tuckshop, library)**

No handling of cash	9
Good if you forget lunch/money	10
Saves time	3
No advantages	5

**Total** **27**

**Disadvantages of other uses (tuckshop, library)**

Overspending	13
Stealing Cards	3
Monitored by parents/school	2
Malfunction	2

**Total** **20**

43.

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Oppose the collation of statistics or reports**

Yes	10
No	20

<b>Total</b>	<b>30</b>
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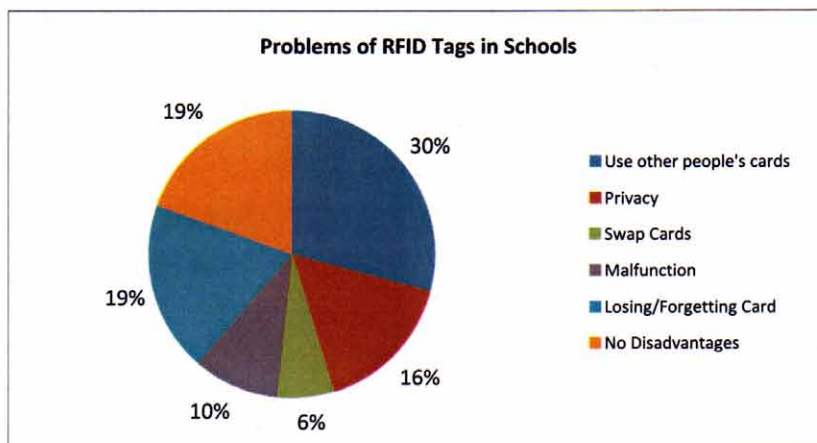
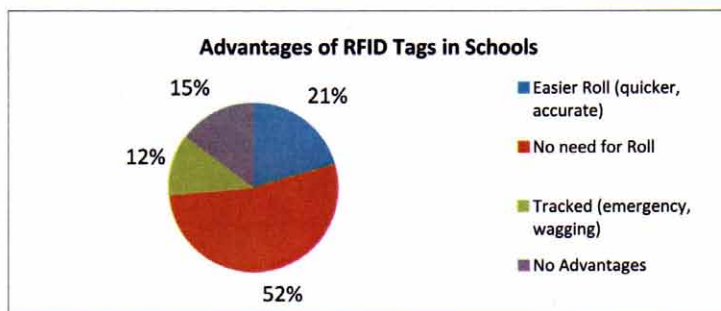
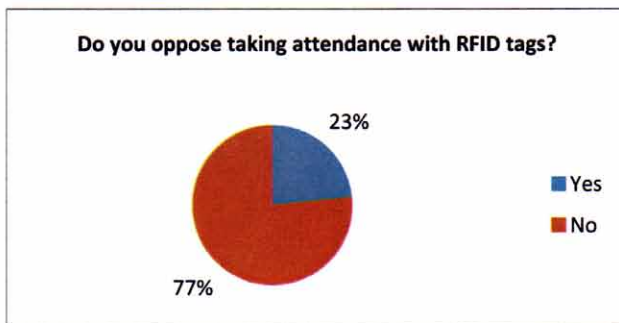
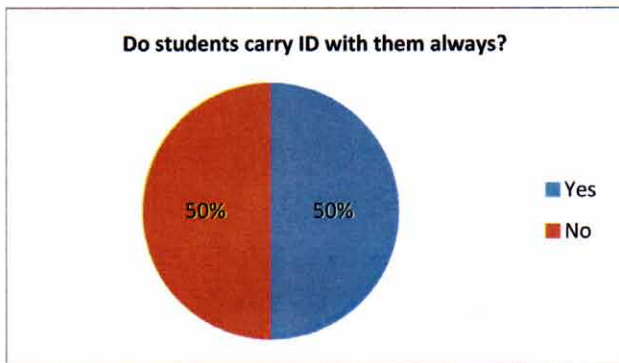
**Support the use of RFID for monitoring Patients**

Yes	28
No	2

<b>Total</b>	<b>30</b>
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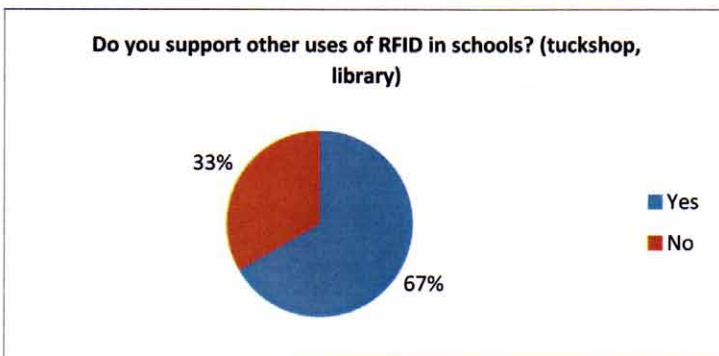
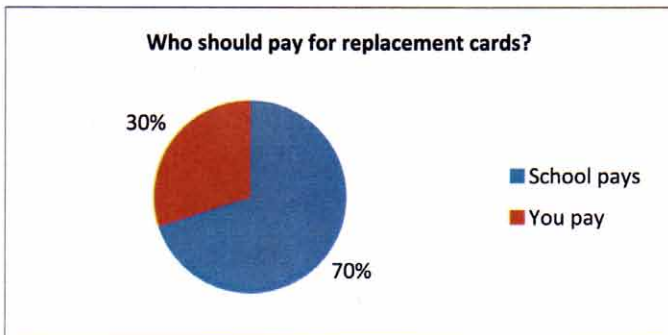
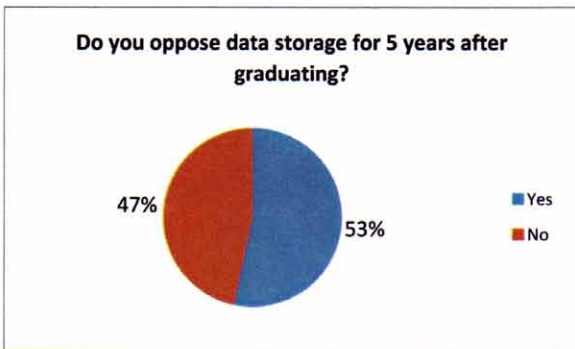
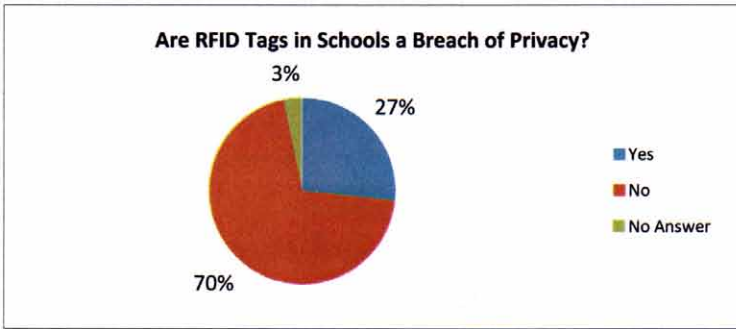
An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

Processed Data

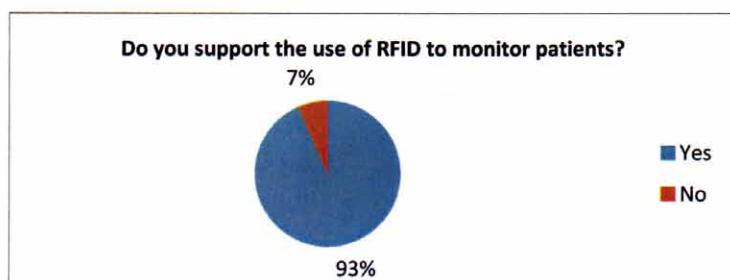
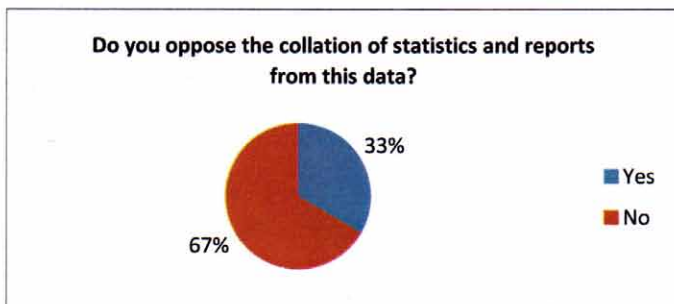
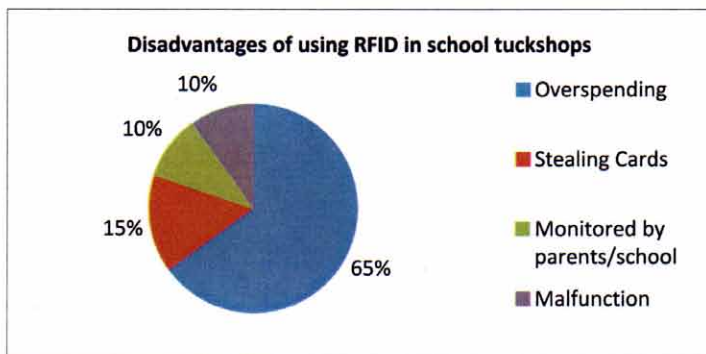
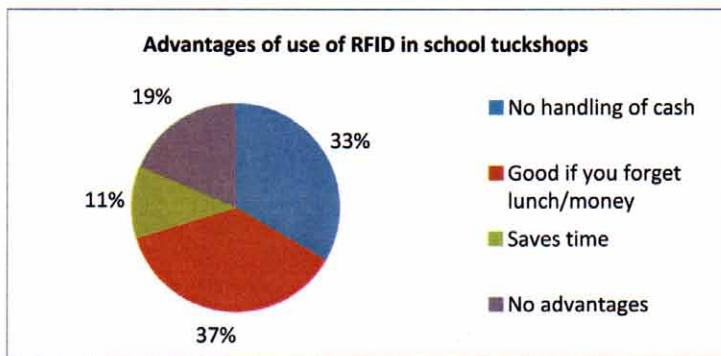




An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 1**

© I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 12
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? yes - easier role calls etc -
5. Any problems? yes - people can take other people's cards
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? \_\_\_\_\_
11. Any problems? \_\_\_\_\_
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** 😊

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

### Survey for Students: No. 2

© I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 12
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? No need for roll call

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5. Any problems? A friend could take your card whilst you are absent
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

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7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

---

8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? No need to carry cash

---

11. Any problems? People might spend too much money at the tuckshop (unhealthy)
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_

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13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** 😊



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No.3**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 12
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? if kids are stolen they can be tracked
5. Any problems? privacy!
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** Following us, scary!
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** None of their business
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? convenient if you forget lunch.
11. Any problems? \_\_\_\_\_
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 4**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 12
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? Less time wastage @ form
5. Any problems? invasion of privacy?
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** they have no right to know where I am.
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** none of their business
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? can eat if you forgot lunch.
11. Any problems? stealing others' cards.
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 5**

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In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 12
2. Do you always have your School ID Card on you?  Yes  No
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
 Yes  No
4. Can you think of any advantages? We don't have to necessary  
go to form or roll call.
5. Any problems? People could simply swap cards.
6. Do you think this is a breach to your privacy?  Yes  No  If Yes, why? \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate?  Yes  No  If Yes, why? I don't miss school
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
 School pay  You pay
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this?  Yes  No
10. Can you think of any advantages? It would mean we didn't have  
to bring money to school each day - simple
11. Any problems? Parents see what we buy.
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library?  Yes  No  If Yes, why Parents would  
get stricter on what we eat.
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery)  Yes  No

**Thankyou for participating in my survey ☺**

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**Survey for Students: No. 6**

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In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 12
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? know where all students are. dont have to do roll / sign out
5. Any problems? privacy issues with people being monitored
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** only if the student opposes the chip.
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

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8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? dont have the time consuming process of lining up.
11. Any problems? could get big bills
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_

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13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** ☺



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 7**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 12
2. Do you always have your School ID Card on you? **Yes Δ No Δ**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes Δ No Δ**
4. Can you think of any advantages? no need for roll call, attendance roll
5. Any problems? some-one else could use it
6. Do you think this is a breach to your privacy? **Yes Δ No Δ If Yes, why?**
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes Δ No Δ If Yes, why?**
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay Δ You pay Δ**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes Δ No Δ**
10. Can you think of any advantages? more efficient
11. Any problems? parents may not approve
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes Δ No Δ If Yes, why**
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes Δ No Δ**

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 8**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? no.
5. Any problems? malfunction
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** It's not needed.
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**   
**No**
10. Can you think of any advantages? easy if you forget \$
11. Any problems? Parents end up paying
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 9**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? \_\_\_\_\_  
\_\_\_\_\_
5. Any problems? losing it
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_  
\_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_  
\_\_\_\_\_
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**   
**No**
10. Can you think of any advantages? \_\_\_\_\_  
\_\_\_\_\_
11. Any problems? Someone taking it
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_  
\_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** ☺



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 10**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 12
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? not having roll call.
5. Any problems? wagging?
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** does it have anything to do with me after I leave?
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**  not on my account!
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? not having to carry money would be more like a debit card...
11. Any problems? spending of parentals money?!
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** ☺

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 11**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? quicker
5. Any problems? people swapping cards, malfunctions
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? quicker, save time
11. Any problems? malfunctions
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No.12**

© I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? \_\_\_\_\_  
\_\_\_\_\_
5. Any problems? malfuctions
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_  
\_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_  
\_\_\_\_\_
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? easy if you forget \$
11. Any problems? not realising how much you've spent
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_  
\_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** 😊



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

### Survey for Students: No. 13

© I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you?  Yes  No
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
 Yes  No
4. Can you think of any advantages? Not as much paper work for form teachers, no roll call
5. Any problems? Easier to wag-
6. Do you think this is a breach to your privacy?  Yes  No  If Yes, why? Not a breach - but more so impersonal.
7. Would you oppose having your attendance information stored for 5 years after you graduate?  Yes  No  If Yes, why? Why would they need it?
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
 School pay  You pay
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this?  Yes  No
10. Can you think of any advantages? Tuck shop would make more profit
11. Any problems? Children would be buying whatever they want - Parents no control.
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library?  Yes  No  If Yes, why
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery)  Yes  No

Thankyou for participating in my survey ☺

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No.14**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? No call call in mornings/afternoon

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5. Any problems? Have to have card on you all the time
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

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7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

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8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? Don't have to always have money on you
11. Any problems? -
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_

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13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 15**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? No roll call in morning or afternoon
5. Any problems? lose it
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**   
**No**
10. Can you think of any advantages? You don't always need money on you
11. Any problems? →
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 16**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes ▲ No ▲**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes ▲ No ▲**
4. Can you think of any advantages? No you'll call.
5. Any problems? if you forget/loss your card.
6. Do you think this is a breach to your privacy? ~~Yes ▲~~ **No ▲** **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? ~~Yes ▲~~ **No ▲** **If Yes, why?** \_\_\_\_\_
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay ▲ You pay ▲**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes ▲ No ▲**
10. Can you think of any advantages? \_\_\_\_\_
11. Any problems? losing track of what is purchased.
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes ▲ No ▲** **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes ▲ No ▲**

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 17**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? No roll call

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5. Any problems? Wag-give your card to someone else
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

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7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** Not attending the school any more

---

8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? wouldn't have to bring money to school
11. Any problems? Overspending
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why?** Unnecessary

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13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 18**

© I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? no roll call, quicker + easier
5. Any problems? people can ~~steal~~ take your card and take your attendance
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

---

7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** Because I've left.

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8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? when you forget money it would be good.
11. Any problems? eat too much junk, spend too much without realising
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

---

13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** ©

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

### Survey for Students: No. 19

© I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 10
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? No role call in the morning.
5. Any problems? If you don't have the card on you, you would be marked not there
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** Because the school no longer should need your personal details.
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**   
**No**
10. Can you think of any advantages? No longer any need to carry around money.
11. Any problems? If someone stole your card they could use your money.
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** 😊



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 20**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 12
2. Do you always have your School ID Card on you? **Yes Δ No Δ**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes Δ No Δ**
4. Can you think of any advantages? nope
5. Any problems? nope
6. Do you think this is a breach to your privacy? **Yes Δ No Δ If Yes, why?**
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes Δ No Δ If Yes, why?** As long as it's safe
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay Δ You pay Δ**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes Δ No Δ**
10. Can you think of any advantages? can't lose money.
11. Any problems? overspending.
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes Δ No Δ If Yes, why**
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes Δ No Δ**

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 21**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 11
2. Do you always have your School ID Card on you? **Yes Δ No Δ**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes Δ No Δ**
4. Can you think of any advantages? Ease of taking accurate rolls ; location of students during emergencies.
5. Any problems? Falsification of rolls (someone carrying a card that is not theirs) forgetting
6. Do you think this is a breach to your privacy? **Yes Δ No Δ If Yes, why?** \_\_\_\_\_

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7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes Δ No Δ If Yes, why?** Unnecessary... creepy

---

8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay Δ You pay Δ**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes Δ No Δ**
10. Can you think of any advantages? No small change

---

11. Any problems? No small change (fundraising etc.) malfunctioning card
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes Δ No Δ If Yes, why** Innacurate, I never use the tuckshop

---

13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes Δ No Δ**

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 22**

© I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 9
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? No roll call, faster
5. Any problems? NO
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** Waste of Computer Space
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**   
**No**
10. Can you think of any advantages? if you forget your lunch,
11. Any problems? NO
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** thats breaching your ~~privacy~~ privacy.
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** 😊



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 23**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 9
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? No rolecall  
• Quicker
5. Any problems? No
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** You are no longer attending meaning they have no right
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? If you forget your lunch
11. Any problems? No
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** It is a breach of privacy
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 24**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 9
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? No colecall
5. Any problems? No
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_
7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** because it is a waste of space when I'm not even attending
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**   
**No**
10. Can you think of any advantages? if you forget your lunch
11. Any problems? No
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why?** because it is a breach of privacy
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**

71.



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 25**

© I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 9
2. Do you always have your School ID Card on you?  Yes  No
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
 Yes  No
4. Can you think of any advantages? not having roll call

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5. Any problems? being monitored all the time
6. Do you think this is a breach to your privacy?  Yes  No  If Yes, why? what if we ~~leave~~ leave the school + move?
7. Would you oppose having your attendance information stored for 5 years after you graduate?  Yes  No  If Yes, why? they don't have a right to were we are all the time
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  School pay  You pay  
why would ~~you~~ they have no right to monitor us for time when we don't attend their school
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this?  Yes  No  
You would result in buying stuff you don't need
10. Can you think of any advantages? forgetting lunch

---

11. Any problems? you'd spend too much
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library?  Yes  No  If Yes, why? they don't need to know - we have a right to privacy
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery)  Yes  No

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 26**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 9
2. Do you always have your School ID Card on you?  Yes  No
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
 Yes  No
4. Can you think of any advantages? No roll call,
5. Any problems? Being monitored all of the time
6. Do you think this is a breach to your privacy?  Yes  No **If Yes, why?** Not Really
7. Would you oppose having your attendance information stored for 5 years after you graduate?  Yes  No **If Yes, why?** \_\_\_\_\_
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
 School pay  You pay
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this?  Yes  No
10. Can you think of any advantages? If you forget your lunch
11. Any problems? Allows people to spend money they don't have!
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library?  Yes  No **If Yes, why** \_\_\_\_\_
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery)  Yes  No

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 27**

© I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 9
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? don't have to go to form

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5. Any problems? you cant wag
6. Do you think this is a breach to your privacy? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

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7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** It might show I miss alot of school

---

8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? No

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11. Any problems? I would buy the whole store
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** my parents would see I go to the tuckshop too much.
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey** ©



An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 28**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 9
2. Do you always have your School ID Card on you? ~~Yes~~ **No** Δ
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
~~Yes~~ **No** Δ
4. Can you think of any advantages? \_\_\_\_\_  
\_\_\_\_\_
5. Any problems? you can't wag!
6. Do you think this is a breach to your privacy? ~~Yes~~ **No** Δ **If Yes, why?** STALKER!
7. Would you oppose having your attendance information stored for 5 years after you graduate? ~~Yes~~ **No** Δ **If Yes, why?** \_\_\_\_\_  
\_\_\_\_\_
8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
~~School pay~~ **You pay** Δ
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? ~~Yes~~ **No** Δ
10. Can you think of any advantages? NO
11. Any problems? NO
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? ~~Yes~~ **No** Δ **If Yes, why** \_\_\_\_\_  
W
13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) ~~Yes~~ **No** Δ

**Thankyou for participating in my survey ☺**

An analysis and comparison of the use of RFID tags for monitoring in Schools and Hospitals: do the benefits outweigh the risks?

**Survey for Students: No. 29**

☺ I'm Sonali Mendis and I'm doing RFID (Radio Frequency Identification) Technology, specifically **monitoring students in Schools** and **patients in Hospitals** for my Extended Essay.

In schools, RFID works in a similar way to cattle tagging, or product tagging in stores. A chip is embedded into your student ID card and when you pass any of a number of 'readers' around the school, your attendance is recorded with the time and place.

1. What year level are you in? 9
2. Do you always have your School ID Card on you? **Yes**  **No**
3. If your ID card had a radio chip, would you oppose the taking of your attendance with it?  
**Yes**  **No**
4. Can you think of any advantages? Students can't wag classes

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5. Any problems? No
6. Do you think this is a breach to your privacy? ~~Yes~~  **No**  **If Yes, why?** \_\_\_\_\_

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7. Would you oppose having your attendance information stored for 5 years after you graduate? **Yes**  **No**  **If Yes, why?** \_\_\_\_\_

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8. If you lost your card, should the school pay ~\$4.50 for a new one or would you pay?  
**School pay**  **You pay**
9. If the RFID system allowed you to make tuckshop purchases without money (but put on your account), or streamline borrowing from the library, would you support this? **Yes**  **No**
10. Can you think of any advantages? You would not have to bring money

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11. Any problems? No
12. Would you oppose statistics or reports being formed from your information of attendance, the tuckshop or the library? **Yes**  **No**  **If Yes, why** \_\_\_\_\_

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13. Do you think it is ethical to monitor patients' safety in the hospitals in this way? (to ensure that patients don't get mixed up in surgery) **Yes**  **No**

**Thankyou for participating in my survey ☺**



