# Information About Ourselves from Ourselves: Young Users of Wearable Technologies in Secondary School

**Ivana Matteucci**
Department of Communication Science, Humanistic and International Studies (DISCUI), "Carlo Bo" University of Urbino, Italy
Email: giorgia.pierleoni@gmail.com

*DOI: 10.2478/ejis-2023-0014*

**Abstract**

Several researchers have recognized the value of self-tracking technologies used to personally obtain data about ourselves. The aim of the present study was to assess the barriers associated with the "technologies of existence", so-called wearables, including lack of knowledge of these devices, lack of information on their correct use, as well as difficulties regarding data integration and interpretation. To help to overcome these barriers we investigated a project involving two self-tracking activities in an Italian secondary school, performing a quantitative and qualitative analysis of the students using these technologies for educational purposes. Thanks to the project and its contextualized practical and theoretical activities, students were able to become "enhanced users" in terms of their knowledge, autonomy and awareness as regards wearable technologies. Our findings regarding the application of wearable technologies in a scholastic setting may also be step forward in addressing a well-known common pitfall of self-tracking: insufficient scientific rigor. Our quantitative and qualitative analysis showed how the use of wearable devices in educational settings had a range of beneficial effects, above all, eliciting satisfaction among students, but also yielding positive outcomes regarding the acquisition of scientific knowledge perceived both in terms of device applications and data interpretation. In conclusion, our findings may have broad implications in the future design and development of wearable technologies.

**Keywords**: Quantified Self, Wearable technologies, Secondary school, Scholastic setting

## Introduction

Self-monitoring involves observing oneself (physiological states, athletic performance, well-being, behaviors, moods) in certain situations and carefully taking note of what is found. It often happens that one is aware of a problem, but unable to clearly define it. Being able to articulate a definition of the problem however can

subsequently help us to have a greater control capacity. In fact, in self-monitoring we take on the role of "scientists", i.e. the phenomenon is analyzed by precisely and consistently recording our own observations. In the field of medicine and health, self-monitoring involves keeping track of the symptoms of a disease and their evolution, which a patient can do at home with the appropriate tools. In sociological terms, it is the observation and systematic control of one's behavior. The concept of self-monitoring is very old, but today smart technology makes the task of self-monitoring much simpler, translating every state and process of the self into numbers.

Self-knowledge through numbers has been defined as *Quantified Self* (Wolf, 2010), built on the idea that we lack the tools to make ourselves understand who we are, so to overcome our human limitations we need to enlist the help of machines and technology. In 2007, Gary Wolf and Kevin Kelly, editors of the magazine *Wired*, set up a blog called "Quantifiedself.com", which became a repository for anyone who wanted to share self-tracking practices. In 2010 Wolf spoke about the movement on *TED@Cannes*, and in May 2011, the first international conference on this topic was held in Mountain View, California. The *Quantified Self* (QS) has since become a movement to incorporate technology into data acquisition regarding aspects of a person's daily life (Kyoung et al., 2014) to improve daily functioning and wellness in terms of inputs (food consumption, air quality in their surroundings etc.), states (mood, arousal, blood oxygen levels etc.), and both mental and physical performance. In the United States in particular, this movement has created real communities of enthusiasts who, using wearable technologies, measure calories consumed, kilometres travelled, quality of sleep, and other minute aspects of their daily lives.

But what exactly do we mean by "wearable technology" (Figure 1)? The term wearable technology refers to all technologies, designed around people's bodies and used as a natural support for their functioning. Sensory detection and monitoring of body signals, including those of an emotional nature, makes these technologies a valuable tool designed to meet the user's needs, while expanding their sensory capabilities as well. There are distinct categories of wearable devices: those that are capable of processing data, those that can communicate with a smart connected device (PC, smartphone or tablet) and those that can connect to the network independently without relying on other devices.

In the academic world several applications of self-tracking technologies in the field of health and wellbeing have been examined (Klasnja, Pratt, 2012; Swan, 2009). Many researchers conducting such investigations, in accord with what QS members claim, believe that thanks to the self-knowledge approach through data acquisition, it is possible for users to reflect on their activities, make discoveries about themselves, and use technology to make changes in their behavior (Bentley et al., 2013; Lin et al., 2006; Mamykina et al., 2008). Although researchers on the whole have reacted positively to these technologies, they have also discovered barriers to their adoption, including insufficient knowledge for an integrated and coordinated use of data,

inadequate skills for an effective use of the devices and insufficient motivation (Li et al., 2010). Other researchers are critical of the commercialization of self-tracking, as they believe that the widespread use of data as a meta-social commentary on a person in his own social position can became the objective basis for a kind of static discrimination. "Disruptive developments are already appearing which show what a new taxonomy of sociality could look like in the future" (Selke, 2016). Some sociologists denounce the emergence of a new form of social and medical surveillance that arises from the merchandising of personal health-related opinions and health information produced and shared on the network by the users of self-monitoring devices (Lupton, 2012, 2014). Others fear the advent of overly accountable patients or users, who may therefore be considered "guilty" of their disease, illness or lack of physical and mental fitness (Morozov, 2013). In the field of health, American researchers (Piwek et al., 2016) point out that it is not yet clear how beneficial these technologies will be in the health field, as the huge amount of information and data collected can generate anxiety and confusion among users in general and patients.

From a commercial standpoint, according to the International Data Corporation (IDC, 2015) (https://www.idc.com/tracker/showproductinfo.jsp?prod_id=962), worldwide shipments of wearable devices reached 101.9 million in 2016, a 29.0% increase over 2015. While most available apps focus on overall wellness, healthcare companies and professionals are increasingly interested in a broader use of these applications, removing barriers to a mainstream adoption of mHealth, especially in the areas of disease management and the promotion of healthy lifestyles. Although the wearable device market in Italy is slightly behind the US market, interest in this sector has been strong for years, and even Italian companies have begun producing wearable devices. Numerous reports, conversations and statements of interest regarding wearable devices from users themselves can be found on the Web. Indeed, a Wearable Technology Observatory (http://wearable.to/osservatorio/) has been set up with the aim of developing a kind of virtual laboratory for new wearable technologies that could monitor national and international projects. The market, which is undoubtedly growing according to the Observatory, has three major problems preventing it from really taking off: the price of wearables, which is still too high, lack of knowledge on the part of users, as well as device usability and the difficulty of data integration and interpretation.

For these devices to come fully into mainstream use, knowledge of wearables and people's ability to use them effectively must be enhanced. Moreover, the functions of these devices must be expanded seeking to develop those that have a high impact on everyday life and are simple to use. Indeed, the aim of this evolving sector is to develop wearable devices that are adapted to the user's lifestyle, moving away from the concept of a passive accessory to become a fundamental and personal part of our existence. Being ever present in the least invasive way is one of the distinctive features of wearable systems, which makes them different from laptops or tablets and contributes to their success among people of all ages.

## The project involving the use of wearable technologies in a secondary school

Two scholastic interdisciplinary activities supported by wearables were analyzed. The first activity was called "*Allena..menti*" and involved the subjects of mathematics and physical education. The second was called "*Mobil..mente*" and involved the subjects of natural science and physical education. The first activity consisted in carrying out the "step test", an indirect test for the measurement of Vo2max, i.e. maximum oxygen consumption, by measuring changes in the heart rate. A heart rate monitor, 36-cm high bench and metronome were used. During the physical education class, one student carried out the test, another monitored it, and a third entered the data into the computer. The data were then processed using an Excel spreadsheet. In math class, the data were then used to plot a graph through equations and the study of the line. Thus, thanks to the synergy between two subjects, the students learned how to perform a basic assessment test for sports and physical activity and how to interpret the results.

The second activity involved the study of heart rate variation and its relationship to exercise intensity. The goal was to study the cardiovascular system in general and, in particular, the concept of heart rate and its relationship to exercise intensity. The students were accompanied by their teacher on a walking or cycling route. During these activities three variables were monitored: the heart rate of the students, altitude and walking/cycling speed. The students were equipped with a heart rate monitor and a GPS device with an altimeter. The data collected along the route were then processed and recorded on a computer. Subsequently, using a specific software, the data were transformed into 3D graphics and used in physical education and natural sciences classes for the study of this biological parameter and its variations. It is interesting to note that the use of wearable technology devices covered both the practical part of the field, namely measurements with heart rate monitors and GPS devices equipped with altimeters, as well as the theoretical part, namely data processing using specific software and data analysis using computers performed in the classroom.

## Survey and study method (quantitative and qualitative)

A questionnaire (Table 1) with seven questions was designed to evaluate the project results. In particular, we analyzed the following aspects: the interest, the knowledge of the devices and their applications, the level of satisfaction of students regarding the proposed activities, the attitude, their perceived level of autonomy in the use of technological devices and their awareness of the reasons for the use of such devices and the possibility of integrating wearable technologies into daily life.

The survey section regarding the interest, the knowledge and the satisfaction level of the participants consisted of three questions: 1. *Did you find the activities practiced using wearables to be interesting?* 2. *In your opinion, did your knowledge of wearable devices and their data improve?* 3. *Are you totally satisfied with this experience?*

Students had to express their opinion choosing from a range of four options: *Definitely No*, *No more than Yes*, *Yes more than No, Definitely Yes* (Chiandotto e Gola method, 1999). The survey section regarding attitude and autonomy in the use of the wearable devices consisted of the following questions: 4. *Do you think that your attitude towards this technology has improved after the initial impact?* 5. *Would you be able to use the wearable device in question alone?* The same range of options used in the previous set of questions was used here.

The results were largely positive (Figure 2). In particular, students report that they found the activities to be very interesting (31%) or rather interesting (51%). They claim to have seen an improvement in their knowledge of the devices in question (42%), although some confusion persists (26%). This is one of the first studies of its kind; hence, further research is clearly needed, and we must be cautious in drawing conclusions from a single investigation. However, the satisfaction level with the experience offered through the project was high for students. Students' attitudes towards wearable technologies improved after the initial impact, and most of them also gained real autonomy in the use of these devices, although a number of subjects remained dependent on the support of an expert (14% and 28%). This finding highlights the difficulty of promoting students as active learners at school and the opportunity offered by experiences that go in the direction of learning how to use new technologies correctly and responsibly.

Students were also asked the following questions to determine whether they viewed the integration of technology into everyday life positively and assess the perceived prevailing aspects or functions of this application. 6. *In general, technology is designed to improve our lives. Do you think these wearable technologies can improve our lives?* 7. *If yes, how?* A Likert scale was used for question 7 with the following items:

*A. Improving our health (track blood pressure, track heart rate, log triggers that cause disease ...);*

*B. Improving wellbeing (track exercise, track weight, log sleep, log food, log panic, log mood ...);*

*C. Offering new life experiences (explore new places, orient in contexts, satisfy curiosity, have fun, enjoy relationship ...).*

The results from this part of the questionnaire are also very interesting. For most students, wearables can really improve our lives (73%). But how? Students are particularly interested in the contribution from the field of wellbeing. Perhaps the high percentage of students (40%) who chose *Improving wellbeing* can be accounted for by the fact that students carried out activities in the field of physical performance and fitness, during the project. The second highest percentage of students (35%) indicated that wearables can improve our lives by *Offering new life experiences.* The relatively high percentage of students who chose this option was probably influenced by the young age of respondents for whom technology nowadays means curiosity, fun,

sharing, even functionality, fitness and is less related to health (Figure 3, Figure 4). However, it is interesting to note that even though it was ranked third, *Improving health* was chosen by 25% of students. These findings are in agreement with world-wide figures that see wearables used mainly in the fields of fitness and wellbeing and less in the health field.

To complete our study, a qualitative survey, based on student interviews, was used to more effectively address three aspects related to the use of wearable technologies, namely knowledge, autonomy and awareness, and to discover any pitfalls related to their use.

**Knowledge - What did you learn?**

In the interview, most students stated that they had made some progress in terms of improving their knowledge of these technologies, their applications and in the reading and interpretation of data. Students emphasized above all the enjoyable nature of this way of acquiring knowledge as a kind of "learning by doing". Some students thus describe a process that involves learning about the devices and at the same time gaining confidence in their use. 1) *At first I felt embarrassed because I wasn't familiar with this technology, then I learned to manage it, and it became easier.* 2) *It's amazing how many things we can learn about ourselves in this way, and it's not hard at all. The machine does almost everything, and you just have to go about your everyday life as if it weren't there.* 3) *It was also very interesting to read the data about ourselves and compare them to those of other classmates.*

Some students stated that they were initially afraid of not being able to meet the performance requirements and of having their performance compared with those of classmates. 4) *At first I was pretty worried about not providing the right data or not being able to do the work. How embarrassing in front of all my classmates!* In fact, the use of these technologies that produce numerical data related to the subject in quantitative terms (*Quantified-self*) can generate performance anxiety in the subject, and fear of comparisons being drawn with others.

There may be a risk of losing sight of the sociality component (Maturo, 2014). However, it is interesting to note how in this case, the social component was called into play. Subsequently, subjects who yielded data uploaded and shared them on social platforms. 5) *I can't wait to add this information about myself on my facebook profile, and then I want to talk about it with my coach and football teammates.* In addition, the data collection and processing activities, although related to individual subjects, were carried out in a groups in which each student was assigned a specific task to be carried out in collaboration with other group members.

**Autonomy - How did you work?**

In the interview, students stated that they were fully engaged in this experience and felt freer, more active and more creative while learning. The conditions in which the

activities were carried out made them practical and enjoyable, especially the fact that the contents were generated by the students themselves. 6) *I felt that the data we were working on hadn't been taken from books, they had been created by us. It was very rewarding!* 7) *It seemed odd to me that those numbers concerned us, our bodies and our work. This made them more interesting in our eyes.*

**Awareness - What has changed?**

From the students interviews a new approach to understanding technology emerges. It is undoubtedly more conscious, as it prompts reflection on how technology can be a simple mild tool for everyday life, but also a "powerful" means to be used carefully by an "improved" or rather, "properly equipped" user. 8) *I want to recommend this tool to my grandfather who has heart problems, but I will have to evaluate it well. The risks could outweigh the benefits because having this device on him all the time would be a constant reminder of his illness. Besides, I don' t know if he could figure out anything from the data.* Finally, some hope that the project will be continued. 9) *I have certainly learned useful and important things for my life. It would be nice to be able to do it again in the future at school.*

Our quantitative and qualitative analysis shows how, the use of wearable devices as "learning environments" at school, is first of all, a rewarding experience for students, it also yields positive outcomes in terms of the acquisition of knowledge regarding both device applications and data interpretation, it increases perceived user autonomy and skills, also prompting reflection on the fundamental reasons for the introduction and implementation of these technologies in everyday life. In addition, the results of the qualitative analysis show that the initial impact of wearable technologies can generate anxiety and worry; however, such feelings are dispelled through the study and application of these devices. The users enhanced sense of autonomy, and confidence was confirmed throughout the entire device application process.

**Conclusions**

As school in general is the biggest engine for innovation, investing in it to implement the use of new technologies and to verify their effects can be a useful and far-sighted strategy. Indeed, this early exposure to wearables , provided at a young age, can also help subjects later as adults to avoid certain pitfalls associated with these technologies while at the same time enhancing their ability to reap the benefits that can be obtained from contextualized knowledge and proper use of these devices. School can become a research lab to introduce novel ideas regarding cutting edge devices and their features, to prompt reflection about technology, and to verify the usability of such technologies.

Our project has yielded positive results in terms of enhancing subjects' knowledge, autonomy and awareness in the field of wearable technologies. The development of "enhanced wearable users" could help to provide what is said to be lacking for the

mainstream development of wearables: widespread dissemination of the technology which would help reduce costs, skills related to the reading and interpretation of data and the need for scientific rigor, contextualization and integration of the devices into everyday life. These results are to be understood not only quantitatively in terms of an increase in the production and dissemination of wearable technologies, but also in terms of an enhancement of the quality of their application and use. In addition, the present study lays the groundwork for further investigations of this kind with the aim of pursuing the desired wider application of wearables in the field of health and, at the same time, improving their application to other areas of life (well-being and other experiences) in which they are already widely used.

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## Tables and Figures

| Questions | Definitely No | No more than Yes | Yes more than No | Definitely Yes |
|---|---|---|---|---|
| 1. Did you find the activities practiced using wearables to be interesting? | 4 % | 12 % | 51 % | 31 % |
| 2. In your opinion, did your knowledge of wearable devices and their data improve? | 12 % | 26 % | 42 % | 18 % |
| 3. Are you totally satisfied with this experience? | 3 % | 7 % | 55 % | 32 % |
| 4. Do you think that your attitude towards this technology has improved after the initial impact? | 13 % | 15 % | 49 % | 21 % |
| 5. Would you be able to use the wearable device in question alone? | 14 % | 28 % | 46 % | 11 % |

| | | |
|---|---|---|
| 6. In general, technology is designed to improve our lives. Do you think these wearable technologies can improve our lives? | Yes 73% | No 27% |
| 7. If yes, how? (score: from 1-2-3) | | |
| Improving health (cure a condition, distinguish healthy and unhealthy lifestyles ...) | track blood pressure, track heart rate, log triggers that cause diseases ... 25% | |
| Improving wellbeing (performance, find balance, experience wellbeing ...) | track exercise, track weight, log sleep, log food, log panic, log mood ... 40% | |
| Offering new life experiences (explore new places, orient in contexts, satisfy curiosity, have fun, enjoy relationships ...) | track every street walked, track the use of time, log activities in a day, track the connected self ... 35% | |

Table 1. Questionnaire

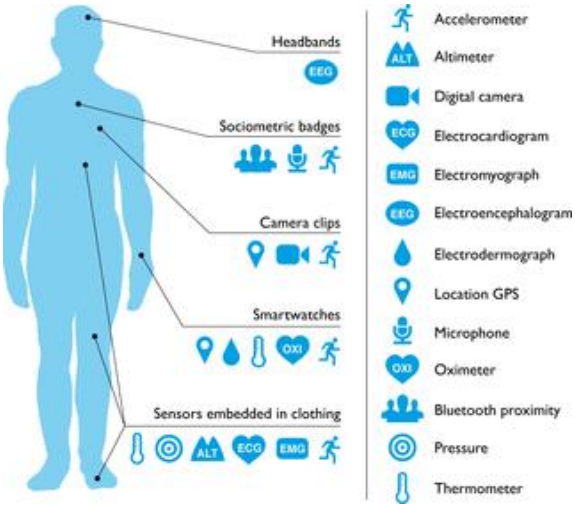


Fig. 1. The Rise of Consumer Health Wearables. Source: Piwek et al. (2016)

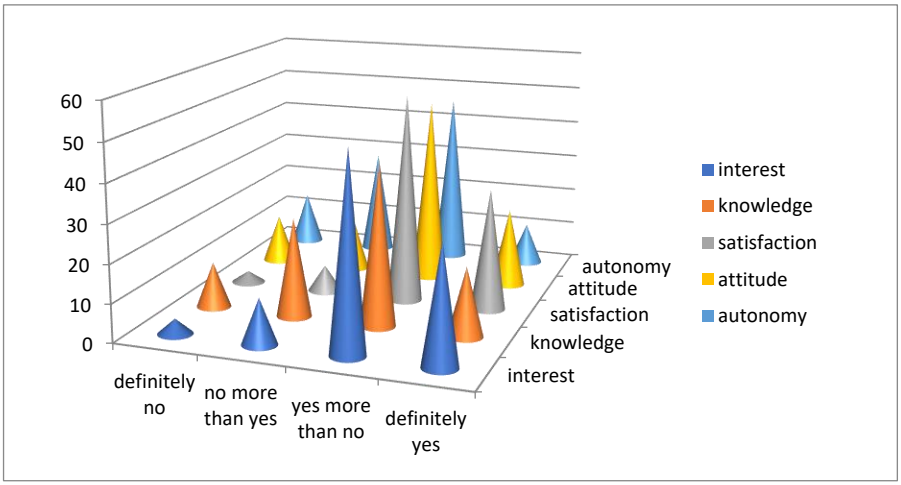


Fig. 2. Factors related to use of wearable technologies at school

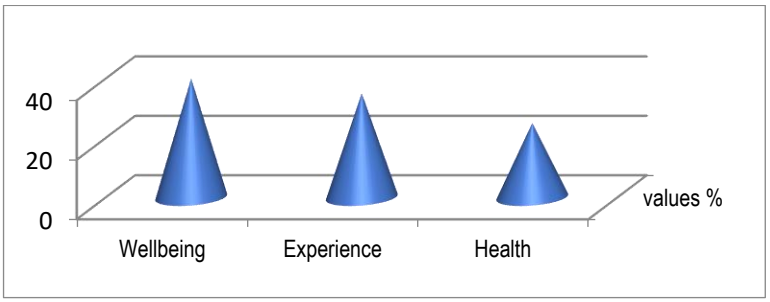


Fig. 3. The fields of application of wearables

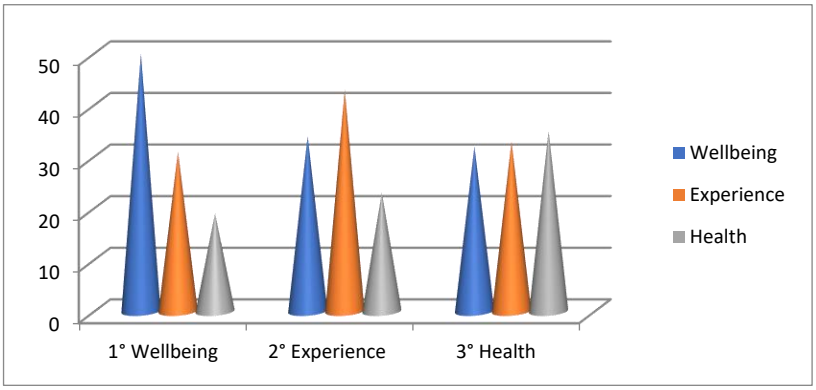


Fig. 4. A classification of the fields of application of wearables