

The Heart Rate Monitor at School

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The objective of the project still going on is to study the use of the heart rate monitor in teaching. The device has originally been designed for sports training and fitness training, from where its use is spreading to physical education at school. The device provides a many-sided learning environment. By means of this device we obtain information on the heart rate but, in addition, this information can be dealt with in a wider reference frame. In the project described here the pupils familiarize themselves besides with the actual device, the heart rate monitor, also with the functioning of the circulatory system and the respiratory organs and with how physical activities affect the fitness and functioning of these organs.

When seen from this wider reference frame, the project can include several different school subjects. In mathematics we can analyze the data given by the heart rate monitor, tabulate them manually and present them graphically. In biology we can study the functioning of the heart, the circulatory system and the respiratory organs. In physics we can study the fluctuations in the electromagnetic voltage of the heart and the wireless transmission of this fluctuation to a receiver which shows the heart rate measured in beats per minute. In information technology we can explain how the heart rate is registered in the receiver and unpacked from it through interface and computer into a final graph showing the time on the X axis and the number of heart beats per minute on the Y-axis.

The Origin of the Project

The project originated from an idea according to which today's school must cooperate with the surrounding community, especially with industry and trade. The manufacturer of the heart rate monitors, Polar Electro Oy, became one partner in the project. The other partner is the Department of Teacher Education of the

University of Oulu and its Training School. The establishment of cooperation was contributed to by the fact that also the University includes the increasing of its connections with industry and trade among its objectives. Polar Electro Oy again had a product idea which had quickly found a wide market. According to the brochure Polar Electro Oy "is the world's leading manufacturer of the heart rate monitoring, registering and evaluation equipment. The company's products represent the state of the art in heart rate measuring devices for athletic training, fitness and rehabilitation. Polar Electro Oy has undergone a rapid process of internationalization, and is now the global market leader in its field. The market share of the company's Polar heart rate monitors is about 80 per cent in the USA, and over 80 percent in Europe, depending on the country in question. Polar Electro Oy's products are exported to over 30 countries, with exports accounting for 95 per cent of total sales."

Thus it was natural that the Department of Teacher Education was greatly interested in the significant local high-tech enterprise. As to the University of Oulu, it is a five-faculty university with over 10,000 students. The Department of Teacher Education of its Faculty of Education graduates class teachers. The Department also provides educational studies for subject teachers. When, in addition, the Department of Teacher Education and its training school have technology education as one of their emphases (cf. Lewis 1992), there was a natural ground for starting cooperation with Polar Electro Oy.

Establishing the Project Group

Because heart rate monitor teaching had not been systematically tested out, at least not in Finnish school education, this became a challenging cooperation project, meeting the objectives of the both partners. For this purpose a project group was established, which had the task to test out heart rate monitor teaching at the Department's training school comprising the grades 1–12 of the general education institution. The project group included representatives of the device manufacturer, and teacher members of the Department of Teacher Education and the training school. Teachers of physical education had naturally a significant role in the group.

Working of the Project Group

The first project meetings were held in spring 1995. The actual work was started in autumn 1995. First the manufacturer arranged training during which the other members of the project group were acquainted with the heart rate monitor and its

functioning. The instructor was a representative of the manufacturer. In October of the autumn 1995 an official agreement of cooperation was concluded, in which it was agreed that the project will study the use of the heart rate monitor at school, and prepare the teaching material for it and test it in practice. According to the agreement, the teaching material was to include plans for 15–20 lessons. The teaching plans were to state the objectives, contents and description of the learning process, and the realization of teaching.

We wanted to include also research in the project. It was carried out by two students in the class teacher education programme. Helped by the project group, they had the task of making detailed teaching plans, and to test them in the training school. The results of the tests were to be reported on in a thesis which the students would write for their Master's degree. The result of this decision was that also the supervisor of the students' thesis was included in the project group. Including the thesis in the project made the students acquaint themselves more extensively with i.a. physical education, keeping up of physical fitness by exercise, and previous research on the use of the heart rate monitor.

Teaching Material

The teaching material is composed of two parts. The first part introduces the objectives of teaching and some essential principles of teaching. The objectives are based on pupil activities, individual work and cooperation, and problem-centeredness. When using the heart rate monitor during physical education lessons each pupil obtains information of the functioning of his/her heart (cf. Shephard 1992, Strand & Reeder 1993). This knowledge is increased by describing the heart, the respiratory organs and the circulatory system, and how they function. The treatment of the information given by the heart rate monitor gives various opportunities to explain matters integrated into mathematics, physics and biology. For instance in mathematics we can tabulate the heart rate as a function of time, present the same data graphically and interpret the results verbally. This is possible to be done either manually or by computer. This is thought to contribute to mathematical literacy (cf. e.g. Murray, S. 1995). The data of the heart rate monitor can be registered in a wrist receiver included in the device, and transmitted from it through interface to a computer and presented by means of it in the form of tables or graphs (cf. Johnson 1989). These data can further be processed with some spreadsheet program. During biology lessons we can study besides the functioning of the heart and the respiratory and circulatory organs, also physiological phenomena connected with food consumption and combustion, and thus contribute to scientific literacy (cf. e.g. Driver et al. 1996).

Model Lessons

The model lessons connected with the different subjects have been numbered and their themes are shown in figure 1. This presentation is called the problem circle by the group. It is divided in four different subject sectors and three levels. The problem circle can be read according to the spiral principle clockwise on level I and after that continue on level II again moving clockwise. The same is repeated on level III. The plans of the model lessons have been marked in the problem circle with consecutive numbers (1–16). During each lesson answers are sought for to certain essential issues of heart rate monitor education.

Figure 1 is missing

Figure 1. The essential issues and the main objectives of heart rate monitor education.

The programme of each lesson presents the theme of the lesson, its objectives and what equipment and materials are needed during the lesson. This is followed by a description of the sub-tasks to be carried out during the lesson and the order of their progression. In addition, special aspects and tips concerning teaching are presented. The second part of the material contains additional information for the teacher. It gives information on the heart and its rate and is meant as supplementary material for the teacher. It deals i.a. with the following questions: What is the structure of the heart like, how does it work and which factors affect its functioning? How is the heart rate measured? What is the relation of the heart rate and exercise? Relevant publications and studies (e.g. Armstrong, N. et al. 1991, Boyadjian, N. 1980, Hinson, C. 1994) have been used as references.

The Heart Rate Monitors

The heart rate monitors transmit the heart beat telemetrically (wirelessly). The Polar heart rate monitors are ECG accurate and easy to use. The difference between an ECG and the heart rate monitor is rather simple: the ECG tells the heart beat rhythm and the signals in the form of a graph whereas the heart rate monitor tells the heart beat frequency or the heart rate, measured in beats per minute.

The up-to-date heart rate monitor has three parts: a light-weight transmitter to be attached to the chest, an elastic belt, and a receiver usually carried on the wrist (figure 2).

Figure 2 is missing

Figure 2. The components of the heart rate monitor: the transmitter, the belt and the receiver.

The Polar transmitter is attached to the chest with an elastic belt around the chest. The length of the belt is adjustable according to the width of the chest. The transmitter contains two electrodes which pick up the electrical signals caused by the heart beat on the skin. The transmitter sends the heart rate wirelessly to the wrist monitor using an electromagnetic field. The heart rate (beats/minute) can be continuously read on the display of the wrist monitor.

Using the Heart Rate Monitor

Figure 3 shows the heart rate curve of a 15 years old pupil participating in the project during an exercise period of 1 hours. The duration of the exercise period has been shown on the X-axis. The hours, minutes and seconds are separated by colons. The markings are at half-an-hour intervals. The Y-axis shows the heart rate. We can read on the curve when the heart rate has been above the average. If we set the limit for instance at 150, so the first time the heart rate exceeds this limit is when the pupil has been doing his first warm-up. The next reading above this limit has been achieved in basketball, the next ones after that in football and in indoor bandy. The peak of the heart rate has been reached towards the end of the teaching period when the pupil has been running from end to end of the gym hall, interrupted by squatting down and up jumps. The computer tells that the maximum heart rate of this exercise has been 202.

Figure 3 is missing

Figure 3. The heart rate curve of a 15-year old pupil during a double lesson in physicaleducation.

The Limits of the Heart Rate

The heart rate monitor helps to chart the heart rate limits characteristic for each person in rest and in various forms of activity. These limits are connected with age so that the peak readings of the heart rate are decreased by age. The heart rate of a 20 years old adult at the starting phase of light exercise is 100–120 beats/minute, a

heart rate intensity of 50–60 per cent of the maximum. The area suitable for efficient weight loss is 120–140 beats/minute whereby the exercise should last for half an hour and up. Fitness training requires exercise with a heart rate of 140–160 and athletic training exercise with a heart rate of 160–200. All the figures are beats/minute.

According to U.S. studies, a pupil should exercise at least three times a week for 20 minutes with a heart rate that is over 60 per cent of the maximum heart rate (U.S. Public Health Service 1991). Exercising in this area improves for instance the condition of the heart and the circulatory system. The boy observed above had been exercising in the heart rate area exceeding this limit for a greater part of the double lesson.

Conclusion

This article has described the origin of the heart rate monitor project, the teaching material made for the project and the use of the teaching material in the training school of the Department of Teacher Education. The thesis concerning the experiment has been mostly passed unnoticed. This is due to the fact that the thesis is still not completed. On the basis of literature it would seem that when realizing physical education lessons, boundaries will be defined on the one hand concerning the teaching of skills and on the other hand concerning the exercises for physical fitness (Quinn & Strand 1994). The skills can give somebody great pleasure for good performance and thus help him/her to take certain type of exercise continuously. On the other hand one sided concentration on one skill may prevent the overall development of the various components (the strength of the heart and the respiratory organs, muscular strength, muscular endurance and flexibility). When we know that physical fitness and the general state of health are related to each other, especially exercise improving physical fitness is very important. Studies in the USA have shown that for instance pupils weighed more in the 1980's and they had more body fat than pupils of the same age in the 1960's (Ross & Pate 1987). It is known that overweight usually is related to a high cholesterol level of the blood and with hypertension which both are risk factors of the coronary disease. Therefore it is not surprising that attention is being paid to physical education at school and it is being discussed how these diseases could be prevented by means of it. The heart rate monitor provides one way to observe the state and condition of the heart and the respiratory organs. It may be possible to prove by longitudinal studies (cf. e.g. Shepherd 1992) whether taking the heart rate monitor to be used at school is one way of increasing the pupils' interest in taking care of their physical fitness and whether this will affect the general health and well-being of citizens in the

future. Maybe the project described here will contribute to this discussion, especially when it proves that the use of the heart rate monitor gives fruitful material to other subjects and may thus motivate pupils to take better care of their own physical fitness.

Descriptors

Technology Education with the Heart Rate Monitor, Integration with other Subjects, Cooperation between a Company and the Department of Teacher education.

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