

# Case Based Learning Applied in Biomedical Engineering Courses

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ΠΑΝΕΠΙΣΤΗΜΙΟ ΙΩΑΝΝΙΝΩΝ

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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING  
UNIVERSITY OF IOANNINA



ΒΙΒΛΙΟΘΗΚΗ  
ΠΑΝΕΠΙΣΤΗΜΟΥ ΙΩΑΝΝΙΝΩΝ



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# CASE BASED LEARNING APPLIED IN BIOMEDICAL ENGINEERING COURSES

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## ΜΕΤΑΠΤΥΧΙΑΚΗ ΕΡΓΑΣΙΑ ΕΞΕΙΔΙΚΕΥΣΗΣ

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από την

Χρύσα Κλιτσινάρη

ως μέρος των Υποχρεώσεων

για τη λήψη

του

ΜΕΤΑΠΤΥΧΙΑΚΟΥ ΔΙΠΛΩΜΑΤΟΣ ΣΤΗΝ ΠΛΗΡΟΦΟΡΙΚΗ  
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## ABSTRACT

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Case Based Learning Applied In Biomedical Engineering Courses

Thesis Supervisor: George Manis, Assistant Professor

This master thesis studies Case Based Learning and presents how it can be applied in science in general and in Biomedical Engineering in particular. The objective of the thesis is to show the benefits of Case Based Learning as an instruction method as well as to introduce the tools through which Case Based Learning can be enhanced.

At first, we studied what is Case Based Learning, the strategies it follows as a process, the benefits it offers, its aims and its pedagogical model needs. A case is a story. Cases describe real, or realistic, events or problems so that students experience the complexities, doubts, and uncertainties encountered by the original participants in the case. Case Based Learning is an instructional design model that can be found in a variety of professional disciplines including science, engineering, medicine, education, law and business.

One of the aims of using Case Based Learning is to provide students with the opportunity to see theory in practice. Real world contexts expose students to viewpoints from multiple sources. Case learning sharpens communication and critical thinking skills as students apply knowledge and evaluate options to solve the problem. Case teaching enhances learning by



engaging students in very powerful ways. Students learn more when they are at the center of the process.

Case teaching is learner-centered, characterized by interaction between instructor and student, as well as among students in a group. Conceptually, case teaching assumes that learning is more effective if students discover or construct knowledge with faculty guidance, than if they sit passively and receive content from the teacher. Case based learning mostly focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice.

- Subsequently, we researched and studied the Information and Communication Technology Tools that can promote Case Based Learning and we present and analyze the features these tools offer. Case based learning can rely on educational software developed to simulate typical scenarios that professionals encounter in real-world settings. Along with communications tools, these online experiences often integrate intelligent tutoring systems, immediate feedback and opportunities for reflection, including the chance to repeat recorded events and adopt alternative decision paths.

There are enough learning platforms which include a variety of features and specifications and mainly focus on supporting schools and faculties. In this thesis, we present a set of ideal platform features focusing on Case Based Learning. A recent tendency is focusing on web-based education platforms while keeping as a minimum client requirement an up to date web browser.

Additionally, we review some ICT Tools that can be used especially for Case Based Learning in Biomedical Engineering. Bioinformatics and Biomedical Engineering are interdisciplinary scientific fields that develop methods and software tools for storing, retrieving, organizing and analyzing biological data. As interdisciplinary fields, they combine computer science, statistics, mathematics and engineering to study and process biological data. Software tools for these fields range from simple command-line tools, to more complex graphical programs and standalone web-services.



Finally, we planned the 12-week curriculum of a Biomedical Engineering course, we composed and performed nine case studies in the field of Biomedical Engineering using one of the platforms we have described, the Casemaker platform. Two of the case scenarios that we built were presented to a class of Graduate students in the Department of Computer Science and Engineering of the University of Ioannina in Greece. So, we were able to assess students' acceptance and be led to important conclusions.



## ΚΕΦΑΛΑΙΟ 1. INTRODUCTION

---

### 1.1 Objectives

### 2.1 Thesis Structure

---

#### 1.1. Objectives

The overall aim of the thesis is the research relating to Case Based Learning and its application in Biomedical Engineering. The specific objectives are:

To analyze the Case Based Learning as an instruction model.

To understand the usefulness and benefits of Case Based Learning.

To classify and describe the ICT Tools that can be used in Case Based Learning and their features.

To confirm the advantages of Case Based Learning through real case scenarios.

#### 1.2. Thesis Structure

This master thesis includes 7 chapters: Chapter 1 is introductory. Chapter 2 is dealing with the case method and the reasons for someone to use it. Chapter 3 is studying the Case Based Pedagogical Model and its needs. Chapter 4 presents the instructional strategies that might be involved with Case Based Learning. Chapter 5 presents the ICT Tools used in Case Based Learning and describes in detail their features. Chapter 6 is studying Case Based Learning in Biomedical Engineering teaching using ICT Tools and some of these tools are presented. Eventually, in Chapter 7, a 12-week curriculum of a Biomedical Engineering course is presented and nine case scenarios concerning Biomedical Engineering are described using the Casemaker platform.





## ΚΕΦΑΛΑΙΟ 2. CASE BASED LEARNING

---

### 2.1 What Is a Case

### 2.2 What Is Case Teaching and Why Use It

### 2.3 What Is the Case Method

---

#### 2.1. What Is a Case

A case is a story. Cases describe- as objectively and meticulously as possible - real (or realistic) events or problems so that students experience the complexities, doubts, and uncertainties encountered by the original participants in the case. As they work with a case, students must emphasize key elements from the real complicated information. Cases compel students to:

- distinguish relevant from unimportant information
- identify the problems in time and define its context and parameters
- identify a set of possible solutions
- develop strategies and recommendations for action
- make decisions
- deal with obstacles to implement

Case formats vary. They can be formal written cases, a lead newspaper article, a movie clip, a radio/TV news story, a picture, a mathematical word problem, a piece of art. Cases do not need to be restricted to narrative descriptions of major events in world history. They can be any piece of shared reality that compels students to deal with multi-layered problems seen from multiple perspectives.



Cases are best used to teach people about realistic decision-making situations. For instance, cases help train pre-service teachers, instructional designers, doctors, lawyers, business people, and others, how to respond to actual problems they will encounter in their fields. Cases are used mainly for corporate and industrial training as well as across many professional university programs.

Case teachers thrive at institutions as diverse as the National Defense University, Mt. Holyoke, Duke, California State Universities and Minnesota. At UCLA, cases are used to teach medical students the nuances of diagnosis. At Harvard, they are the prime vehicles for teaching government professionals the intricacies of diplomatic negotiation. At Syracuse, Brandeis, Haverford, and Yale, they are used to teach undergraduates the principles of economics. At the Air Force Academy, they are used to teach ethics, international relations, the visual arts, and social psychology to aspiring officers. Cases have even been used by USC faculty to teach the value of interpersonal understanding to members of LA street gangs.

Table 1 Disciplines that work well with cases

|                        |                       |                          |
|------------------------|-----------------------|--------------------------|
| Accounting             | Data Processing       | Philosophy               |
| Allied Health          | Drama                 | Photography              |
| Arts                   | Economics             | Professional Development |
| Biology                | English               | Psychology               |
| Business               | History               | Reading                  |
| Communications         | Human Services        | Social Sciences          |
| Computer Science       | Human Studies         | Sociology                |
| Information Systems    | International Studies | Speech                   |
| Counseling             | Management            | Telecommunications       |
| Criminal Justice       | Mathematics           | Writing                  |
| Curriculum Development | Nursing               | Zoology                  |



## 2.2. What Is Case Teaching and Why Use It

Case teaching grounds academic instruction in reality by engaging students in discussion of specific situations. Case teaching is learner-centered, characterized by interaction between instructor and student, as well as among students in a group. Conceptually, case teaching assumes that learning is more effective if students discover or construct knowledge with faculty guidance, than if they sit passively and receive content from a distant "wise" teacher. They simultaneously learn curricular content and skills such as writing, speaking, listening, and critical thinking.

One of the aims of using Case Based Learning is to provide students with the opportunity to see theory in practice. Real world contexts expose students to viewpoints from multiple sources. It also requires students to analyze data in order to reach a conclusion. Instructors who use case-based learning say that their students are more engaged, interested, and involved in the class. Finally, in their effort to find solutions and reach decisions through discussion, students analyze real data, apply analytic tools, reflect on their relevant experiences, and draw conclusions they can relate to new situations.

Case learning depends on inductive reasoning, making content the foundation of a case course. Case learning sharpens communication and critical thinking skills as students apply knowledge and evaluate options to solve the problem. Case discussions learn students to listen carefully to each other, to respect opinions of others, and to work collectively to solve a problem. In this manner, students learn to value the contributions of others while strengthening their own ability to think creatively and communicate effectively.

Case teaching enhances learning by engaging students in very powerful ways. Students learn more when they are at the center of the process. Case teaching actively connects students with course content and shifts responsibility for learning to students. With faculty as their guide, students discover or construct a body of knowledge and life learning skills at the same time. Active learning promotes deeper understanding and improved memory. Working with cases advances interpersonal skills that find significant resonance with life after the university where teamwork can be as critical to success as the ability to work through problems individually.



A study carried out by the Socony-Vacuum Oil Company concluded that students absorb 10% of what they read, 26% of what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say and 90% of what they say and do.

### 2.3. What Is the Case Method

Case method instruction has been an accepted educational technique in higher education for almost a century. Popularized by Harvard Business School in 1910 (Jennings, 1996), case method instruction is found in a variety of professional disciplines including science, medicine, education, ethics, law, business, and the military. The case method approach has been almost universally embraced as an effective teaching methodology and practitioners have claimed several benefits to it. Some of the most commonly cited benefits is that case method instruction provokes critical and creative thinking and case studies provide students with an opportunity to apply the abstract lessons learned from books and lectures to the actual situation described in a case.

Using a case-based approach engages students in discussion of specific scenarios that resemble or are real-world examples. This method is learner-centered as mentioned above and the instructor's role is that of a facilitator while the students collaboratively analyze problems and resolve questions that have no single right answer.

Clyde Freeman Herreid provides some basic rules for case-based learning. In particular, it has to:

- focus on an interest-arousing issue
- have pedagogic utility
- provoke conflict
- force decisions

Case-based learning is promoted in many universities because it teaches important concepts and facts within the context of authentic or real-world situations. Context is thought to be more motivational to learners and it provides a particular framework from which complex



concepts can be more easily understood. Further, case-based learning reduces the potential for inactive knowledge. Inactive knowledge is learned information that is difficult or impossible to apply to realistic situations, because it was learned out of all context or relation to reality. Isolated facts are more difficult to integrate within memories than facts taught in a realistic context. Generic concepts should be applied and reiterated over a number of cases, so students can begin to understand the diversity of uses for that information.

More information can be found in references [12], [14], [17] and [26].



## ΚΕΦΑΛΑΙΟ 3. PEDAGOGICAL MODEL NEEDS IN CASE BASED LEARNING

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### 3.1 Case Based Pedagogical Model

### 3.2 Teaching Science with Case Studies

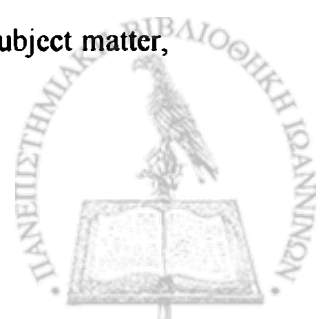
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#### 3.1. Case Based Pedagogical Model

A case based pedagogical model combines the possibility of working with more than one problem at a time. This means that students have to combine, choose and prioritize the different domains and problems. Case Based Learning allows the development of a collaborative, personal or team based teaching approach suitable for any education field. Its main features include hypothesis generation and the unification of learning activities.

Case based learning is similar to problem-based learning but it is also considered as an iterative process through routine, problem orientation, problem solving, and innovation. In the case-based pedagogical model every case intends to teach specific aspects, and reflects needs like organizing, communication, risk management, faster, cheaper, better, easier management, and every need is featured by specific terms. However, using cases does not necessarily constitute a case based learning by itself.

Case-Based Learning's main feature which derive from Problem-Based Learning, is that a case, problem, or query is used to encourage the acquisition of knowledge, skills, and attitudes. Cases place events in a context or situation that promote authentic learning. The basic difference between Case Based Learning and Problem Based Learning is that Problem Based Learning does not require any prior experience or understanding of the subject matter,



whereas Case Based Learning requires students to have a degree of prior knowledge that can help them in solving the problem.

Although many instructors support case method instruction as a valuable technique, little empirical research has tested the effectiveness of this approach. In a comparison of Case Based Learning with traditional lecture/didactic formats, studies were able to demonstrate several important aspects to students' attitudes to Case Based Learning after changing their teaching methods during several work sessions. They showed that the Case Based Learning format facilitated students in asking questions and making comments during class and made the learning process more enjoyable. The lecture format on the other hand made students feel that the lecture method was more helpful in preparing for a written exam. Despite the preparation time being longer, tutors believed that students developed better problem solving skills under a Case Based Learning model compared with a lecture mode.

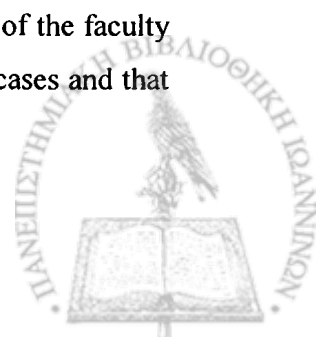
More information can be found in reference [2] and [26].

### **3.2. Teaching Science with Case Studies**

The National Center for Case Study Teaching in Science, which has trained thousands of science teachers in the case study method, conducted a survey to examine whether faculty who had been taught to use case studies in teaching science applied the method and, if they did, how they would characterize their experiences.

Faculty believed students' critical thinking increased, their understanding deepened when learning via case-based instruction and were able to make connections across multiple content areas. Most of the faculty also agreed that when they used case study, the students were better able to view an issue from multiple perspectives.

As it was reported, students gained much from cases although content coverage did not have a significant change. Faculty mentioned that students retained more, did better on tests and realized better the practical applications of course concepts through case-based instruction. Participation of students increased when cases were used in class. The majority of the faculty agreed that students took an active part in the learning process when they used cases and that



students worked easily in small groups. However, 55% of the faculty were neutral and 17.5% of them disagreed when asked if attendance increased on the days when cases were used, which is contrary to other research showing that students tend to attend class more when cases are used.

However, faculty reported some obstacles to implementing case-based teaching, with lack of preparation time as one of the main. Some, also, had difficulty in assessing student learning with the case method and reported that the biggest challenge is developing objective assessment tools for evaluating students' learning on case studies as it involves multiple layers: individual preparation, group participation, group/individual productivity. Another main obstacle was the lack of relevant case studies. In fact, increased use of case studies is expected to minimize these obstacles.

Students say they are motivated by solving real-world problems. At the same time, most educators consider learning-by-doing the most effective way to learn. Yet for decades, case based learning has been difficult to implement. Certain experiments are too dangerous, difficult, or expensive to perform in the classroom and many are simply impossible to perform. Internet as well as a variety of emerging communication, visualization, and simulation technologies now make it possible to offer students case based learning experiences, from experimentation to real-world problem solving.

Case based learning mostly focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice. The learning environment is similar to some 'real world' application or discipline.

Students involved in case based learning activities work the kind of skills that beginners in any discipline have the most difficulty achieving on their own:

- the judgment to differentiate reliable from unreliable information
- the patience to follow possible disagreements
- the ability to recognize relevant patterns in unfamiliar contexts
- the flexibility to work in various situations and generate innovative solutions





The learning process encourages students to compare their personal interests with those of a working disciplinary community. It helps them wonder if they can see themselves becoming members of some culture, what would inspire them, what would concern them, how would they work with the people around them, how would they make a difference.

Although foundational skills (reading, writing, mathematics, history, language) remain essential, a more complex set of skills are required today. These go beyond being technically qualified to being able to get things done, demonstrate ethics and integrity, and work well with others. According to employers, the most important skills in new hires include teamwork, critical thinking/reasoning, assembling/organizing information, and innovative thinking/creativity.

The learning process works really well with the common practice of using discussion groups in case classes makes the role of discussion important in a case-based learning environment. Small groups can be used within plenty instructional methods, including cooperative learning, collaborative learning, problem-based learning, or case-based learning. Small groups are used in all of these to enhance learning and performance and it has been proved through studies that they help indeed. Furthermore, discussion can be used to help students comprehend content and analyze information since it is difficult for students to learn how to do analysis.

Students learn from the group process and arrange their efforts and time despite the fact that working with others may take more time than working alone on a problem. It has been reported that students who work alone to learn from a computer simulation access supplemental materials more than those who work in small groups. Since students do not have the opportunity to discuss the cases with others, their only means of gaining new perspectives on the case is to access relative reading material.

Findings of studies suggest that the use of discussion groups in case-based classes can be an effective and motivating method of instruction if students are prepared and time is available for both individual preparation and group discussion. The case method allows students to



build the necessary body of knowledge for their chosen profession and apply it to real situations while improving analytical and problem-solving abilities in a team environment.

More information can be found in references [11], [13], [18] and [24].



## ΚΕΦΑΛΑΙΟ 4. CASE BASED LEARNING AND INSTRUCTIONAL STRATEGIES

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4.1 Case Based Learning and Related Strategies

4.2 Problem Based Learning

4.3 Challenge Based Learning

4.4 Role Play and Debates

4.5 Virtual Environments and Simulation

4.6 Analysis and Reflection

4.7 Group Projects

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### 4.1. Case Based Learning and Related Strategies

The past decades because of the advances of new technology there are major changes in how people do business, access and share information, create and transfer knowledge. Teaching and learning strategies and procedures also need to be updated to better prepare students to deal with these new situations. Students need more than ever to be able to set questions, search and find appropriate resources for answering these questions, cooperate with others and communicate their solutions effectively to others.

Duch et al. (2001) describe extensively the desirable skills that a problem based learning strategy has to promote, mentioning specifically the ability to do the following:

- think critically and be able to analyze and solve complex, real-world problems
- find, evaluate and use appropriate learning resources
- work cooperatively in teams and small groups
- demonstrate flexible and effective communication skills, both verbal and written



- use content knowledge and intellectual skills gained at the university to become continual learners

On the other hand Case Based Learning is related to a variety of possible instructional strategies as the following:

- problem based learning
- challenge based learning
- role play and debates
- virtual environment simulation
- analysis and reflection
- group projects

#### **4.2. Problem Based Learning**

Problem-based learning is a learner-centered educational strategy using realistic problems and team support to enhance practical applications of what students have learned. It involves carefully designed problems which motivate students to use problem solving techniques, self-directed learning strategies, team participation skills and disciplinary knowledge. Problem-based learning was adopted in order to enhance transfer of learning, the degree to which learners effectively apply the skills, knowledge, behaviors, and attitudes gained in a class to either similar or new situations in their real life. In natural sciences it is quite common to effectively use problem-based learning in the learning process.

A primary assumption of Problem Based Learning is that when we “solve the many problems we face every day, learning occurs”. Although such a statement may seem self-evident, there is the public assumption that learning occurs only in formal education settings, so once we leave school we stop learning. Supporters of Problem Based Learning believe that “all life is problem solving”. If all life is problem solving, then all life is full of learning opportunities. In PBL, all of the learning arises out of consideration of the problem. From the start, the learning is synthesized and organized in the context of the problem.

Problem-based learning is based on constructivist assumptions about learning, such as:



- knowledge is individually constructed and socially co-constructed from interactions with the environment and it cannot just be transmitted
- there are multiple perspectives concerning every situation
- thinking is shared among the culture and community in which we exist and the tools that we use
- learning is most effective when it is embedded in authentic tasks that are encountered in everyday contexts
- problems provide a purpose for learning. Without an intention to learn, which is provided by problems, meaningful learning rarely occurs.

The primary goal of Problem based learning is to enhance learning by requiring learners to solve problems. It is a methodology with the following characteristics:

- It is problem focused, so that learners begin learning by addressing simulations of an authentic, unstructured problem. The content and skills to be learned are organized around problems, so a mutual relationship exists between knowledge and the problem. Knowledge creation is motivated by the problem and applied back to the problem.
- It is student centered, because faculty cannot dictate learning.
- It is self-directed, so that students individually and collaboratively take responsibility for producing learning issues and processes through self-assessment and peer assessment and access their own learning materials. Required assignments are rare.
- It is self-reflective, so that learners observe their understanding and learn to adjust strategies for learning.

Tutors are facilitators who support reasoning processes, facilitate group processes and interpersonal dynamics, look into students' knowledge deeply, and never provide direct answers to questions.

More information can be found in references [7], [15] and [22].



### 4.3. Challenge Based Learning

Challenge based learning originates from problem based learning approach. There is a redefined approach that focuses on increasing student engagement, especially for students who run the risk of giving up. In challenge based learning, teachers and students work together to learn about fascinating subjects, suggest solutions to real cases, and take action. This approach challenges students to consider their learning and the impact of their actions, and publish their solutions to a worldwide audience.

Challenge-based learning includes these features:

- Multiple points of access and various and multiple possible solutions.
- Authentic connection with multiple disciplines.
- Focus on the development of 21st century skills.
- Full access to up to date technology tools and resources, allowing students to do the work.
- Use of Web 2.0 tools for organizing, collaborating, and sharing.
- A focus on universal challenges with local solutions.
- Requirement that students do something rather than just learn about something.
- Documentation of the experience from challenge to solution.

These features are intended to ensure that challenge-based learning engages learners, provides them with valuable skills, connects formal and informal learning and embraces a student's digital life.

### 4.4. Role Play and Debates

Role play and debates is usually a real time teaching interaction. It is one of the best ways to educate people and can be often used even in cases where the students are potential - future teachers of the same lesson. In real time interaction the skills of speed and real time adjustment are trained to the maximum. Achieving real time online teaching, including the tutor, through synchronous web based conference platforms is an all-time need of any e-



education platform with high demands. In simple cases of asynchronous online teaching, there are class related debates based on text-based chat or forum platforms.

Role playing is a technique in which students are presented with roles in the form of a case scenario. It involves human interaction and realistic behavior under artificial or imaginary conditions. The goal of role playing as a teaching method is not only to practice competences but also to induce a discussion that allows identification of effective and ineffective patterns of behavior under given circumstances. Each role play regardless of its scenario and subject develops a range of skills in students such as: communication skills, research skills, problem solving and critical thinking, team and group work skills.

Information, alone, rarely makes people change their minds, but personal experience often does. Role-playing, like any good research approach, converts the content of education from information into experience and emphasizes the intersection between science and daily life. The creative aspect of a role playing exercise makes it seem more like play than like work. Additionally, students learn that skills they learn separately are often used together in order to accomplish many real-world tasks. The pressure to solve a problem or to resolve a conflict can motivate a student far more than the sort of pressure that they usually encounter preparing for an exam. And it is far more typical of the pressure that they will have to confront in real life.

When students participate in role-playing and debates, they are fully engaged. In role-playing, students pretend to be other people and interact as these new persons. In debates, students argue two or more sides of an issue by bringing up facts and important points. Through this process they learn the art of persuasion. Research has shown that participation in debate exercises increases students' academic performance as well as skills that are mandatory in some real world situations. Students benefit from preparing for debates by sharpening their research skills and from the experience of speaking in public.

More information can be found in reference [25].



#### 4.5. Virtual Environments and Simulation

A new approach is focusing on the use of Virtual Environments and Simulation of real cases where the students can effectively learn and train their skills dealing with close to reality situations. This is an emerging approach with many possible expansions and features that may be used even in providing virtual worlds for educative purposes and skill training. The technological trends in portable devices and upgraded metropolitan infrastructures enable the use of augmented reality tools to embed simulated educative context to the real world.

Virtual learning environments can be identified by the following features:

- a virtual learning environment is a designed information space
- a virtual learning environment is a social space as educational interactions occur in the environment
- the virtual space is clearly represented: the representation of this information/ social space can vary from text to 3D worlds.
- Students are not only active, but also actors: they co-construct the virtual space
- virtual learning environments are not restricted to distance education, they also enrich classroom activities
- virtual learning environments combine various technologies and multiple pedagogical approaches

More information can be found in references [6], [8], [9], [10].

#### 4.6. Analysis and Reflection

Higher education institutions are usually based on the relation among analysis and reflection. The scope of the analysis stage includes often very wide and undefined real case problems that are very hard to be confronted by students. Tutors often have to gather student's thoughts and motivate them to proceed to new and better analysis. Analysis is the process of breaking a complex topic or substance into smaller parts to gain a better understanding of it.

Reflecting on academic or professional practice may make students' personal beliefs and expectations more evident to them. This understanding of themselves helps them accomplish





their studies successfully as it makes them aware of the assumptions they might automatically make as a result of their view of the world. The key to reflecting, is identifying the patterns and links in thought which emerge as a result of experiences in life and in learning. The great benefit of using reflection as a learning approach is that students can see their strengths and weaknesses by understanding why they do something in a particular way and recognizing how they feel about it. This gives them the chance to promote their strengths and develop strategies to minimize their weaknesses.

When students reflect, they consider deeply something which they might not otherwise have given much thought to. This helps them to learn. Reflection concerns looking at and thinking about their experiences, actions, feelings and responses and then explaining or analyzing them in order to learn from them. Students usually do this by asking themselves questions about what they did, how they did it and what they learnt from doing it. Reflection has been incorporated into study processes in numerous ways as it fits well in practice based learning, problem based learning and research and analysis cases.

More information can be found in reference [20].

#### **4.7. Group Projects**

Last but not least, there is a teaching strategy based on the creation of groups to work on long term projects. Learning and working in groups involves shared and learned values, resources and ways of implementing tasks. Teams learn how to succeed by combining these factors. Each team and their individuals can be really effective and able to respect differences within the team. Working with others generates innovation and growth. Learning now more than ever needs to be social and active as our everyday life is about connecting with people using digital and social media.

Group work on projects is a method of instruction that gets students to work together in groups on a common task. The task can be as simple as solving a multi-step math problem together, or as complex as developing a design for a new kind of school. In some cases, each group member is individually responsible for part of the task. In other cases, group members work together without formal role assignments. Employers value a person's ability to work



cooperatively. Indeed, studies show that they value it more than the ability to work independently. This is because, in most contemporary workplaces, people work in teams, which are often cross-disciplinary and quite diverse.

Research shows that group work on projects:

- allows students to become active participants in their learning
- helps students develop skills valued by employers (such as problem solving, negotiation, conflict resolution, leadership, critical thinking and time management)
- exposes students to diverse ideas and approaches
- allows students to experience situations that resemble the workspace, through authentic real world projects, and facilitates a better understanding of course content
- develops higher-level thinking, oral communication, self-management, and leadership skills
- increases student retention, self-esteem, and responsibility
- offers students more opportunities to actively participate in their learning, question and challenge each other, share and discuss their ideas, and personalize their learning

More information can be found in references [4] and [19].



## ΚΕΦΑΛΑΙΟ 5. ICT TOOLS FOR CASE BASED LEARNING

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### 5.1 Case Based Learning Environments

5.2 ATutor

5.3 Dokeos

5.4 dotLRN

5.5 ILIAS

5.6 LON-CAPA

5.7 Moodle

5.8 OpenACS

5.9 Sakai

5.10 Docebo

5.11 Claroline

5.12 Shareville

5.13 Casemaker

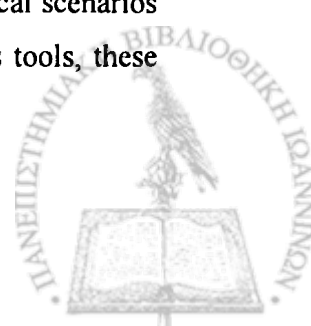
5.14 Learning Platforms Comparison

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### 5.1. Case Based Learning Environments

The value of case based learning activities can be realized through careful design of Web-based learning environments. Today's Web-based learning environments give students access to many resources that professionals use in their research.

Case based learning can rely on educational software developed to simulate typical scenarios that professionals encounter in real-world settings. Along with communications tools, these



online experiences often integrate intelligent tutoring systems, immediate feedback and opportunities for reflection, including the chance to repeat recorded events and adopt alternative decision paths.

Technological support for today's case based learning environments usually includes:

- High-speed internet connectivity for provision of multimedia information, including dynamic data and practical visualizations of complex phenomena and access to remote means along with expert advice.
- Asynchronous and synchronous communication and social networking tools for the support of teamwork, including collaborative online research, resource sharing and knowledge construction
- Intelligent tutoring systems, virtual laboratories and feedback mechanisms that conceive rich information about student performance and help students transfer their learning to new situations
- Mobile devices for accessing and inputting data during field-based investigations

Those who adopt innovative learning strategies must be ready to adjust their assessment strategies accordingly. Otherwise, the purpose of the entire operation may have no result. There are eight critical elements that researchers say must be adjusted to assure a successful learning environment:

- goals
- content
- instructional design
- learner tasks
- instructor roles
- student roles
- technological affordances
- assessment

There are enough learning platforms which include a variety of features and specifications and mainly focus on supporting schools and faculties. In this chapter, we will present a set of ideal platform features focusing on Case Based Learning. A recent tendency is focusing on



web-based education platforms while keeping as a minimum client requirement an up to date web browser.

There are many ICT tools and platforms available for tutoring, provided by several vendors, claiming that they have features for case based learning. There are also many papers in the literature with a lot of cross reference platforms. We have categorized and evaluated the following:

Table 2 ICT Tools and Platforms

| Platform   | Web Page  |
|------------|---|
| ATutor     | <a href="http://www.atutor.ca">http://www.atutor.ca</a>                       |
| Dokeos     | <a href="http://www.dokeos.com">http://www.dokeos.com</a>                     |
| dotLRN     | <a href="http://www.dotlrn.org">http://www.dotlrn.org</a>                     |
| ILIAS      | <a href="http://www.ilias.de">http://www.ilias.de</a>                         |
| LON-CAPA   | <a href="http://www.lon-capa.org">http://www.lon-capa.org</a>                 |
| Moodle     | <a href="http://www.moodle.org">http://www.moodle.org</a>                     |
| OpenACS    | <a href="http://www.openacs.org">http://www.openacs.org</a>                   |
| Sakai      | <a href="http://www.sakaiproject.org">http://www.sakaiproject.org</a>         |
| Docebo     | <a href="http://www.docebo.com">http://www.docebo.com</a>                     |
| Claroline  | <a href="http://www.claroline.net">http://www.claroline.net</a>               |
| Shareville | <a href="http://www.shareville.bcu.ac.uk">http://www.shareville.bcu.ac.uk</a> |
| Casemaker  | <a href="http://casemaker.phases.dk">http://casemaker.phases.dk</a>           |



This chapter reviews most of the currently available Case Based Learning tools that are presented in alphabetical order and it concludes with a table that summarizes the functionality of the reviewed tools. Below we provide an extensive description of each platform.

## 5.2. ATutor

ATutor is a Web-based Learning Content Management System (LCMS) used to develop and deliver online courses. It is suitable for creating online courses, school, high school, college and university web sites. It is written in PHP and requires a MySQL database. Its functionality and visualization can be extended with various modules and themes. Tutors can easily upload and manage the content which will be published for the students in a user-friendly environment.

ATutor was first released in late 2002. It came in response to two studies conducted by the developer in the years prior that looked at the accessibility of online learning systems to people with disabilities. Results of the studies showed none of the popular Learning Management Systems at the time even provided minimal conformance with accessibility guidelines. At the time a blind person for instance, could not participate fully in online courses.

ATutor is used in various contexts, including online course management, continuing professional development for teachers, career development, and academic research. The software is cited as unique for its accessibility features, (useful to visually impaired and disabled learners); and for its suitability for educational use according to software evaluation criteria established by American Society for Training and Development (ASTD). ATutor is used internationally and has been translated into over fifteen languages with support for over forty additional language modules currently under development.

ATutor allows access to:

- all potential learners
- course developers
- instructors



- administrators, including those with disabilities who may be accessing the system using assistive technologies.

Administrators can install or update ATutor in minutes, develop custom themes to give ATutor a new look, and easily extend its functionality with feature modules. Educators can quickly assemble, package, and redistribute Web-based instructional content, easily import prepackaged content, and conduct their courses online. Students learn in an accessible, adaptive, social learning environment. Users have some control with regard to development, use, and distribution of the software. Educational institutions are permitted to charge for course content built in ATutor, and for hosting services.

ATutor is designed for adaptability to any of several teaching and learning scenarios. There are four main areas that reflect this design principle: themes, privileges, tool modules, and groups. The ATutor theme system allows administrators to easily customize the look and layout of the system to their particular needs. Themes are used to give ATutor a new look, to give categories of courses their own look, or to provide multiple versions of ATutor on a single system, from which users could choose one as a preference setting. The privilege system allows instructors to assign tool management privileges to particular members of a course. Instructors may create assistants or course tutors that have limited control over any of the authoring or management tools.

The most important accessibility features in the system are text alternatives for all visual elements and keyboard access to all elements of the program. With these features, a blind person can listen to the entire interface of the system with the help of a screen reader, and he/she can access the system without needing a mouse. These features also allow ATutor to adapt to a wide variety of technologies including cell phones, personal data assistants (PDAs), and text-based Web browsers, to name a few.

ATutor includes a content authoring tool that prompts content developers to create accessible learning materials. Such prompts encourage authors to add a text alternatives if they forget to include one when adding an image, for instance. The authoring tool also includes a Web service that evaluates the accessibility of authored content against various international

standards. In addition to creating accessible content, the tool is itself accessible, allowing a blind user to create content themselves. (More information can be found in reference [28]).

### **ATutor's Features**

The most popular features for the ATutor users (learners and instructors) are presented below.

#### **Learners**

**Accessibility:** ATutor was designed with accessibility as a priority. A wide range of features ensure that assistive technology users can participate fully in learner, instructor, and administrative activities. ATutor's themes are available for added accessibility. ATutor conforms with international accessibility standards and it allows learners to configure the environment and content to their specific needs.

**Social Networking:** All ATutor users can develop a network of contacts, create and join interest groups, setup a network profile, and link any of the thousands of remote gadget applications into their networking environment. Photos can be shared across courses, or through the social networking area.

**Things Current:** When a student or instructor logs into My Start Page, a list of all current information is presented, providing quick access to ongoing activity in their courses.

**Security:** Login passwords are encrypted. Forgotten passwords must be reset, rather than retrieved by email, removing the possibility they might be intercepted when being sent over the Internet.

**My Courses:** Instructors and students can manage the ATutor courses they teach and/or are registered in. When students register, they are automatically logged into My Courses.

**Inbox/Messaging:** All users on an ATutor system have an Inbox, through which they can send and receive private messages from other users. Messages that have been sent are saved to Sent Messages, where they remain for a certain period before being deleted. Messages can be exported and saved externally.





**Student Profile:** Students can add personal information about themselves for others to see, and include a profile picture, which is also displayed with forum posts. The photo gallery can be used to create a profile album, where a collection of profile pictures can be stored.

**Adaptive Navigation:** Learners can move through ATutor content using global, hierarchical or sequential navigation tools. Navigation elements can be hidden to simplify the environment.

**Work Groups:** Learners can collaborate with others on course projects, communicate as a group through the forums, share resources using the File Storage service, and work together authoring project documents. Exercises or assignments can be submitted to a group leader or course instructor.

**File Storage:** All users on an ATutor system have their own file storage service. File storage areas can also be shared across groups or an entire course. Version control can be enabled to keep track of drafts or changes to documents.

**Group Blogs:** Each group has access to their own blog, to which they can post public messages, available to all course members or private messages available only to group members and instructors.

**Feedback:** Following an action (such as saving preference settings or posting a message), feedback is given on the status of the operation. This could be a success message, warnings to consider or errors to fix.

**Preference Settings:** Students can control visual display settings, content adaptation settings, navigation controls and learning tools settings. The Preference Wizard is available from anywhere in ATutor, to make quick adjustments to preference settings.

**Communication Tools:** Learners can communicate with others through their Inbox using ATutor's private mail, through the discussion forums, the chat rooms, or the "User's Online" tool. Messages can be sorted in a variety of ways. Students can communicate with students in other courses through shared forum or a community forum, or through networking contacts or



groups. By subscribing to forums or topic threads, students can have messages sent by email. Students can edit their forum posts for a specified number of minutes and can search through messages in the current course, the registered courses or all the available courses.

**Content Package Viewer:** Standard Content Packages can be exported from ATutor to be viewed offline in the accompanying viewer.

**Content Tracker:** Learners can keep track of the content pages they have visited.

**Test Manager:** Learners can take tests, review test results, and keep track of their scores.

- **Course Guests** can take practice tests. Students can return to a test previously started but not completed, and begin where they left off.

**Glossary:** Words and phrases added to the glossary by the instructor can be accessed from terms embedded within content pages or viewed alphabetically in their entirety through the Glossary tool.

**Links Database:** Web-based information can be added as links in the ATutor database. Both students and instructors can add links. Instructors can manage course links and students can manage group links.

**Course Search:** A search engine allows learners to search course content and search for courses in the course catalogue.

**AContent Repository Search:** Learners can search the AContent learning objects repository for content related to the topics they are studying, and download content packages to view offline.

## Instructors

**Social Networking:** Instructors have the same networking features that learners have. They can turn on social networking within courses and create course networking groups to enhance class interaction.



**Instructor ATutor Handbook:** A link to the ATutor Instructor documentation is provided in every section. A link to the full Handbook is available on every screen. The handbook can also be searched or browsed. If enabled, instructors can add their own notes to the handbook.

**Guest Access to Courses:** Guests can access private courses through a guest URL, sent to them by a course instructor. Guests can view but not modify courses.

**Course Tool Preferences:** Instructors can choose from the available course tools and menu modules, and configure them for each particular course. They can optionally display tools in the main navigation bar or link them into the course home page for quick access. Tools can be located on the course home page or moved to a separate Student Tools page. Instructors can drag-and-drop course tools to arrange their order.

**Course Manage Page:** All ATutor tools can be accessed quickly under Manage tab.

**Content Usage:** Individual usage statistics are provided to identify issues with the content coverage and the learning progress of each student.

**Work Groups Manager:** Instructors can manually create or automatically generate work groups for a variety of purposes. Groups might be used to provide a private area where students can work, to create an assignment submission area, or to assign a test to specific students.

**File Storage:** In addition to the File Manager, which contains files associated with ATutor content pages, the File Storage service can be used as a place to collect assignment submissions, or to store private files, or share files with course or group members.

**Assignment Drop Box:** Extending the File Storage, instructors can create file folders for collecting assignment submissions, collected from all course members, from group members, or from individuals. A collection of assignments can be zipped together and downloaded. Comments can be made on each submitted assignment for review by the submitter.



**Content Editor:** Instructors can create content in HTML or plain text. This content can be imported from a local editor, or edited directly online. Release dates can be set to control when content is viewable to learners. Content pages can be rearranged within a course. Related pages can be linked to content as references or relevant information. Content authors can include scripts and style sheets to control the functionality and appearance of content. Tests can be associated with content for quick access to a test after completing a learning unit. Tests can also be setup as prerequisites, so students must pass a test before accessing new content.

- **Visual Editor:** A JavaScript based WYSIWYG editor is available as an extension of the Content Editor so that content creators can format course materials without knowing any HTML.

**Accessibility Checker:** The AChecker web service has been integrated into the Content Editor to allow authors to review the accessibility of their content to people with disabilities who may be accessing ATutor using assistive technology. A variety of standards are available for an international audience. AChecker automatically identifies known accessibility problems and allows authors to make decisions on potential problems that AChecker cannot identify. Accessibility reports are saved in the AChecker database and allow continuous monitoring of accessibility as content evolves.

**Interoperable Content:** Instructors can export content from ATutor as IMS/SCORM compatible Content Packages that can be viewed offline in the accompanying viewer, or imported into ATutor or another compatible e-learning system. Entire courses or individual course units can be packaged for viewing or redistribution. Content from other compliant systems can be imported into ATutor.

**Reading List:** Instructors can gather a list of resources (books, papers, urls etc.) related to topics in a course and create a Reading List based on those resources.



**AContent Learning Objects Repository:** Instructors can search the AContent repository for course related materials. They can download compatible content packages from the repository for viewing, or to import into a course. They can also export content from ATutor into the repository, or export content from ATutor or from the repository to be used in other learning environments.

**Backup Manager:** The entire content and structure of a course can be backed up and stored on the ATutor server or downloaded and saved to the user's local computer for safe keeping.

**News & Announcements:** Instructors can post messages to the course Home Page to guide learners through the course. News can be used for weekly introductions, announcing important dates, or posting critical information. The announcements page is always the first page a learner visits when they log into a course. An RSS feed can be started in order to display course announcements on other Web sites, or through news feed compilers.

**File Manager:** Instructors can upload and manage course related files. Directories can be created to sort files, and zip archives can be uploaded and unpacked. Course files can be easily linked into content pages as they are being created. Text or HTML files can be created or edited online.

**Test Manager:** Instructors can create tests with multiple choice, multiple answer, true/false, ordering, matching, drag and drop, and a number of open ended question types. Multiple choice, multiple answer, ordering, matching, and true/false questions are marked automatically. A test release window can be set to make a test available for a certain period, feedback can be customized, and test results can be archived. Self-marking tests can be created to provide students with instant feedback. A test property can be set to allow guests to take tests. Test questions can be presented all on a single page, or one at a time.

**Polls:** Instructors can create question polls to quickly gather student opinions.

**FAQs:** Instructors can create a collection of Frequently Asked Questions to provide additional documentation for students.



**Forums:** Instructors can create and manage multiple forums for each of their courses. Messages can be edited, deleted, locked from reading and/or replying, and "stuck" to the top of a thread list if a message is important. Administrators can create forums shared across multiple courses. Students can subscribe to forums or to topic threads so as to have messages sent by email. Instructors can set a time limit for editing forum posts, so messages can be corrected if errors are made in the original post. Past forum discussions can be archived.

**Course Email:** Instructors can send bulk email to course members, assistants, or both. Indexes can be inserted so that messages can be customized for each individual user.

**Course Properties:** A default display language can be set for each course. Instructors can assign a course as public, protected, or private, or hide a course while it is being developed. Instructors control student access to content packaging and they can start an RSS feed for course announcements, and display them on other Web sites. They set the start and finish dates for a course, during which it is available to students. A custom course icon can be uploaded as a visual representation of the course. The course directory name can be customized to extend Pretty URLs (described for Administrators) creating a unique URL for each course.

**Enrolment Manager:** Instructors may import a comma separated list of students to enroll in their courses, or export an enrolment list for staff keeping or to import into other systems. They have to create an enrolment list online when they need to add new students to a course. Then, they automatically generate login names and passwords for students and send them by email when a student is registered in a course. They can also assign students as Alumni so that they can participate in discussions for future course sessions.

**Privileges:** Through the Enrolment Manager, instructors can assign course members access to various instructor tools, creating teaching assistants or co-instructors.



Addon Modules: Google Search, RSS Feeds, EWiki, SCORM Player, ACollab, ATalker Text-to-Speech, Payments, Certificates, Open Meeting and Adobe Connect, and many other modules are each available with a quick installer to extend the functionality of ATutor.

Figure 1 ATutor \_ My Start Page-Course Home

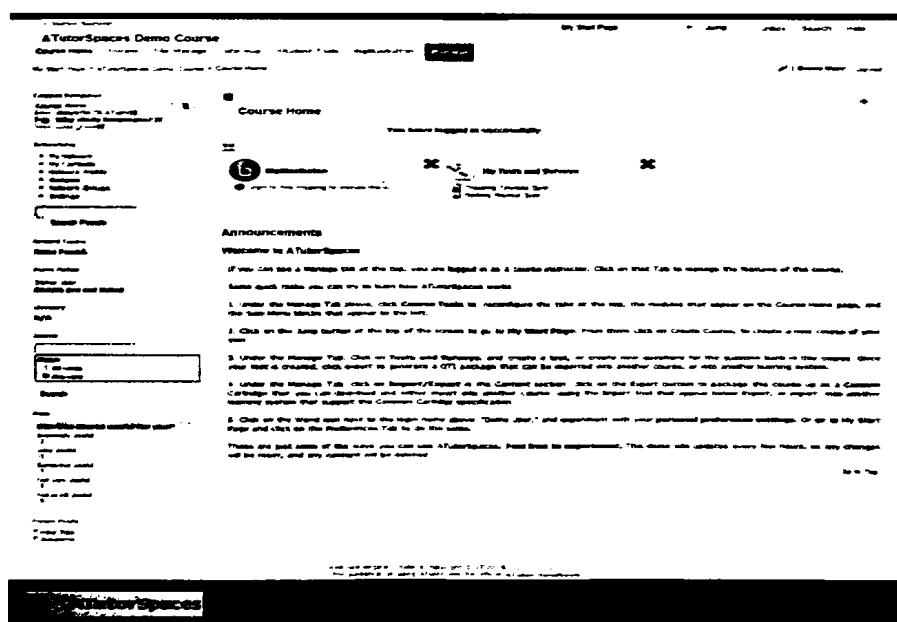


Figure 2 ATutor \_ Forums

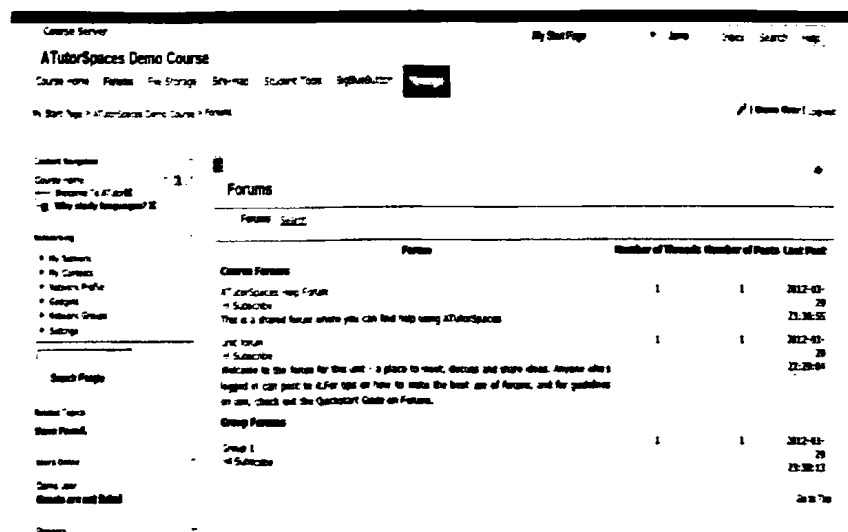


Figure 3 ATutor \_ Inbox

Course Server My Start Page Jump

**ATutorSpaces Demo Course** Inbox Search Help

Course Home Forums File Storage Site-map Student Tools BigBlueButton **Messages**

My Start Page > ATutorSpaces Demo Course > Inbox Demo User | Log-out

Content Navigation

Course Home

- Welcome To ATutor!
- Why study languages? X

Networking

- My Network
- My Contacts
- Network Profile
- Gadgets
- Network Groups
- Settings

### Inbox

[Inbox](#) [Sent Messages](#) [Send Message](#) [Export](#)

| From        | Subject | Date |
|-------------|---------|------|
| None Found. |         |      |

[Delete](#)

[Go to Top](#)

Figure 4 ATutor \_ My Tests and Surveys

Course Server My Start Page Jump

**ATutorSpaces Demo Course** Inbox Search Help

Course Home Forums File Storage Site-map Student Tools BigBlueButton **Messages**

My Start Page > ATutorSpaces Demo Course > My Tests and Surveys Demo User | Log-out

Content Navigation

Course Home

- Welcome To ATutor!
- Why study languages? X

Networking

- My Network
- My Contacts
- Network Profile
- Gadgets
- Network Groups
- Settings

### My Tests and Surveys

| Title                 | Status    | Start Date       | End Date         | Attempts    |
|-----------------------|-----------|------------------|------------------|-------------|
| Creating Courses Quiz | On Going! | 2012-03-28 00:00 | 2015-03-30 00:00 | 1/Unlimited |
| Getting Started Quiz  | On Going! | 2012-03-28 00:00 | 2015-03-28 00:00 | 0/Unlimited |

### Your Submissions

| Title                 | Date Taken       | Time Spent | Mark       | Submission     |
|-----------------------|------------------|------------|------------|----------------|
| Creating Courses Quiz | 2012-03-14 13:08 | In 54s     | Unreleased | No Results Yet |

[Go to Top](#)





Figure 5 ATutor \_ Student Tools

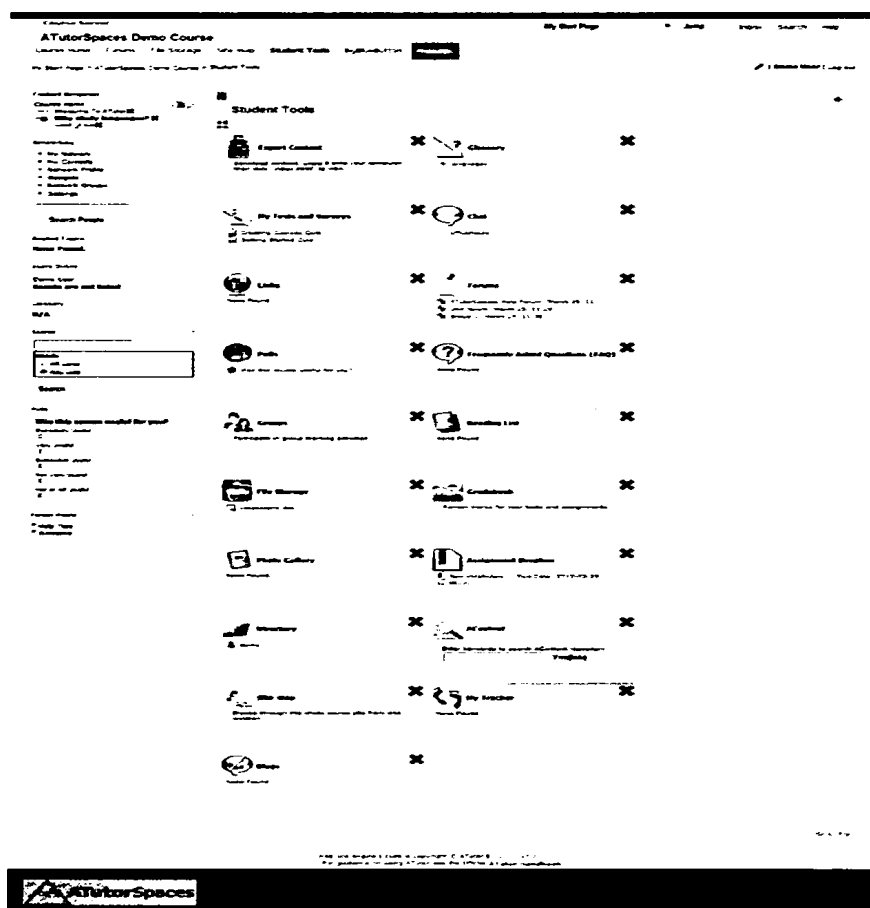
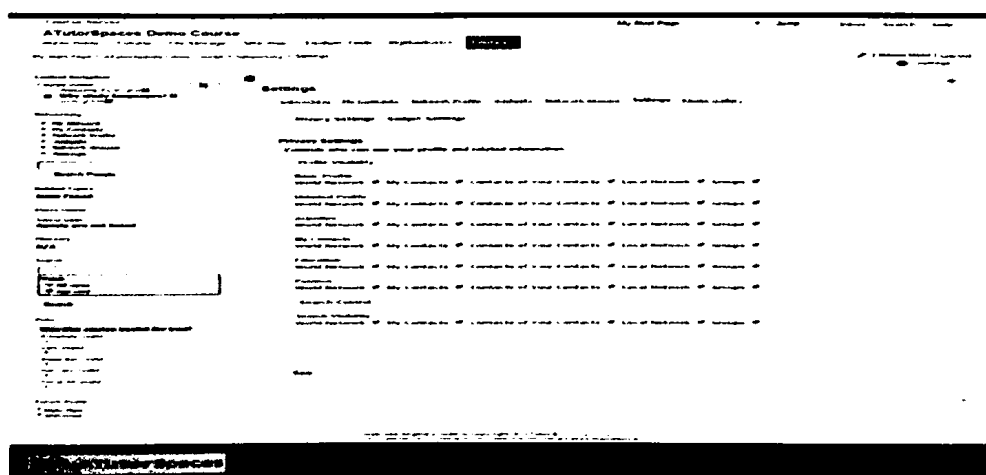


Figure 6 ATutor \_ Settings



### 5.3. Dokeos

Dokeos is a platform for distance learning, intuitive and easy to use mainly by instructors and learners. Dokeos allows instructors to focus on creating scenarios and content by freeing them of any technical aspect. It also provides collaborative tools: video conference, forums, blogs, and wiki e.t.c. Dokeos supports many different kinds of learning and collaboration activities. Teachers can create, manage and publish their courses through the web. Students can follow courses, read content or participate actively through groups, forums, chat. (More information can be found in reference [29]).

- Dokeos includes four main components: AUTHOR to build e-learning content, LMS to handle interaction with learners, SHOP to sell a course catalog, and EVALUATE for assessment and certification.

It offers tools for producing online content such as:

- media box (where one can put texts, pictures and playlists)
- rapid content creation with or without templates
- quiz creation
- link insertion
- glossary creation
- conversion of presentations into modules

#### Dokeos' Features

Dokeos is characterized for its simplicity and usability. It also offers to users the following features.

**Reporting:** Teachers can track time, progress and scores of students' learning and can also print their certificates.

**Authoring:** Dokeos' templates facilitate online authoring and rapid learning.

**SCORM:** Users can import third party content and certify reporting.



**SOCIAL:** Teachers are prompted to enhance students learn from each other and to organize video conferences.

**Mind maps:** Visual learning can be built without graphical expertise and mind maps can be imported. A mind map is a diagram used to visually outline information. It is often created around a single word or text, placed in the center, to which associated ideas, words and concepts are added.

**Documents:** The files that are supported are: Word, PDF, Powerpoint, Flash and there is also a Virtual library.

**Scenarios:** Teachers have the ability to structure learning by chapters, weeks or activities and build case studies.

**Quizzes:** There are 29 templates of online learning activities and Medical imaging delineation.

**Podcasts:** Users can publish images, audio and video for mobile learning and record their voice online. These files can be downloaded through web syndication or can be streamed online to a computer or mobile device.

**Personalized modules:** Teachers can create online personalized training courses that are responsive, powerful and offer total control.

**Assessment:** Teachers can follow the progress of their course participants and assess their skills using questionnaires or scenarios and then see the results in detail using the integrated reporting tool.

**Content integration:** A user can easily re-use his own training materials by importing content from his computer to integrate into their training modules.



**Flexibility:** The user can connect to Dokeos on all devices (computer, tablet or Smartphone) from anywhere at any time.

Figure 7 Dokeos \_ Customize the Course Home

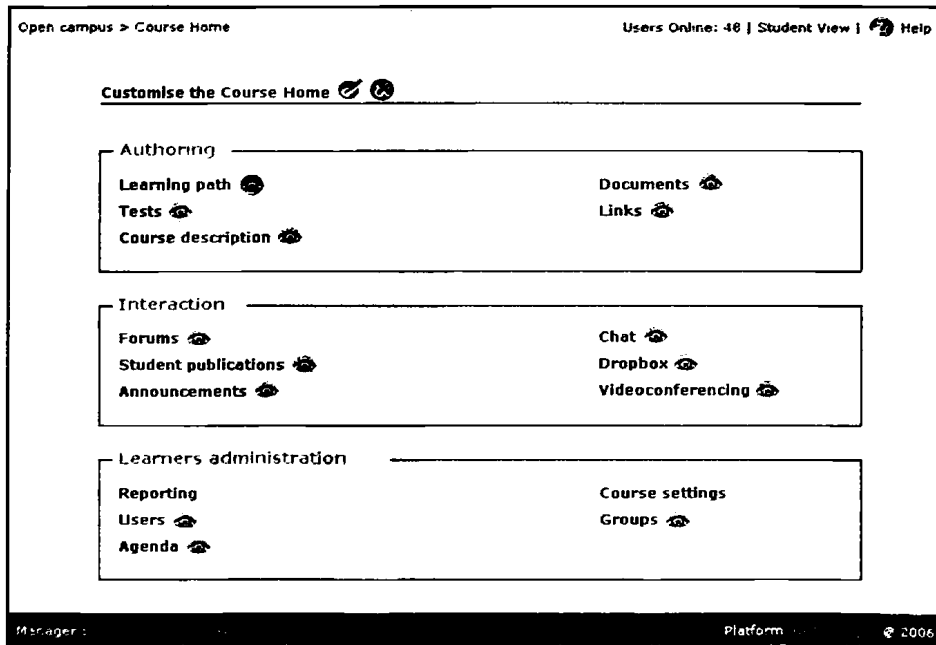


Figure 8 Dokeos \_ Learning Path

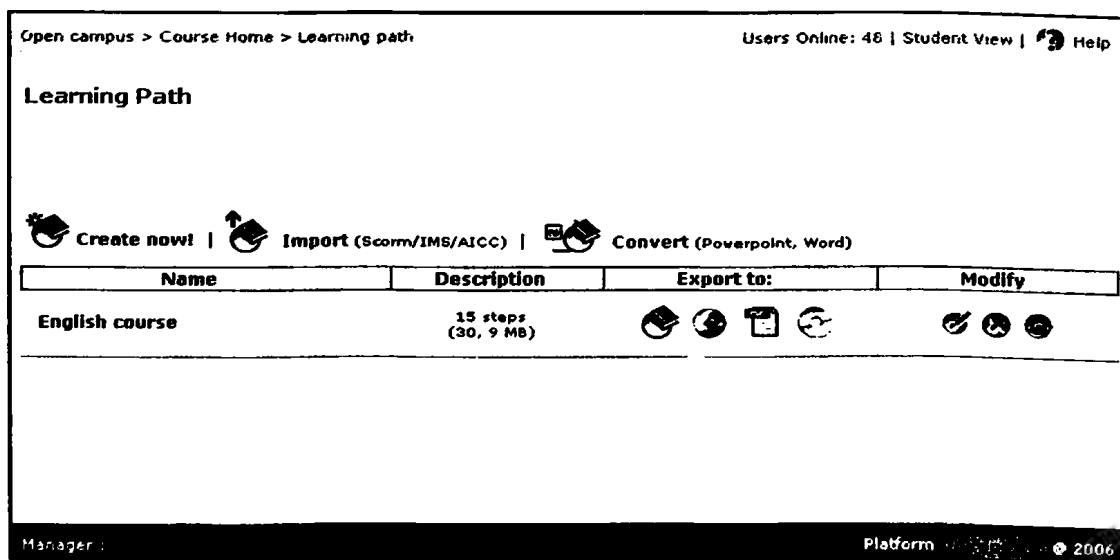


Figure 9 Dokeos \_ My Courses

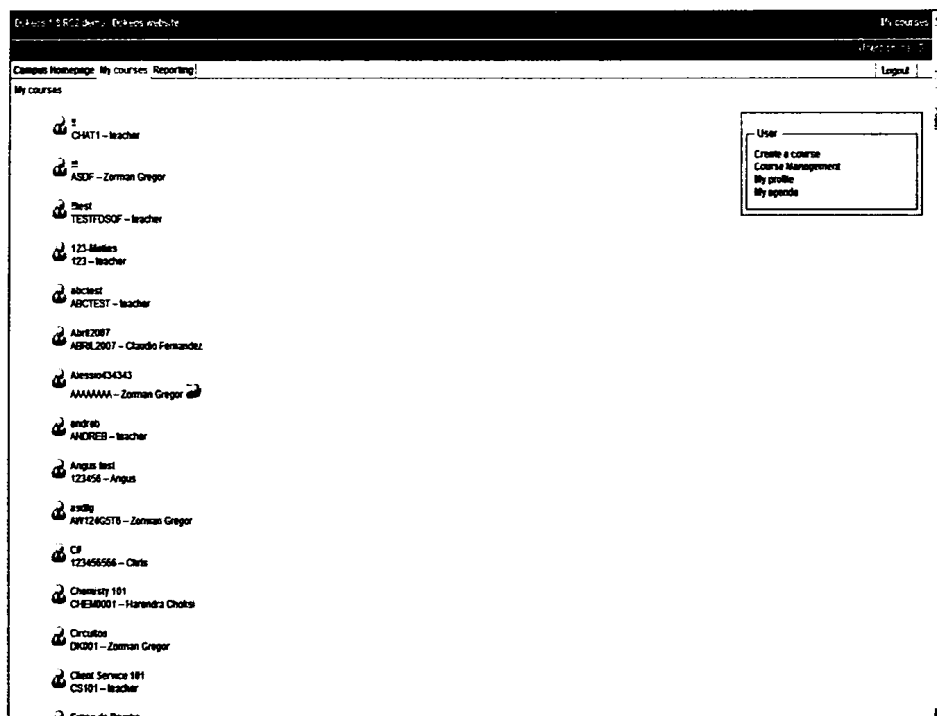


Figure 10 Dokeos \_ My Portal

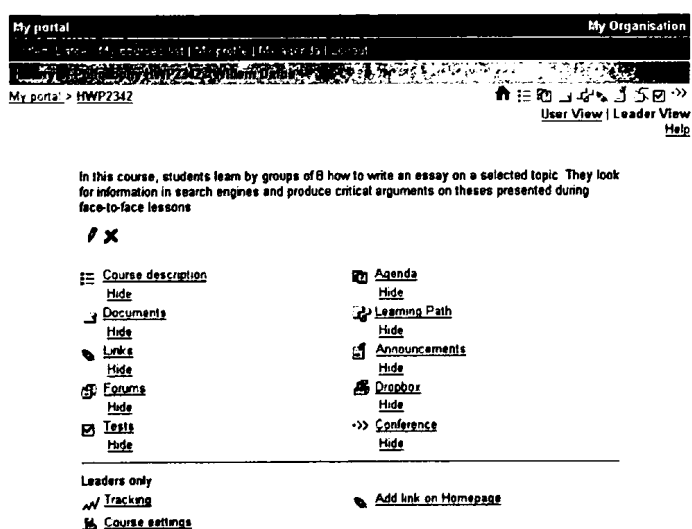
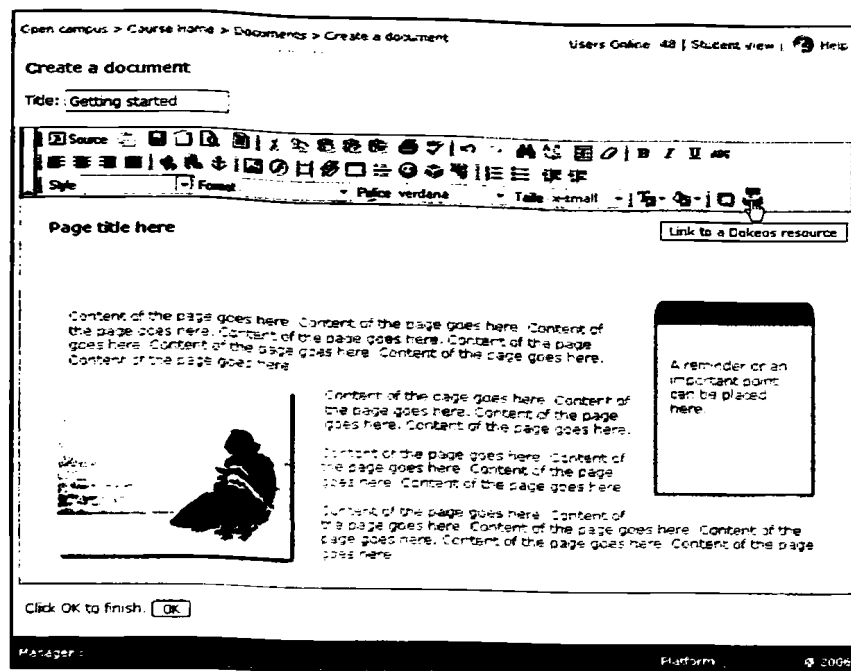


Figure 11 Dokeos \_ Create My Document



#### 5.4. dotLRN

.LRN is a global community of educators, designers, and software developers who partner together to drive educational innovation. As this software is open source, organizations can invest in people and curriculum development instead of expensive licensing and support fees. .LRN is backed by the .LRN Consortium, a non-profit organization committed to advancing innovation in educational technology through open source principles. Consortium member institutions work together to support each other's deployments and to accelerate and expand the adoption and development of .LRN. (More information can be found in reference [30]).

.LRN is a full-featured application for rapidly developing web-based learning communities.

.LRN comes with the following applications:

- EditThisPage
- Gradebook/ Evaluation
- FAQs
- FileStorage



- News
- Calendar
- Assessments
- Survey
- Syllabus
- Weblogger
- Slide presentations
- Homework Dropbox
- Curriculum
- E-mail/ Bulk e-mail

.LRN also offers the following functions:

- Personalization: Personalized portal page, appointments, tasks, learning statistics, learning progress, Notes, Bookmarks, File Storage
- Course contents: E-Books/E-Scripts, glossary, learning progress monitoring, interactive sample exams, downloads
- Course Management: syllabus, Latest Announcements, schedule management, FAQ
- Communication: discussion forums, feedback on teaching content
- Teaching Support: Homework management, gradebook, problem-based learning

### **dotLRN's Features**

**Customization:** Instructors can administer "classes" or "communities", customizing the layout, choosing the language, and setting the time zone for their class, as well as adding custom portlets if desired.

**Class Management:** Classes and Communities can be created by administrators who can select whether the policy to join them is closed, open or requires approval.

**Roles:** Different roles are supported for .LRN Classes, such as students, professors and administrative staff. Different roles are supported for .LRN Communities, such as administrators and members.



**Personalization:** Individual users can personalize their own personal portal layout, customizing the layout, choosing their preferred language and changing their current time zone as required (useful for users who travel and want to keep their schedule to date).

**Internationalization:** .LRN has been internationalized to support multiple languages, dialects and time zones. Languages are constantly being added. If a language is not offered, users can add it themselves using a simple online distributed translation interface built into .LRN.

## 5.5. ILIAS

ILIAS is an open source web-based learning management system (LMS). It supports learning content management and tools for collaboration, communication, evaluation and assessment. The software is published under the GNU General Public License and can be run on any server that supports PHP and MySQL.

A general characteristic of ILIAS is the concept of Personal Desktop and Repository. While the Repository contains all content, courses and other materials structured in categories and described by metadata, the Personal Desktop is the individual workspace of each learner, author, tutor and administrator. (More information can be found in reference [31]).

### ILIAS' Features

**Personal Desktop:** The Personal Desktop contains selected items from the repository (e.g. currently visited courses or an interesting forum) as well as certain tools like mail, tagging, and personal blogs. From the Personal Desktop a user has access to the Personal Profile with the settings of each user and to the personal Learning Progress too.

**Listing of selected courses, groups and learning resources**

- Forums and Blogs
- Calendar and time scheduler





- Administration of the personal profile, for instance the language setting or public profile
- Administration of the personal bookmarks for internal and external links
- "Who-is-online?"-feature including invitation to the chat
- New and unread internal mails, for example course mails or system messages
- Overview and administration of personal notes (Desktop and all content items of the repository)
- Overview for monitoring of the personal learning progress
- Push-feature for the contents (tutor can place all contents on the Personal Desktop of the users)
- e-Portfolio
- Personal Workspace
- External Web Feeds
- Internal News

**Learning Content Management:** All learning content but also forums or chat rooms, tests and surveys, as well as plugged in virtual classrooms or other external tools, are created, offered and administrated in the repository and its categories. Therefore it is not necessary to develop courses for offering learning content. ILIAS could also be used like a kind of knowledge base or website.

ILIAS offers four kinds of container for delivering content: Categories, Courses including member administration, Groups including member administration, Folders (within courses and groups). Container objects can be extended by using the page editor for adding text, images or videos to the page. All content objects are handled as references. They can be moved, copied or linked into other sections of the repository. A file that has already been uploaded can be linked multiple times in different courses and categories without being uploaded a second time.

**Course Management:** ILIAS allows effective creation of courses and course materials. It offers tools and templates for the learning and working process including integrated navigation and administration. It also offers a comprehensive and flexible course management



to create a choice of e-Learning courses. The close functional connection of the course management with test and assessment, allows the individual check-up of previous knowledge and accomplished learning target of the course members. The tool "tracking of learning progress" supports the course tutor in helping the course members. Different entrance rules, current times, registration settings, course news and (Google) map are supported.

**Cooperation:** Groups in ILIAS allow cooperative learning and working on the platform without additional tools. Learning groups, working groups or groups for certain fields of interest could be created. Groups can use all ILIAS tools like wiki, forums or file sharing. Users can create groups that are open for everyone or have specially defined access restrictions, for example access with a password.

Cooperation between users in ILIAS is achieved by the following:

- Group Management
- Awareness feature (who is online)
- vCard Export (file format with individual information that can be exchanged electronically)
- File Sharing
- Wiki

**Communication:** ILIAS supports standard ways of communication as chats, forums and mails. The personal desktop includes an awareness function, that shows users, that are currently online. ILIAS also sends information via RSS to the user and displays external RSS feeds in the system. In particular:

- Internal news system for all users
- ILIAS supports the delivery of internal mails to internal and/or external e-mail addresses as well
- News to groups
- Discussion forums with different modes of presentation ("Who answered last?" / "Who answered whose questions?")
- Notice of new articles in forums by email



- File attachment to articles in discussions
- Invitation to the chat by the "Who-is-online?"-mode
- Podcasting
- Edupad / Etherpad plugin (a web-based collaborative real-time editor, allowing authors to simultaneously edit a text document, and see all of the participants' edits in real-time)

**Test and Assessment:** ILIAS offers an integrated environment for the creation and enforcement of tests & assessments. This can be used for the monitoring of learning progress by the users as well as the tutors and examiners. ILIAS Test and Assessment supports multiple choice, single choice, allocation questions, cloze questions (free text, select box), ordering, matching, and more question types. The exams can be online. There are also question pools for re-using questions in different tests as well as randomization of questions and choices.

**Portfolio:** With ILIAS users do not need to connect an additional portfolio management system to their learning management system. They can use the integrated portfolio features that are coming out of the box: multiple portfolios for each user depending on the target group, integrated page editor to create portfolio pages, easy embedding of personal blogs and user information, presentation of own artifacts and certificates.

**Online Surveys:** In ILIAS users can use surveys to easily collect information from a large number of users, for example to evaluate courses or other events. ILIAS surveys are easy to create and administer, even for non-experienced users. With a sufficient basis of survey questions, teachers could create their own evaluations fast and efficient.





## 5.6. LON-CAPA

LON-CAPA (Learning Online Network with Computer-Assisted Personalized Approach) is an e-learning platform which possesses the standard features of many learning platforms (user roles, calendar, e-mail, chat rooms, blogs, resource construction, test grading, etc.). The difference between traditional e-learning platforms is that the web servers can communicate with each other. LON-CAPA is an integrated system for online learning and assessment. It consists of a learning content authoring and management system, allowing new and existing content to be used flexibly, a course management system, an individualized homework and automatic grading system, data collection and data mining system, and a content delivery system.

The LON-CAPA software provides instructors with a common, scalable platform to assist in all aspects of teaching a course, from lecture preparation to administration of homework assignments and exams. It allows instructors to create educational materials and to share such learning resources with colleagues across institutions in a simple and efficient manner. It provides an extremely sophisticated assignment engine that can create unique homework assignments and examinations for each student in a class. Its formative and summative assessment tools grade a wide variety of objective problems and assist in the evaluation of essays.

LON-CAPA provides prompt feedback for students and instructors, as well as statistical information on performance and on effectiveness of materials. Discussion pages attached to every homework assignment encourage communication among students and faculty. (More information can be found in reference [32]).

### LON-CAPA's Features

**Remote Control:** LON-CAPA also offers a Remote Control menu. The Remote Control is a separate pop-up browser window, and is automatically sized and placed in the upper left of the screen.

**Language and Time Localization:** This panel lets you adapt the language and date format of your course.



**Feedback Messages:** LON-CAPA allows users to send messages to course staff via the Send Feedback link at the bottom of most content pages in a course. This requires recipient(s) to have been set for those messages.

**Critical Messages:** A “Critical Message” is a message that will appear immediately after the recipient user logs in. The user must acknowledge receipt to continue; it is not possible to use the rest of LON-CAPA until they do so. Only Course Coordinators and/or Instructors can send Critical Messages.

- **Discussion and chat:** This panel lets users control who gets to participate in discussions and the chatroom. Participation can be role-based and/or set for specific course users. It can also be controlled if users can edit or delete their own postings.

**Drop Box:** A dropbox is used for students to upload files for grading.

**Course calendar:** Students can see the upcoming events of a course.

**Group Portfolio:** Group Portfolio adds a page with information about files located in file repositories within course groups. Which files are listed as viewable will depend on the types of access controls set for individual files, and the identity of the person viewing the Group Portfolio page.

**Syllabus:** It adds a syllabus to a course. By default this will be a traditional syllabus template page, which can be filled out with standard syllabus information.

**Homework, tests and exams:** Tutors can assign homework to students as well as tests and exams.

**Chart Student Progress:** The chart is designed to give you quick access to your students performance data. It has many output options and output formats.



**Grades and Submissions:** LON-CAPA automatically grades all online homework problems by default. However, the Instructor and Course Coordinator both have permission to override the computer scores and submit their own grades.

**Portfolio:** The portfolio allows users to store and retrieve files on the LON-CAPA server. There are two main purposes of using a portfolio: (a) to upload documents that could then be submitted in response to an essay/drop box/task, and (b) to upload documents. Files stored in users' portfolio can only be accessed by themselves, unless they set access controls for them which allow other users to view them. By storing files in the portfolio space of LON-CAPA users can access these files from any computer with an internet/web connection.

Figure 14 LON-CAPA \_ Main Menu Page

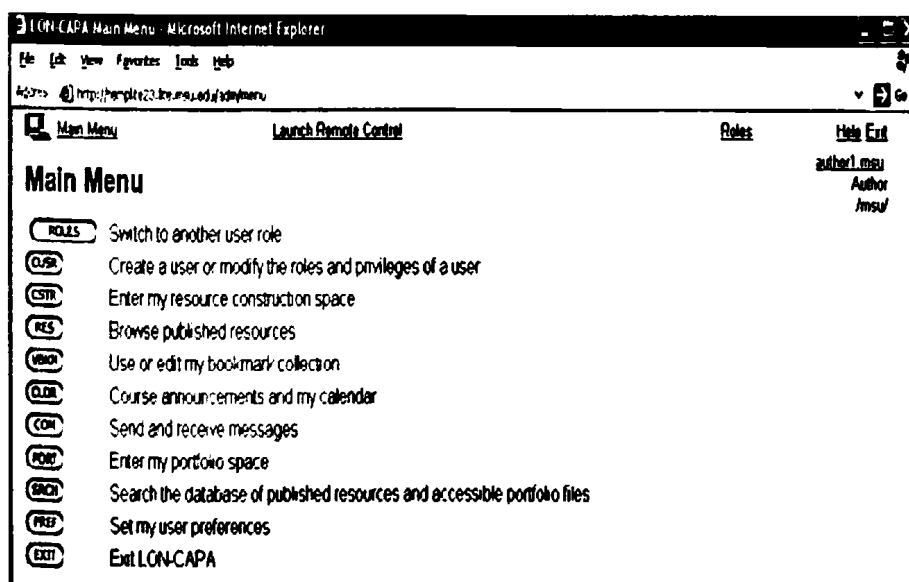


Figure 15 LON-CAPA \_ Course Documents

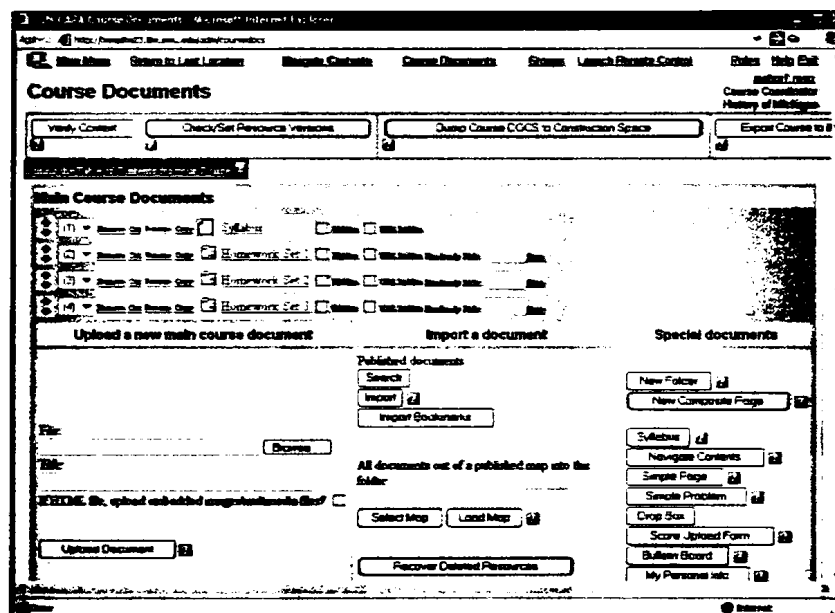


Figure 16 LON-CAPA \_ Browse Resources

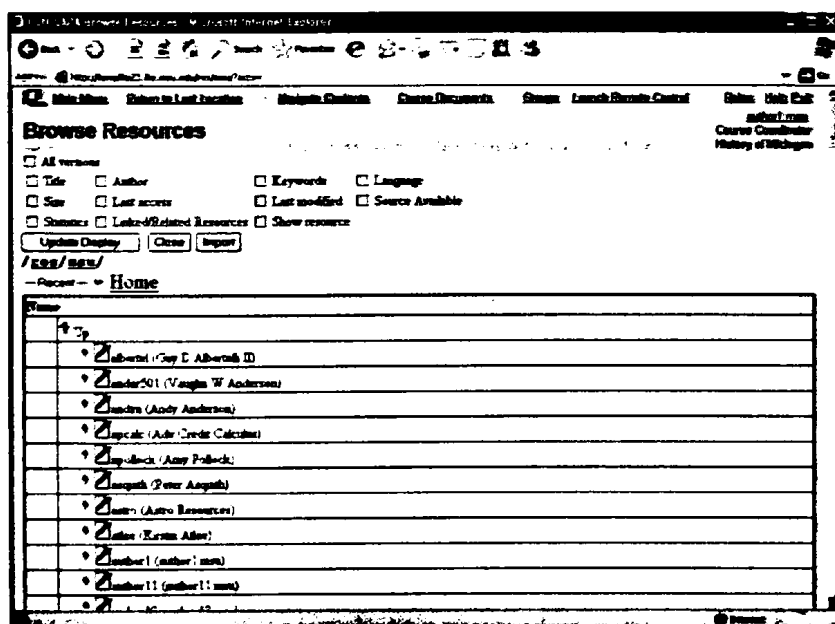
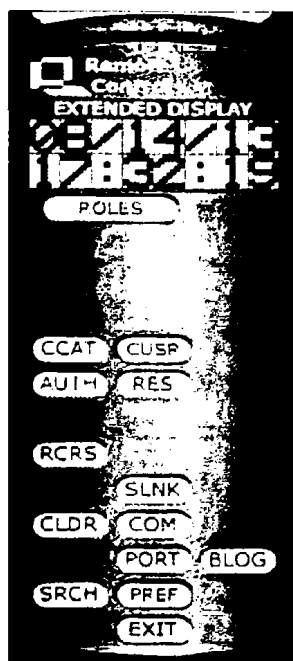




Figure 17 LON-CAPA \_ Remote Control



### 5.7. Moodle

Moodle (acronym for Modular Object-Oriented Dynamic Learning Environment) is a free software e-learning platform, also known as a Learning Management System, or Virtual Learning Environment. Moodle has several features considered typical of an e-learning platform, plus some original innovations (like its filtering system). Moodle is very similar to a learning management system and can be used in many types of environments such as in education, training and development, and business settings.

Users can install Moodle from source, but this requires more technical proficiency. The philosophy of Moodle emphasizes that learners, and not just teachers, contribute to the educational experience. Moodle has also import features for use with other specific systems and it runs without modification on any system that support PHP and a database. Moodle users can use PHP to write and contribute new modules. (More information can be found in references [5] and [33]).



## **Moodle's Features**

**Assignments:** Students submit their assignments and teachers are enabled to grade and give comments on the uploaded files and assignments created on and off line.

**Discussion forum:** Participants are allowed to have asynchronous discussions. The forum module is an activity where students and teachers can exchange ideas by posting comments. Forum posts can be graded by the teacher or other students.

**Files:** Moodle provides an easy way for a teacher to present materials to their students. Most types of files can be uploaded and accessed through Moodle but the student needs to have the correct software to be able to open them or they can simply download them.

**Gradebook:** All the grades for each student in a course are kept in the gradebook.

**Chat:** Participants can have a real-time synchronous discussion. This is a useful way to get a different understanding of each other and the topic being discussed. The Chat module contains a number of features for managing and reviewing chat discussions.

**Online calendar:** Moodle's calendar tool helps users keep track of their academic or company calendar, course events, group meetings, in addition to assignment and quiz deadlines, chat time and other personal events.

**Messaging:** "Messaging" refers both to automatic alerts from Moodle about new forum posts, assignment submission notifications etc, and also to conversations using the instant messaging feature.

**Online quiz:** The Quiz activity module allows the teacher to design and build quizzes consisting of a large variety of question types, including multiple choice, true-false, and short answer questions. These questions are kept in the question bank and can be re-used in different quizzes. Quizzes can be configured to allow multiple attempts. Each attempt at a question is automatically marked, and the teacher can choose whether to give feedback and/or show the correct answers.



**Wiki:** A wiki is a collection of collaboratively authored web documents. Basically, a wiki page is a web page everyone in a class can create together, right in the browser, without needing to know HTML. A wiki starts with one front page. Each author can add other pages to the wiki by simply creating a link to a page that doesn't exist yet.

**Database:** The database activity module allows the teacher and/or students to build, display and search a bank of record entries about any conceivable topic. The format and structure of these entries can be almost unlimited, including images, files, URLs, numbers and text amongst other things.

**External tool:** The external tool enables Moodle users to interact with learning resources and activities on other web sites. For instance, an external tool could provide access to a new activity type or learning materials from a publisher.

**Survey:** The Survey module is a course activity that provides a number of verified survey instruments that teachers can use to gather data from their students that will help them learn about their class and reflect on their own teaching.

**Feedback:** The Feedback module allows users to create and conduct surveys to collect feedback. Unlike the survey tool it allows them to write their own questions, rather than choose from a list of pre-written questions and unlike the quiz tool, they can create non-graded questions. The Feedback activity is ideal for the likes of course or teacher evaluations.

**Glossary:** The glossary allows participants to create and maintain a list of definitions, like a dictionary. A glossary can be a collaborative activity or be restricted to entries made by the teacher. Entries can be put in categories. The auto-linking feature will highlight any word in the course which is located in the glossary.

**Lesson:** The lesson module presents some pages to the student who is usually asked to make some sort of choice underneath the content area. The choice will send them to a specific page in the Lesson.



**Workshop:** Workshop is a peer assessment activity with many options. Students submit their work via an online text tool and attachments. There are two grades for a student: their own work and their peer assessments of other students' work.

**Personalized Dashboard:** My home is a customizable "dashboard" page for providing users with links to their courses and activities within them, such as unread forum posts and upcoming assignments. Users can customize their My home page and add and remove blocks.

Figure 18 Moodle \_ My Home

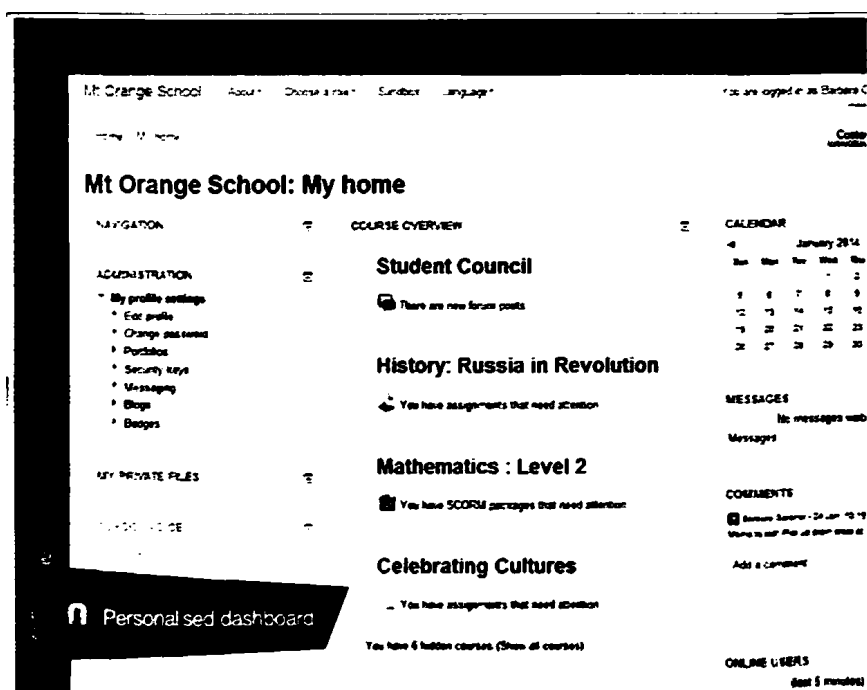


Figure 19 Moodle \_ Assignment

**Wikis and their use in teaching and learning**

For this assignment you need to write a 3,000 word essay on wikis and how they can be used in teaching and learning.

Watch the video below and read this article - Everything you should know about wikis, Educause Learning Initiative.

Wikis in Plain English

**Submission status**

Submission status Nothing has been submitted for this assignment

Grading status Not graded

Due date Saturday, 30 June 2012, 2:20 PM

Time remaining 14 days 23 hours

[Edit my submission](#)

Figure 20 Moodle \_ Forum

**Learning Styles**

Display replies in nested form

**Learning Styles myth**  
by Albert Ensten - Wednesday, 30 October 2013, 2:09 PM  
According to Professor Daniel Willingham, learning styles are a myth. Discuss.

Reply

**Re: Learning Styles myth**  
by Charles Darwin - Wednesday, 30 October 2013, 2:39 PM

I disagree. I am attaching my research paper to prove my point.

LearningStylesResearch.pdf

Show parent | Edit | Delete | Reply



Figure 21 Moodle \_ Glossary

### Revolution Glossary

Please contribute to this glossary by adding key figures of the period.

A. Poster-friendly version

Search  Search full text

**Navigation:** Browse by alphabet | Browse by category | Browse by date | Browse by Author

Browse the glossary using this index:

Special | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | All

---

#### A

**Alexander Kerensky**

Served as the second prime minister in the Provisional Government of 1917, until its overthrow in October. Kerensky's failure to end the war contributed to polarisation and his eventual reliance on the workers to defend him against a right-wing coup in August 1917.

X ●

**April Theses**

A series of instructions issued by Lenin on his return to Russia. Contrary to what the Bolsheviks had planned to do, Lenin argued they should not participate in the Provisional Government and continue to argue for communist policies within the soviets. These separated the Bolsheviks off from every other party at the time.

X ●

Figure 22 Moodle \_ Quiz

### Moodle History Quiz

**QUIZ NAVIGATION**

1 2 3 4 5

6 7

Finish attempt ...

Time left 0:08:38

**Question 1**

Not yet answered

Base mark: 1.00

Flag question

Why is the 20th August an important date? (You may choose more than one answer)

Select one or more

☐ a. It is World Mosquito Day

☒ b. It is the birthday of the founder of Moodle, Martin Douglaimes

☒ c. It is the date of the first official release of Moodle in 2002

Certainty ☒ C=1 (Unsure: <67%) ☐ C=2 (Mid: >67%) ☐ C=3 (Quite sure: >80%)

---

**Question 2**

Not yet answered

Base mark: 1.00

Flag question

Match the cool Moodle features with the version in which they first appeared

Groupings Choose

Repositories Choose

Drag and drop files Choose

Certainty ☒ C=1 (Unsure: <67%) ☐ C=2 (Mid: >67%) ☐ C=3 (Quite sure: >80%)



Figure 23 Moodle \_ Survey

The purpose of this survey is to help us understand how well the online delivery of this unit enabled you to learn. Each one of the 24 statements below asks about your experience in this unit. There are no 'right' or 'wrong' answers, we are interested only in your opinion. Please be assured that your responses will be treated with a high degree of confidentiality, and will not affect your assessment. Your carefully considered responses will help us improve the way this unit is presented online in the future. Thanks very much.

All questions are required and must be answered

#### Relevance

| Responses   | Not yet<br>answered   | Almost<br>never       | Seldom                | Sometimes             | Often                 | Almost<br>always      |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| In this online unit                                       |                       |                       |                       |                       |                       |                       |
| 1 my learning focuses on issues that interest me.         | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2 what I learn is important for my professional practice. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3 I learn how to improve my professional practice.        | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Figure 24 Moodle \_ Calendar

Mt Orange School About Choose a role Sandbox Language You

Home Site pages Calendar January 2014

### Mount Orange School

Detailed month view All courses

4 December 2013 **January 2014** February 2014

**January 2014**

| Sun | Mon | Tue | Wed            | Thu | Fri | Sat |
|-----|-----|-----|----------------|-----|-----|-----|
|     |     |     | 1              | 2   | 3   | 4   |
|     |     |     | Happy New Year |     |     |     |
| 5   | 6   | 7   | 8              | 9   | 10  | 11  |
|     |     |     | 15             | 16  | 17  | 18  |
|     |     |     | Tutor meeting  |     |     |     |
| 19  | 20  | 21  | 22             | 23  | 24  | 25  |
|     |     |     |                |     |     | 26  |
|     |     |     |                |     |     | 27  |
|     |     |     |                |     |     | 28  |
|     |     |     |                |     |     | 29  |
|     |     |     |                |     |     | 30  |
|     |     |     |                |     |     | 31  |

**EVENTS KEY**

- Hide global events
- Hide course events
- Hide group events
- Hide user events

**MONTHLY VIEW**

**DECEMBER 2013**

| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
|-----|-----|-----|-----|-----|-----|-----|
| 1   | 2   | 3   | 4   | 5   | 6   | 7   |
| 8   | 9   | 10  | 11  | 12  | 13  | 14  |
| 15  | 16  | 17  | 18  | 19  | 20  | 21  |
| 22  | 23  | 24  | 25  | 26  | 27  | 28  |
| 29  | 30  | 31  |     |     |     |     |

**JANUARY 2014**

| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
|-----|-----|-----|-----|-----|-----|-----|
|     |     |     | 1   | 2   | 3   | 4   |
| 5   | 6   | 7   | 8   | 9   | 10  | 11  |

AI in-one Calendar

### 5.8. OpenACS

The Open Architecture Community System (OpenACS) is an open-source web application framework. OpenACS is the foundation for many PRODUCTS AND WEBSITES, including the .LRN e-learning platform. (More information can be found in reference [34]).

The Open Architecture Community System provides:

- A set of applications that can be used to deploy web sites that are strong on collaboration. Some of the applications are Workflow, CMS, and Messaging, Bug/Issue tracker, e-commerce, blogger, chat and forums.
- A sophisticated application development toolkit that provides an extensive set of APIs and services to enable quick development of new applications. Features include sophisticated permissioning, full internationalization, Ajax, form builder, object model, automated testing, subsites and a powerful package manager.

#### OpenACS Features

**Workflow:** This package lets you define the process that your articles, documents, reports, change requests, or any other object of interest, must go through to ensure consistent quality.

**Webmail:** Provides a web-based email service and uses the database for message storage.

**Vocabulary:** Multilingual lists of vocabulary words plus training tools. Users can import or/and export words.

**Photobook:** Users can enter, manage, and present their data appropriate for generation of a "facebook" or general user profile. It also allows upload of a photo portrait as well as general education/work history.

**Photo Album:** Photo album allows users to upload photos, store and edit attributes, and group photos into albums and folders.

**Glossary:** Glossaries for multiple contexts are supported. A site, subsite, group, user, or even a document may have one or more glossaries associated with it. Terms may have illustrations.





**Events:** Event registration and management such as a lectures or a social gathering online.

**Evaluation:** It allows the professors to assign tasks to the students and grade them, and to the students to upload their answers and see their grades.

**Bulk mail:** An API is provided for sending messages to a collection of users. Mails can be personalized and can be scheduled for a later date.

**Bug Tracker:** There is a bug tracking application with notifications, configurable state management, and patch upload.

**Bookshelf:** Store commentary on books with an interface to amazon to retrieve thumbnails and other book data.

**Address-book:** Address Book provides a storage mechanism for contact information and associating it with other objects. Each contact has identity info as well as an arbitrary number of custom attributes (which may be used for phone numbers, email addresses, etc.) and an arbitrary number of street addresses.

OpenACS also offers a variety of other already built, high quality applications such as: wiki, survey, notifications, comments, forums, file storage, content management system, calendar, e-commerce, blogger, chat.





### 5.9. Sakai

Sakai is a community of academic institutions, commercial organizations and individuals who work together to develop a common Collaboration and Learning Environment (CLE). The Sakai CLE is a free, community source, educational software platform distributed under the Educational Community License (a type of open source license). The Sakai CLE is used for teaching, research and collaboration. Systems of this type are also known as Course Management Systems (CMS), Learning Management Systems (LMS), or Virtual Learning Environments (VLE). (More information can be found in reference [35]).

Sakai CLE is a set of software tools designed to help instructors, researchers, and students create websites for collaboration. Using a web browser, users choose from a set of features to create a site that meets their needs. Here are some examples of websites possible to create using Sakai CLE software:

- A project director can create a website to make announcements and share resources, such as documents or links to other resources on the web.
- An instructor can create a website that serves as an online discussion board for students to collaborate on an assignment.
- A student can create a class website to work on and submit assignments electronically.

### Sakai's Features

The Sakai software includes many of the features common to course management systems, including document distribution, a grade book, discussion, live chat, assignment uploads and online testing. In addition to the course management features, Sakai is intended as a collaborative tool for research and group projects. To support this function, Sakai includes the ability to change the settings of all the tools based on roles, changing what the system permits different users to do with each tool. It also includes a wiki, mailing list distribution and archiving and an RSS reader.

The tools that the SAKAI project offers are:

**Announcements:** used to inform site participants about current items of interest.



**Dropbox:** allows instructors and students to share documents within a private folder for each participant.

**E-mail archive:** all messages sent to a site's email address are stored in the Email Archive.

**Resources:** Users can share many kinds of material securely with members of their site, or make them available to the public by adding documents and URLs to their worksite.

**Chat room:** Site participants who are signed on to the site can participate in real-time, written conversations at the same time.

**Forums:** Instructors or site leaders can use a communication tool that is offered to create an unlimited number of discussion forums.

**Presentations:** allows users to present a set of slides to many viewers.

**Schedule:** Allows users to post items and keep track of important dates and deadlines on worksite calendar.

**Message Center:** a communication tool that allows site participants to communicate using internal course mail.

**News:** Displays an RSS feed from an external site to bring news to users' worksite.

**Polls:** allows users to set up online site-based surveys and polls.

**Profile:** A Facebook-style interface is provided for editing user profiles and a Twitter integration is included.

**Roster:** A list of participants can be viewed.

**Assignments:** Users can post assignments and receive submissions online.



**Gradebook:** Instructors can compute and store grades.

**Syllabus:** A worksite syllabus can be created.

**Wiki:** Users are allowed to collaboratively edit simple web pages.

**Tests and quizzes:** Teachers can create, administer, and correct tests and quizzes online, and automatically feed the results to the Gradebook.

**Membership:** Users can choose sites in which they would like to participate.

**Site Stats:** Users have the chance to view site usage statistics.

**Web Content:** Users can include external website content in their worksite.

**Lesson Builder:** Teachers create lessons that can be organized by week or unit.

**Podcasts:** Create podcasts from audio or video files, post them to a course or work site and broadcast them to subscribers.

**e-Portfolio:** Sakai includes an electronic portfolio application with the flexibility to support a wide range of academic uses. Portfolios can enhance the learning process through synthesis and reflection, provide a showcase for accomplishments, or offer a rich platform for assessing learning outcomes.

**Evaluation:** Users can evaluate e-Portfolio content submitted for review. Ratings and/or comments are also provided.

**Glossary:** It provides definitions for terms used on a course or work site.



Figure 27 Sakai \_ Calendar

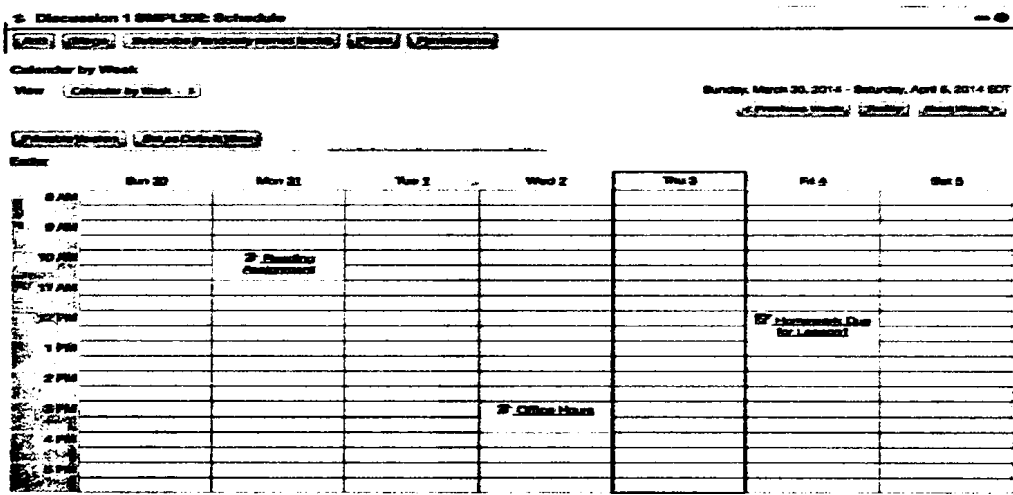


Figure 28 Sakai \_ Chat

## Discussion 1 SMPL202: Chat Room

Options: Permissions

Currently viewing messages for 'Main Chat Room'

View: [Date and Time](#) | [View messages from...](#) [Last 100 messages](#)

All chat messages are archived and can be read by any site participant.

Users in Chat

Showing 2 messages out of 2

The Instructor

0181 Student | Apr 3, 2014 5:29 PM EDT | I notice that some of the questions on the assignment require solving simultaneous differential equations and I need a refresher.

0181 Student

The Instructor | Apr 3, 2014 9:30 PM EDT | I understand. You should use the Signup tool, in this course site, to schedule a time to speak with a teaching assistant. Plus you will see links to online resources also posted in this site.

Enter chat message



Figure 29 Sakai \_ Dropbox

Discussion 1 SMPL202: Drop Box

Site Resources Upload files to multiple dropbox folders Upload-Download Multiple Resources Options Check Details

Location: Discussion 1 SMPL202 Drop Box

View: Discussion 1 SMPL202 Spring 2013

Files in your Drop Box can only be seen by you and the site maintainers. Other participants cannot access them.

Highlight (x) individual dropboxes with recent changes: 1 day ...

| Thumbnail | Copy | Title A       | Access       | Created By     | Modified            | Size    |
|-----------|------|---------------|--------------|----------------|---------------------|---------|
|           |      | janedoe       | Add  Actions | The Instructor | Apr 3, 2014 9:38 pm | 0 items |
|           |      | Student, 0181 | Add  Actions | The Instructor | Apr 3, 2014 9:38 pm | 0 items |
|           |      | Student, 0182 | Add  Actions | The Instructor | Apr 3, 2014 9:38 pm | 0 items |
|           |      | Student, 0183 | Add  Actions | The Instructor | Apr 3, 2014 9:38 pm | 0 items |
|           |      | Student, 0184 | Add  Actions | The Instructor | Apr 3, 2014 9:38 pm | 0 items |
|           |      | Student, 0185 | Add  Actions | The Instructor | Apr 3, 2014 9:38 pm | 0 items |
|           |      | Student, 0186 | Add  Actions | The Instructor | Apr 3, 2014 9:38 pm | 0 items |
|           |      | Student, 0187 | Add  Actions | The Instructor | Apr 3, 2014 9:38 pm | 0 items |
|           |      | Student, 0188 | Add  Actions | The Instructor | Apr 3, 2014 9:38 pm | 0 items |

Figure 30 Sakai \_ Forums

Discussion 1 SMPL202: Forums

Reply to Initial Message Mark All as Read

Forums / Simultaneous Differential Equations / Applying to Environmental predictions and Regression Analysis / Video help

View by Conversation

Video help  
0181 Student (student0181) Apr 3, 2014 9:37 PM - Read by: 1 Reply

I found this great video which helped me remember the difference between dependent variables and independent variables in simultaneous differential equations.



Figure 31 Sakai \_ Resources

SIMPL101 Spring 2013: Resources

Update Content Multiple Resources | Permissions | Online | Check Content

Location: ☐ SIMPL101 Spring 2013: Resources

Actions | Add | Edit | Delete | View

| Title  | Actions                   | Created By     | Modified             | Size     |
|--|---------------------------|----------------|----------------------|----------|
| <input type="checkbox"/> SIMPL101 Spring 2013: Resources | Add  Actions              |                |                      |          |
| <input type="checkbox"/> Citations                       | Add  Actions  Entire site | The Instructor | Apr 3, 2014 10:05 pm | 3 Items  |
| <input type="checkbox"/> Images                          | Add  Actions  Entire site | The Instructor | Apr 3, 2014 10:04 pm | 2 Items  |
| <input type="checkbox"/> Links to External Resources     | Add  Actions  Entire site | The Instructor | Apr 3, 2014 10:05 pm | 12 Items |
| <input type="checkbox"/> Sample Outcomes                 | Add  Actions  Entire site | The Instructor | Apr 3, 2014 10:04 pm | 5 Items  |
| <input type="checkbox"/> Week 1 Resources                | Add  Actions  Entire site | The Instructor | Apr 3, 2014 10:05 pm | 4 Items  |
| <input type="checkbox"/> Week 2 Resources                | Add  Actions  Entire site | The Instructor | Apr 3, 2014 10:05 pm | 3 Items  |
| <input type="checkbox"/> Week 3 Resources                | Add  Actions  Entire site | The Instructor | Apr 3, 2014 10:05 pm | 3 Items  |
| <input type="checkbox"/> Week 4 Resources                | Add  Actions  Entire site | The Instructor | Apr 3, 2014 10:05 pm | 5 Items  |

Content Editor | My Content Editor

Figure 32 Sakai \_ Evaluation

Other Feedback Area:

| Criteria   | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
| <b>Problem Solving</b><br>The student's ability to identify the problem and apply the appropriate knowledge and skills to solve the problem. |   |   |   |   |   |
| <b>Communication</b><br>The student's ability to communicate effectively in writing and speaking.  |   |   |   |   |   |
| <b>Teamwork</b><br>The student's ability to work effectively in a team.  |   |   |   |   |   |
| <b>Leadership</b><br>The student's ability to lead a team.   |   |   |   |   |   |
| <b>Self-Motivation</b><br>The student's ability to motivate themselves.  |   |   |   |   |   |
| <b>Time Management</b><br>The student's ability to manage their time effectively.  |   |   |   |   |   |
| <b>Overall Performance</b><br>The student's overall performance in the course.   |   |   |   |   |   |

Rating: 2.0 / 5.0

Score: 3.2

Comments:






Figure 33 Sakai \_ Portfolio

Home Page This I Believe Teaching Practice Community Practice NETE WTASC Journalism

## Welcome to Ms. Poole's Portfolio!

*"It is the supreme art of the teacher to awaken joy in creative expression and knowledge." - Albert Einstein*



### My journey as a teacher...

Looking back at my time spent here at Virginia Tech, I realize how far I've come in the past five years of my life - and let me tell you, what a journey it was!


I began my undergraduate career as a Holde in 2004, dedicating some of the greatest years of my life to my education. In addition to those four undergraduate years, I took the chance to study abroad in Malawi, Africa during the summer of 2006. There, I combined my knowledge as a student with my passion to teach for the first time. Having had all of these experiences, I knew I wanted to pursue teaching after completing my undergraduate career. In May 2008, I graduated from Virginia Tech with a BS in Psychology and a BA in English. I went on to apply to graduate school for education, entering Virginia Tech's Secondary English Education Masters Program this past summer.

This past year and a half has truly been a wonderful experience, and I am proud to say I will be graduating again from Virginia Tech with a Masters in Curriculum & Instruction with an endorsement to teach Secondary English this May.

Figure 34 Sakai \_ Profile

My Workspace: Profile

My profile Pictures Connections Messages Search Privacy Preferences



### 0181 Student edit

[Say something](#)
[Say it](#)

[Profile](#)
[Wall](#)

---

#### Basic Information

Nickname: Sonny  
 Birthday: Apr 15, 1982  
 Personal summary: Love canoeing and solving differential equations.

---

#### Contact Information

Email: student0181@local.host

---

#### Staff Information

You haven't filled out any information yet

---

#### Student Information

Degree/Course: Journalism

---

#### Social Networking

You haven't filled out any information yet

---

#### Personal Information

Favorite books: Lord of the Rings, Moby Dick  
 Favorite TV shows: Big Bang Theory, How I Met Your Mother  
 Favorite movies: To Sir With Love



### 5.10. Docebo

Docebo is a completely free content management (CMS) and e-learning (LMS) platform released under Open Source license. Docebo is used for corporate learning and has interfaces for video-conferencing and HR systems. Using an online system for learning and training cuts down time needed and costs that would be used on such things as printing and distributing materials. The program now operates as a cloud-hosted software as a service platform as well as being third-party compatible. The company using the platform loads a course, creates a username and password for employees, and tracks the progress of its users. (More information can be found in reference [36]).

#### Docebo's Features

**ILT-Classroom:** This App allows users to schedule both classroom and blended training sessions, by easily managing courses, sessions and locations.

**Assignment:** Users can upload videos as part of a course assignment. Once uploaded, a course instructor can evaluate the assignment, assign a score, and leave feedback for learners.

**Upload any kind of Training Material:** With Docebo users can easily upload and share their training materials like PPT, PDF, SCORM, Tin Can and Video files.

**Download material:** Learners can download materials directly from the course that can be made available to students on demand by the course instructor.

**Slides Converter:** Users can transform their PDF, PPT, PPTx and ODP files into Multimedia Courses.

**Video Converter:** Users can convert any kind of video in web-optimized MP4 files.



**Advanced Tracking & Reporting Features:** Tutors are enabled to easily monitor and track the training performance of their students.

**Single Page Web-App:** Single-page Course area, drag and drop features, as simple as favorite Social Network. Everything a user needs is “on the wall”.

**Add a logo:** Users can upload their logo and it will replace the Docebo one. They can also upload a customized favicon.

**Personalized homepage:** Users can personalize the home page in different ways using the Branding and Look and Feel features. They can add an image, define the position of the buttons, display courses or catalogues before log-in, and add text that will be displayed near the log in button.

**Calendar:** A calendar can be added to the learner menu and events and all the learning activities scheduled are visible in each learner's calendar.

**Waitlist:** Tutors can enable the waitlist for each course. They can define a maximum number of learners for each course and the learners exceeding this number must wait until a seat in the course is available.

**User notifications via SMS or email:** Notifications can be sent for each event.

**Twitter/Facebook/Google Apps/LinkedIn Integration:** Single Sign On can be enabled for users with their Twitter/Facebook/Google Apps/LinkedIn accounts.

**Gmail Integration:** Allows users to sign in the Docebo LMS using their existing Gmail account.

**Communities:** Using all the social widgets in the course area users can build a community of learners enrolled in the course.



**Forum/Discussion board:** In the course area there are two social widgets: forum and comment. Users have the chance to create forums and they are also allowed to comment on content etc.

**WordPress/Joomla/Drupal Plugin:** Using the WordPress/Joomla/Drupal App and the WordPress/Joomla/Drupal plugin, the SSO can be enabled between the LMS and a website built with WordPress/Joomla/Drupal. Users can also insert a preview and a direct link to the course within the WordPress/Joomla/Drupal website.

**E-commerce:** Online Courses, events (seminars, webinars), materials (PDF, Doc) can be easily sold by using the Docebo E-Learning platform. Payment via Credit Card and users can collect 100% of their net sales price directly in your Paypal for Business account.

**Tablet Compliant:** The LMS is fully accessible via mobile devices, regardless of operating system or browser used.

**Quizzes /surveys:** Tutors can build a test or a survey using the LMS tool which supports different types of questions: Single/multiple choice, Extended text, Text entry, Essay, Upload file. Images or videos can be added to a quiz question.

**Multilanguage:** Docebo supports 31 languages.

**Reports:** Users can build their personal report using the widgets and filters available in the Report area. Reports can be exported in different formats (xls, csv, html).

**Web conferencing integration:** The Docebo Learning Management System is integrated with Adobe Connect, BigBlueButton, Cisco WebEx, Citrix GoToMeeting, Digital Samba by OnSync, TeleSkill Live.

**3rd party courses:** Users can purchase courses from other vendors and then upload them within the system.



**Certificates:** Learners can build and download certificates for different learner achievements. Each certificate can be customized.

**Courses Library:** Docebo's Courses Marketplace allows tutors to buy and instantly deliver more than 200 online training courses to their learners, by adopting a convenient “pay per seat” formula.

**Apps Marketplace:** Users have the chance to access the App Marketplace and expand the features of their Docebo by activating Apps and integrations with any kind of software: HR solutions, Web conference tools, Social Networks and CMS.

**Enterprise Cloud Solution App:** Docebo's users can run their LMS on an Isolated Cloud single-tenant instance with top class Help desk services and additional advanced features.

Figure 35 Docebo \_ Homepage

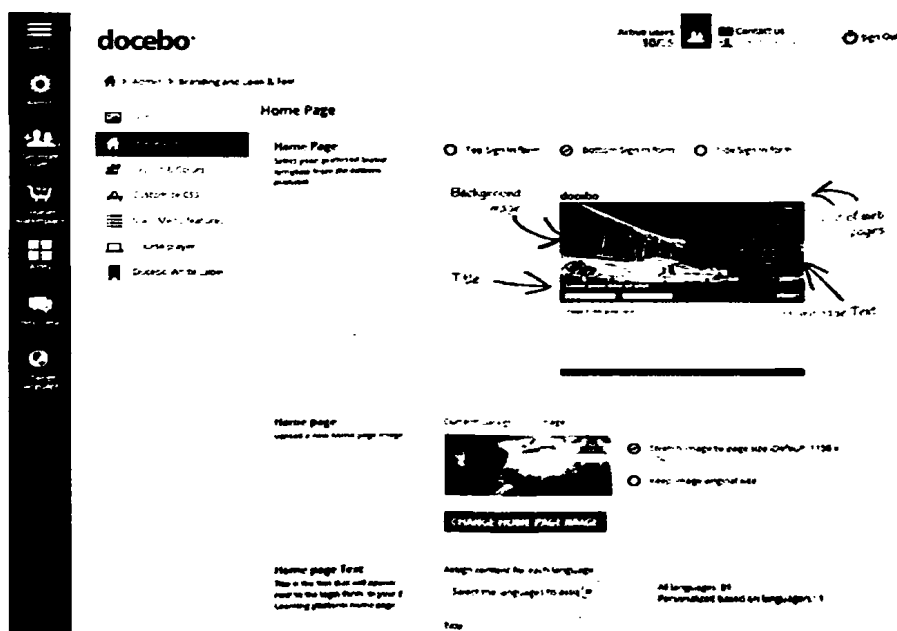


Figure 36 Docebo \_ Course



### 5.11. Claroline

Claroline is a collaborative e-Learning and e-Working platform (Learning Management System) released under the GPL Open Source license. It allows hundreds of organizations worldwide ranging from universities to schools and from companies to associations to create and administer courses and collaboration spaces over the web. The platform is used in more than 100 countries, it is available in 35 languages and can be downloaded and installed freely.

Claroline is based on a flexible instructional model where the information becomes knowledge through activities and productions in a system driven by the motivation and interaction. The wide range of tools available to the user allows any teacher or learner to establish or operate a pedagogical method that promotes learning. The generic tools (calendar, documents, videos...) allow use of the platform in a variety of contexts.

Claroline is a stable platform, open to all, which allows easy use of space for training and collaboration. Its operation requires no special technical skill. Easy to install and just a



browser in needed to manage the different spaces and registered users. (More information can be found in reference [37]).

### **Claroline's Features**

**Files:** Teachers can publish documents in any format such as text, PDF, HTML, video.

**Forums:** Claroline allows the creation of public or private forums. In the forum section students are allowed to interact with each other as well as with the teacher.

**Groups:** Claroline allows the creation of groups of users. The group section allows students to be assigned into groups and work collaboratively. Students do not need to be online at the same time.

**Chat:** The chat section encourages students and the teacher to communicate in a real-time conversation since most of the online learning is asynchronous.

**Assignments:** Teachers can propose home work to make online or exercises with a list of questions.

**Agenda:** There is a course calendar that includes tasks and deadlines as well as a complete calendar that displays the events from all courses.

**Announcements:** The announcement section allows quick updates by the teacher. Announcements can be posted on the course homepage or sent by email.

**Statistics:** Teachers have the chance to view statistics of attendance and monitor the completion of the exercises.

**Wiki:** The wiki section allows students to add information about a subject area they are knowledgeable about. Teachers or other students can update this information in case of a mistake.



Learning path: Teachers can create complete sequences of learning activities. They can put together modules that consist of documents or exercises and then stimulate students to read the documents, fill the exercises and follow the learning activity.

Figure 37 Claroline \_ Course Home

The screenshot shows the Claroline 1.8.2 Demo interface. At the top, there's a header with 'Claroline 1.8.2 Demo' and 'Claroline.net'. Below the header, there's a navigation menu on the left with options like 'Course description', 'Announcements', 'Documents and Links', 'Exercises', 'Learning Path', 'Assignments', 'Forums', 'Groups', 'Users', 'Chat', and 'Wiki'. The main content area is titled 'Welcome on the Global warming online course!'. It features a small image of a polar bear on ice and a text block explaining that the average surface temperature of earth has increased more than 1 degree Fahrenheit since 1900. Below this, there's a paragraph about the greenhouse effect and its consequences. At the bottom, there's a 'Add Text' button.

Figure 38 Claroline \_ Agenda

The screenshot shows the Claroline Agenda page. At the top, there's a header with 'Biodiversity' and 'John Hollington BIODIVERS'. Below the header, there's a navigation menu with options like 'My Agenda', 'Biodiversity', and 'Agenda'. The main content area is titled 'Agenda' and shows a list of events. The first event is 'Second lesson: Aristotle and ancient logic' with a date of 'September 06, 2002 at 11:31 AM'. Below this, there's a form to 'Add an event' with fields for Day, Month, Year, Hour, Minutes, and Lasting. The form is filled with '9', 'March', '2002', '08', '45', and '2h' respectively. Below the form, there's a 'Title' field with the text 'Second lesson: Aristotle and ancient logic' and a 'Detail' field with the text 'Local: A019'. At the bottom, there's a 'Theme' field with the text 'Contrary to other scientific disciplines, Logic remained unchanged from 400 AC to XIXth century. Why?'. At the bottom right, there's a 'OK' button.





Figure 39 Claroline \_ My Desktop

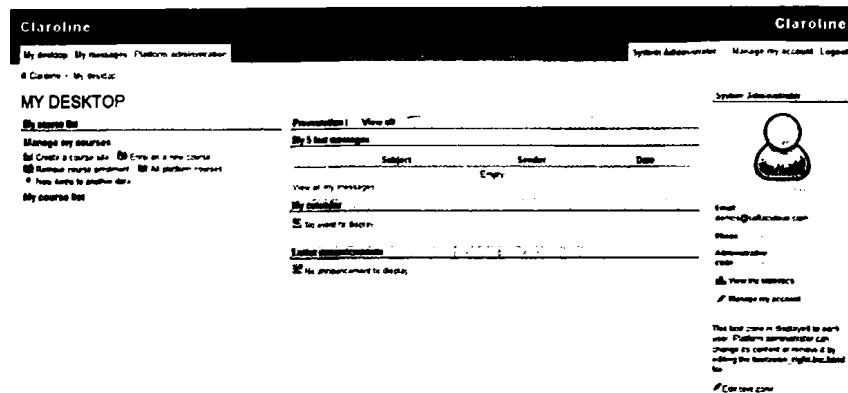
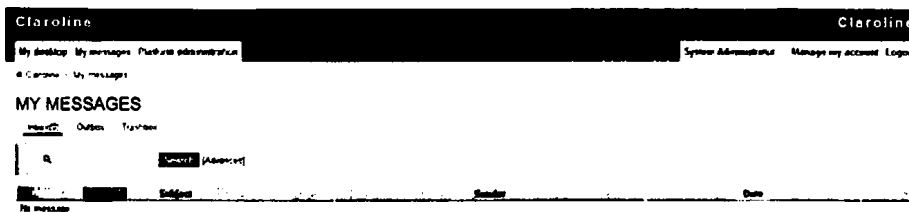


Figure 40 Claroline \_ My Messages



## 5.12. Shareville

Shareville is a backronym for Shareable, Holistic Assets and Resources, Existing in a Virtual Interactive Lifelong Learning Environment. The hardware specification required to run the environment is minimal, and being web-based works on a variety of computer platforms. Shareville provides an approximation of the socially and ethnically diverse city of Birmingham, England, and many of the different areas and landmarks within the city are parodied in the names used within Shareville.

Navigation within the environment through 'point and click' is possible, and in order to improve accessibility there is a breadcrumb trail at the top of each page, alongside quick



navigation to the locations. There is no 'full screen' mode or fully immersive environment. The perspective of the student is always 'first person', so there is no requirement for an avataristic representation on screen.

Figure 41 Shareville Map



Shareville is an online learning resource developed by the e-learning team at Birmingham City University. In essence, it is a virtual town with a hospital, university, school, law practice and care home. Environments are presented as 3D panoramas that students can explore, accessing material relevant to their area of study.

Much of this comprises of video scenarios: when a character in a location is clicked, the user is presented with a short video showcasing the character's circumstances, followed with questions about it. Different answers lead to different consequences, again shown as a video. Quite complex scenarios can be simulated and decisions explored.

As well as videos, other resources can be accessed including documents, pictures and websites. For example, a room in the care home may have several characters each with their own situation, a filing cabinet full of relevant documents, a telephone with answer phone



messages on it and so forth. It certainly leads to a more immersive and engaging way of learning.

Students are able to make connections between different aspects of their work and understanding work contexts and situations. They are allowed to experience a scenario in which they need to interact with clients and make decisions based on this interaction. As Shareville has been trialed with groups of students in different professions, it has been noted that they particularly liked the way it allowed them to see the client's reaction as well as the facts of a case and that it helped them link theory to practice. (More information can be found in reference [38]).

### 5.13. Casemaker

Casemaker is a freely available service which aims to facilitate and enhance case-based teaching by enabling three participant communities – case writers, teachers and students – to work with cases, to review progress of study, and to give feedback. The three participant communities are not mutually exclusive. Teachers can be case authors and vice versa, students can be co-creators of cases. (More information can be found in references [39] and [40]).

The Casemaker platform can be used for the benefit of teachers and learners in any culture and learning environment. This is achieved this by:

- facilitating collaborative work between teachers and researchers to create online multimedia cases
- enabling groups of students to collaborate in analyzing complex case material
- allowing teachers, researchers and students to get detailed information about the learning being developed.

In technical terms the platform is an online app which is accessed via a browser. It is designed around three integrated software components:

- CaseDeveloper facilitates the collaborative development of multimedia-cases



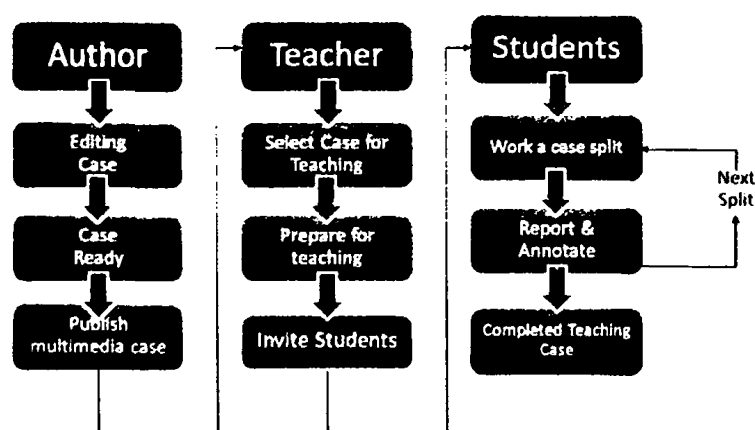
- CaseTeacher helps teachers to plan their case-based teaching by formulating case-based assignments and learning objectives for students
- CaseAnalyser allows students to analyze and solve cases, and teachers to be able to view and assess the learning being achieved by individual students.

The Casemaker platform is designed to simplify the introduction and application of case based teaching and learning in a wide range of learner communities including, but not limited to, doctors, engineers, lawyers, managers, nurses, and teachers.

Figure 42 describes the basic steps for achieving case based teaching within the Casemaker platform (in green: the steps performed in CaseDeveloper, in orange: the steps performed in CaseTeacher, and in blue: the steps performed in CaseAnalyser). The three main steps cover:

- the creation of a multimedia case from one or more authors
- the preparation of a completed multimedia case for teaching by a teacher
- the analysis of the case by the participating students

Figure 42 Data flow for Case Based Teaching based on the Casemaker Platform



The Authoring Dashboard offers the following options:



- Add Co-author to the working multimedia case
- Import Resources from other published cases available in the database
- Save a draft work on progress of a case
- Publish a completed multimedia case to the case database
- Update Case Name

The author of the case is offered the following options:

- Give a title of the case
- Add information about the case
- Import case files (Images, Powerpoint presentations, Excel files, Text Files, PDF files)
- write the abstract
- write teaching notes
- write the learning objectives
- set the case progress
- add co-authors
- import resources from other cases

The Abstract space (which offers an ‘edit box’ into which text can be uploaded) gives you the opportunity to outline in one paragraph what your case study is about. Here you have the option of posing a question that underpins determines the entire case and possibly any findings relating to the case study.

The Teaching Notes space allows you to add specific teaching details to the designed case. The Casemaker platform is a repository of uploaded cases from many authors and/or teachers and each user of the platform has the ability to utilize cases developed and created by other users. The teaching notes associated with a case will help and assist teachers who choose to use this in their own teaching provision.

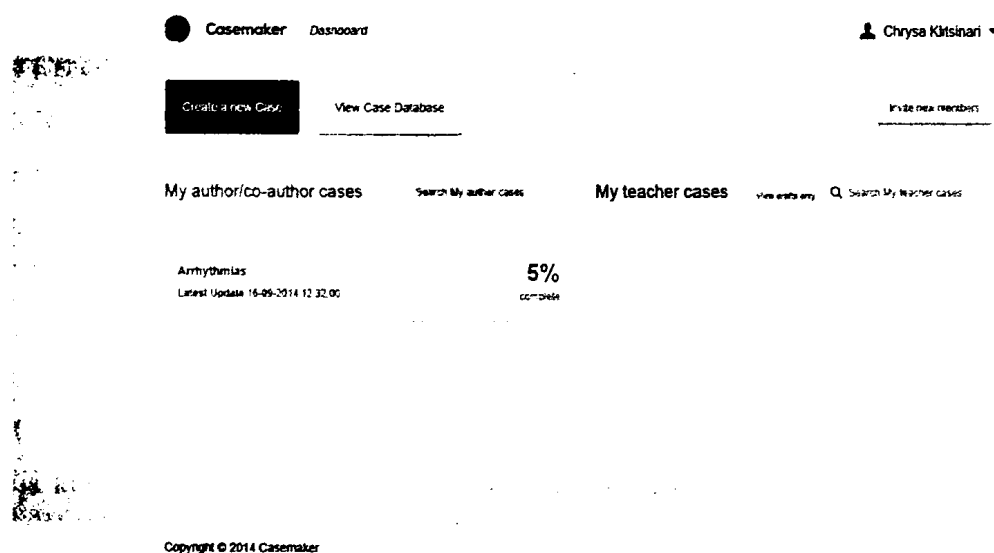
The Learning Objectives space is the container for criteria that will help the teacher assess what students should know or be able to do after studying the case that they couldn't do before.



A Casemaker user logging on as a teacher has the following options:

- View the entire case database and use advanced filters
- Search the user's teaching cases
- Select a particular case for teaching
- Prepare a case for teaching
- Send students a case for them to work on
- View reporting and annotations of a teaching case.

Figure 43 Casemaker \_ Teacher's Dashboard



## ΚΕΦΑΛΑΙΟ 6. CASE BASED LEARNING IN BIOMEDICAL ENGINEERING TEACHING USING ICT TOOLS

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6.1 Computer Science Teaching

6.2 Tools for Case Based Learning in Biomedical Engineering

6.3 Rosalind

6.4 CaseIt!

6.5 NetBio

6.6 Ugene

6.7 Raptor

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### 6.1. Computer Science Teaching

It is known that teaching in Computer Science area is still based on traditional teaching approaches and specified pedagogical methods have not yet been introduced and advanced ICT tools are not widely used for teaching purposes. Here we are going to introduce how Case Based Learning could be implemented in this area and in Bioinformatics and Biomedical Engineering in particular.

Technology creates and transforms the learning and teaching processes, which brings new opportunities to the educational system. Programming is a fundamental skill that all computer science students are required to learn. However, programming courses are generally regarded as difficult mostly because of the methodology and tools used as well as the students' difficulty with abstract concepts. This is why the use of ICT tools to show program execution has been used to reduce students' difficulties.



In this manner, students are able to connect, interact and collaborate simultaneously at the same time and at the same space. Reflection is also promoted, a mechanism that enhances the learning process. Also, it is well accepted that effective problems engage the students' interest and motivate them to search for deeper understanding of the concepts being introduced. Consequently, it is important that the students are introduced to programming in an appropriate manner.

Through this approach of teaching programming, students can be more committed in completing a certain project and can even create other programs just for fun, by their own initiative, as the whole process is much more pleasant than the traditional one. Students are motivated to not only execute the things they have to but also expand what they have learned in their own way because eventually they want to.

Universities have been using Case based learning in the delivery of Bioinformatics on Biomedical Science, Biotechnology and Biomedical Engineering. Whilst a wide range of academic disciplines have been delivered using CBL, it is particularly appropriate for bioinformatics given the extremely dynamic nature of this field. The case based learning environment enhance peer learning and team building and provides students with a practice-based approach that enforces integration of knowledge from diverse disciplines, valuable skills that will readily translate to the workplace.

More information can be found in references [16] and [21].

## **6.2. Tools for Case Based Learning in Biomedical Engineering**

Bioinformatics and Biomedical Engineering are interdisciplinary scientific fields that develop methods and software tools for storing, retrieving, organizing and analyzing biological data. As interdisciplinary fields, they combine computer science, statistics, mathematics and engineering to study and process biological data. Software tools for these fields range from simple command-line tools, to more complex graphical programs and standalone web-services available from various bioinformatics companies or public institutions.





Many free and open-source software tools have existed and continued to grow since the 1980s. The combination of a continued need for new algorithms for the analysis of emerging types of biological readouts, the potential for innovative in silico experiments, and freely available open code bases have helped to create opportunities for all research groups to contribute to both bioinformatics and the range of open-source software available. There are also software platforms designed to teach bioinformatics concepts and methods.

More information can be found in references [3] and [23].

### 6.3. Rosalind

Rosalind is an educational resource and web project for learning bioinformatics through problem solving and computer programming. Learning bioinformatics usually requires solving computational problems of varying difficulty that are extracted from real challenges of molecular biology. To make learning bioinformatics fun and easy, Rosalind was founded. Rosalind offers an array of intellectually stimulating problems that grow in biological and computational complexity. Each problem is checked automatically, so that the only resource required to learn bioinformatics is an internet connection.

Rosalind also promises to facilitate improvements in standard bioinformatics education by providing a vital teaching help and a central homework resource. Rosalind is likely to inspire a new generation of bioinformatics students by attracting biologists who want to develop vital programming skills at their own pace in a unique environment as well as programmers who have never been exposed to some of the stimulating computational problems generated by molecular biology.

There is a variety of problems one can find in Rosalind in various topics such as alignment, dynamic programming, genome assembly, genome rearrangements, string theory and others. It is really easy as well as funny for students as they can learn in a very simple and interactive manner. All they have to do is register, login, select any topic they want and try to solve as



many problems as they wish online. Rosalind can also be used by instructors as a tool for students to implement part of a bioinformatics case scenario they are asked to. (More information can be found in reference [41]).

We are going to present an example from the string theory topic that can be part of a case of a Bioinformatics course which students are invited to solve using the Rosalind platform.

**Problem:**

A string is simply an ordered collection of symbols selected from some alphabet and formed into a word. The length of a string is the number of symbols that it contains.

An example of a length 21 DNA string (whose alphabet contains the symbols 'A', 'C', 'G', and 'T') is "ATGCTTCAGAAAGGTCTTACG."

Given: A DNA string  $s$  of length at most 1000 nt.

Return: Four integers (separated by spaces) counting the respective number of times that the symbols 'A', 'C', 'G', and 'T' occur in  $s$ .

After reading the problem, the student has to download the dataset to his computer and then copy his/her answer to the corresponding box and optionally attach the code he/she used. Rosalind will then inform the user whether his answer was wrong or right. Users have the possibility to attempt as many times as they wish.

Our dataset was the following:

```
AGCTTTTCATTCTGACTGCAACGGGCAATATGTCTCTGTGTGGATTAAAAAAAGA
GTGTCTGATAGCAGC
```

And the right output was:

```
20 12 17 21
```



#### 6.4. CaseIt!

Case It! is a project providing a framework for collaborative case-based learning via free, open-ended molecular biology simulations. It is a simulation that performs common laboratory procedures on any DNA or protein sequence.

Most of the cases currently available were developed for use in introductory undergraduate biology classes to help students address concepts and issues in molecular biology, but they can be adapted to a variety of educational settings. These cases guide students through the analysis steps and then provide focused questions to prompt interpretation and application of the results.

Each case description includes the case scenario and instructions for analyzing the case, as well as background information and discussion questions. Students first read the background information provided and gather additional information from online sources. They then carry out the analysis, interpret results, and discuss the significance of scientific and social issues raised by the case. Alternatively, instructors can edit the cases to add or omit information as appropriate for the backgrounds of students and the course objectives. Students may be asked to:

- Focus on the ethical and social issues raised by the analysis and the decision-making process involved
- Take on a particular role, e.g. genetic counselor or family member, and present the case interpretation from that perspective
- Develop hypotheses about the results, based on background information about the molecular biology in the case, before running the analysis
- Start with the case analysis and results, then carry out their own research to obtain information necessary to interpret the case

In addition to using cases and sequences provided with the simulation, instructors may develop their own cases using DNA sequences obtained from GENBANK or elsewhere. Students in more advanced biology courses can be assigned to develop new cases. These student-designed cases can then be subjected to peer review, and used by students in introductory courses.



Since the Case It simulation works with any DNA or protein sequences, students can use the software for open-ended research projects, accessing online sequence databases or research articles to gather sequences they need to address their research questions.

There has been particular success when students interact online, taking on different roles as they analyze and discuss the case results. Students work in teams using the Case It simulation to analyze samples in the case, then present their results in web-based format. Any online system that allows students to upload images and text and communicate interactively could be used to accomplish these steps.

Playing the role of a lab technician, students use the Case It simulation to analyze DNA or protein samples. Images from the simulation are saved and posted to a web page, along with background information and an interpretation of the results. Students play the role of a genetics or health counselor as they compose a statement to the patient or family.

While interacting online, students switch between roles when they ask and answer questions. For example, when students visit other web pages they play the role of patients/family members in the case, whereas when responding to questions about their own web pages they play the role of genetic/health counselors. It is possible to do something similar in person rather than online, but students seem to prefer the anonymity of online communications because they can be more open in their answers and it is easier to assume roles. An online format also gives them more time to reflect and gather information before responding. (More information can be found in reference [42]).

## 6.5. .NETBio

.NETBio is an open source library of common bioinformatics functions, intended to simplify the creation of life science applications. It includes the .NET Bio Sequence Assembler that demonstrates how the .NET Bio Framework can be used to create applications for bioinformatics research. The .NET Bio Sequence Assembler uses rich user interface elements to enable the manipulation and visualization of genomic data. The .NET Bio Sequence



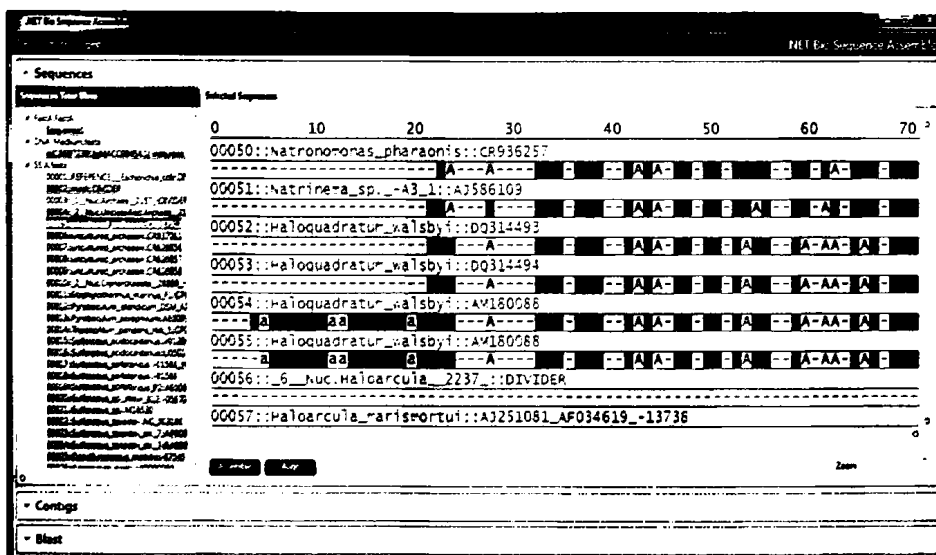
Assembler implements several features of the .NET Bio Framework such as a set of algorithms for alignment and/or assembly of DNA, RNA, or Protein strands. (More information can be found in reference [43]).

.Net Bio can perform common bioinformatics tasks such as:

- Read and write standard alignment and sequence-oriented data files.
- Access online web services to search known databases for sequence fragments.
- Algorithms for local and global alignments.
- Algorithms for sequence assembly.

For example, let's show how a user can align sequences using NetBio. First of all, the user has to import the sequences. The result is shown in the following figure:

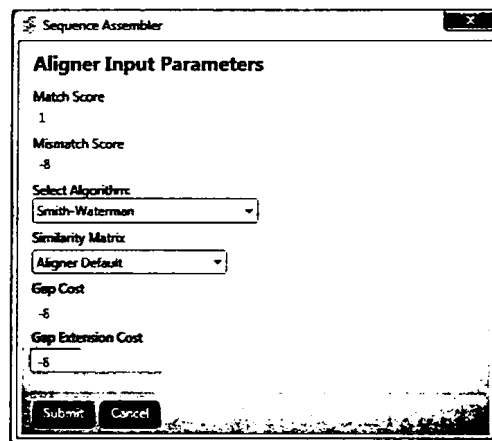
Figure 44 NetBio \_ Import Sequences



DNA, RNA, and protein sequences can be aligned using some algorithms. After choosing an algorithm and two or more sequences, the user sets the parameters for the alignment (Figure 45), which includes selecting a similarity matrix.

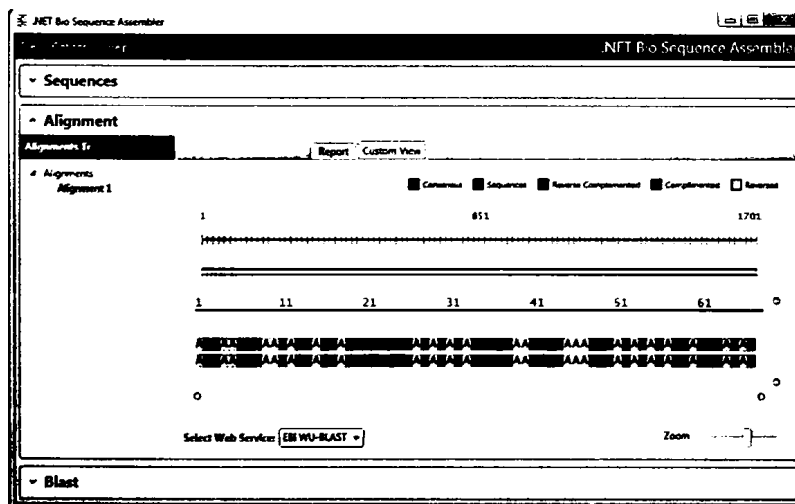


Figure 45 NetBio \_ Aligner Input Parameters



The resulting alignment will then be displayed as shown in the following figure.

Figure 46 NetBio \_ Alignment



## 6.6. Ugene

UGENE is a free open-source bioinformatics software. It helps biologists to analyze various biological data which can be stored both locally (on a personal computer) and on a shared storage (a lab database). UGENE integrates dozens of well-known biological tools and



algorithms, as well as original tools in context of genomics, evolutionary biology and other branches of life science. It provides a graphical interface for the pre-built tools so biologists without programming skills can access those tools more easily. (More information can be found in reference [44]).

The software supports features such as:

- Creating, editing and annotating nucleic acid and protein sequences
- Fast search in a sequence
- Multiple sequence alignment
- Search through online databases
- Visualization of sequencing data UGENE Assembly Browser

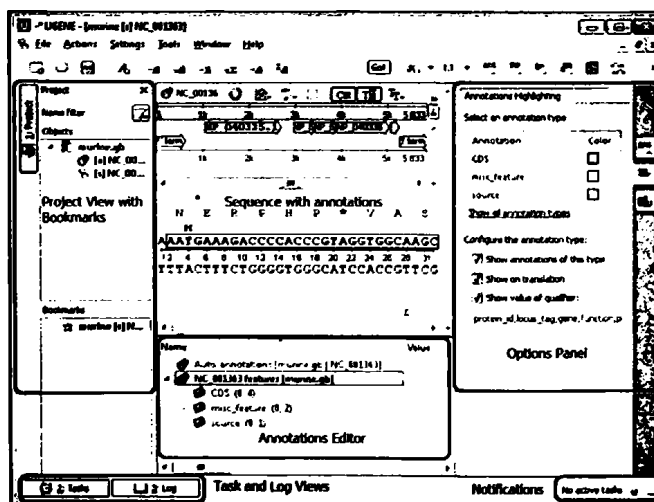
We will display some examples which could be part of cases in a Bioinformatics course.

### Problem

Find "TTCCGAGGGACACTAGGCTGACTCCATC" pattern in a given sequence.

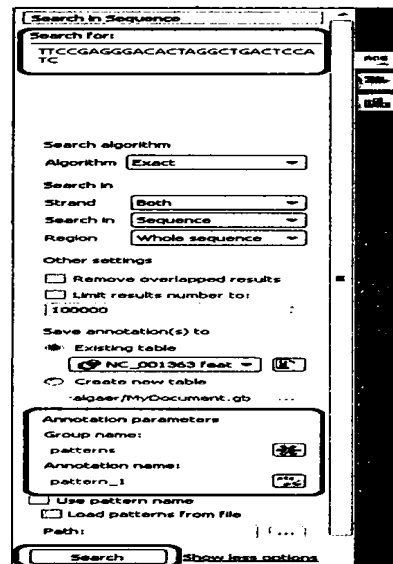
For each file UGENE analyzes the file content and automatically opens the most appropriate view. To activate the Sequence View, the user opens any file with at least one sequence. After opening the file in UGENE the Sequence View window appears:

Figure 47 Ugene \_ Sequence View



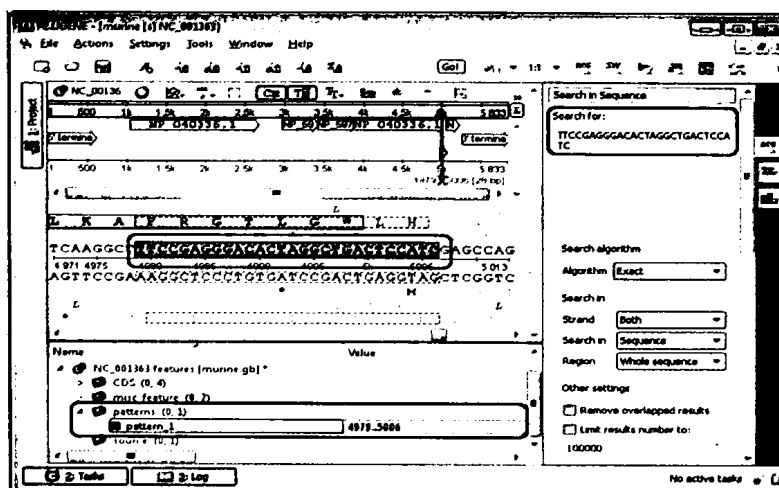
The user has to enter the wanted pattern and check the appropriate parameters as shown below.

Figure 48 Ugene \_ Searching for a pattern



After that, he clicks the Search button. If the pattern is in the sequence, it appears as new annotation:

Figure 49 Ugene \_ Pattern View





### 6.7. Raptor

RAPTOR is an innovative software tool designed for accurate protein structure prediction. It combines advanced analysis tools in one integrated software solution and provides three different threading methods. RAPTOR's unique integer programming optimization approach is most effective for finding structure templates of targets with low sequence homology and is able to generate high quality models. The easy-to-use interface is ideal for beginners and experts. Above all, the intuitive display of the output enables users to understand the results simply at a glance.

Given a query protein sequence, RAPTOR scans a template library which is a set of known structures derived from the PDB (Protein Data Bank). For each structure template, RAPTOR threads (aligns) the query sequence against the template by optimizing a scoring function and an optimal alignment will be obtained. After threading, all the alignments are ranked by a statistical measure. The structure of the query sequence is built on the alignment from the top template. RAPTOR provides three different threading algorithms as well as statistical measures to rank alignments. A SVM (Support Vector Machine) technique is used to rank the alignments after threading. The resulting score reflects the quality of the sequence-structure alignment.

Some of the "Case Uses" of RAPTOR are: protein threading, secondary structure prediction and crystallography. The goal of any software is to allow its users to accomplish tasks in a minimum amount of time, with optimal results. In addition to using a great software such as RAPTOR, live webinars are also offered as a successful method of learning how best to utilize the given tools. (More information can be found in reference [44]).

Figure 50 Raptor \_ Edit Sequence

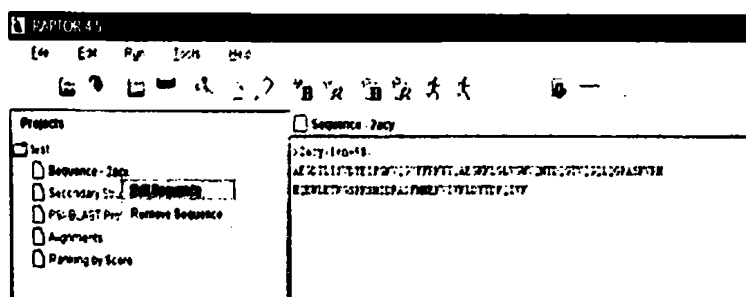


Figure 51 Raptor \_ Secondary Structure

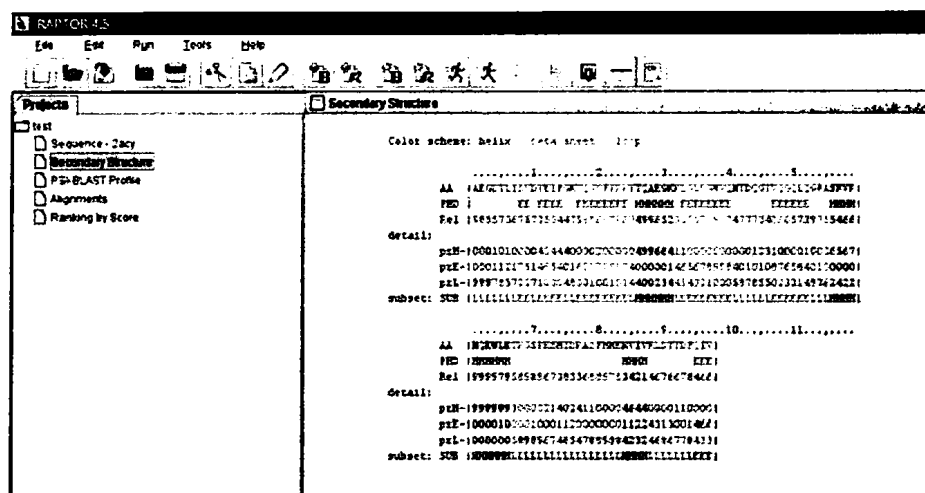
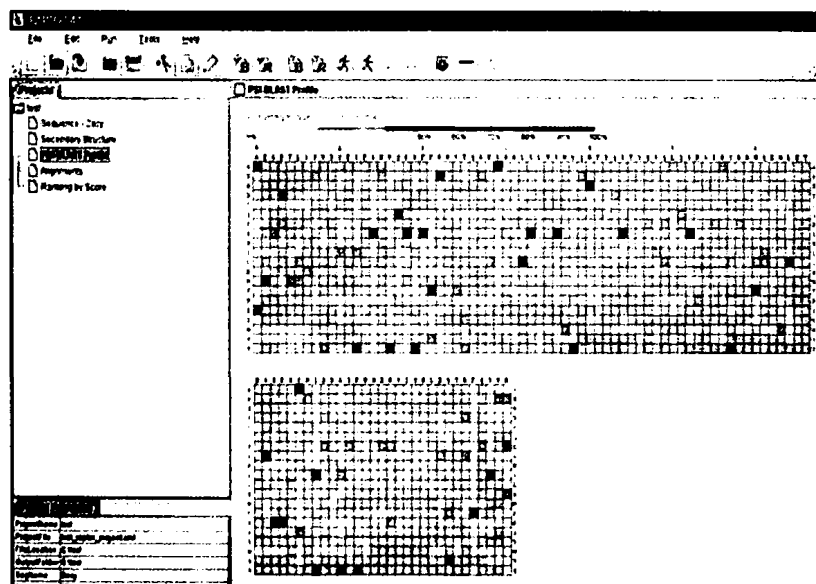


Figure 52 Raptor \_ Occuring frequency color schema



### Figure 54 Raptor\_ 3D Modeling

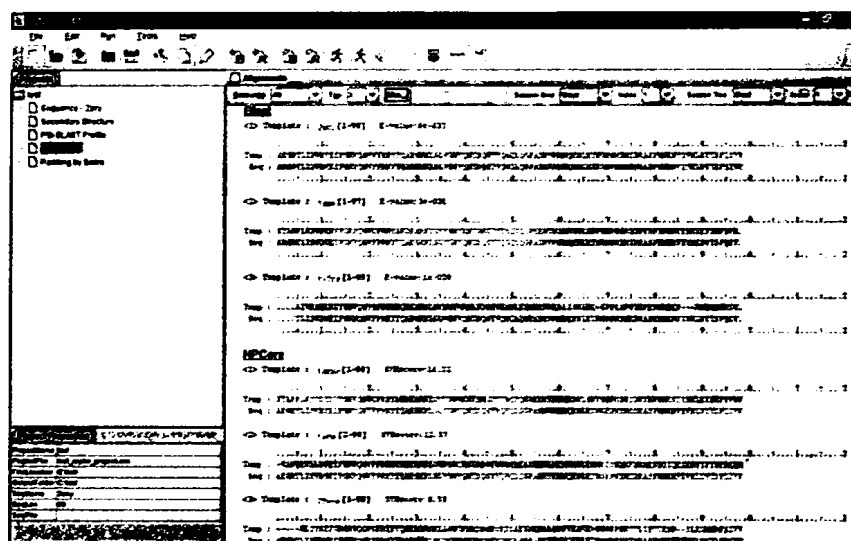
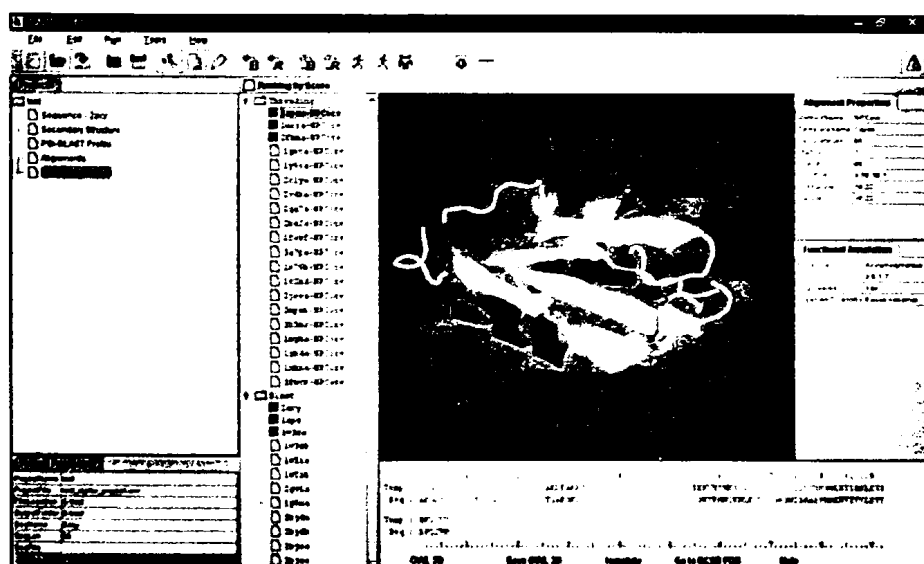


Figure 54 Raptor\_3D Modeling



## ΚΕΦΑΛΑΙΟ 7. BIOMEDICAL ENGINEERING COURSE PLANNING AND CASE SCENARIOS

- 
- 7.1 Course curriculum and planning
  - 7.2 Case Study: Heart Rates
  - 7.3 Case Study: Arrhythmias and Electrocardiography
  - 7.4 Case Study: Holter Monitor
  - 7.5 Case Study: EEG of human sleep stages
  - 7.6 Case Study: Medical Imaging
  - 7.7 Case Study: Patient Support System
  - 7.8 Case Study: Diabetes
  - 7.9 Case Study: Blood Pressure
  - 7.10 Case Study: Patients Support System 2
  - 7.11 Applying the case based learning method to Graduate students
  - 7.12 Assessing students' acceptance of the case based learning method
- 

### 7.1. Course Curriculum and planning

We have composed and organized the curriculum of a 12-week Biomedical Engineering course and we present it below. The curriculum includes the following:

**Introduction:** Biomedical Engineering advances knowledge in engineering, biology and medicine, and improves human health through engineering techniques, biomedical sciences and clinical practice. In most stages of diagnosis, treatment or rehabilitation and management of biomedical equipment, there are problems that require an engineering approach. The increasing complexity of medical technology has increased the demand for trained



professionals to bridge the gap between clinical medicine and applied medical technology. The application field of Biomedical Engineering is huge and includes:

### **Biosignals and medical images processing:**

Physiology of the Heart and Electrocardiogram (ECG): Myocardium, Rhythmical Excitation of the Heart, Normal cardiogram, Cardiac Arrhythmias and their interpretation, Equipment required to record the signal of the heart, Identification and analysis of ECG waveforms.

Special ECG Systems: Cardiotocography, Holter Monitor, Fetal ECG.

Physiology of the Brain and Electroencephalography (EEG): Cerebral Neurophysiology, Electroencephalography function, EEG features, EEG processing and Information Extraction for Intracranial function.

### **Diabetes:**

Types: Diabetes mellitus type 1, Diabetes mellitus type 2, Gestational diabetes

Clinical picture: Causes, Symptoms, Diagnosis, Treatment

Characteristic points: Glucose, Blood pressure, Cholesterol

Methods of Measuring and Monitoring Glucose: Glucose Meters and Continuous glucose Recording Devices using sensors.

### **Blood Pressure:**

Types: Arterial, Venous and Pulmonary Blood Pressure, Systolic and Diastolic, Blood pressure waveform.

Methods of blood pressure measuring: Sphygmomanometer, 24-hour blood pressure monitor (Holter).

### **Medical Imaging:**

Imaging Categories and their uses:

Radiography: Description and Uses

Magnetic Reasonance Imaging (MRI): Description, Why it is done, Risks

Ultrasound: Description, Uses, Biomedical applications, Types, Benefits

Tomography: Description, Types: Conventional Tomography and Computer assisted tomography



### **Surveillance Systems for vital functions and Helpful Applications:**

Patients Surveillance Systems - Support Systems for vital functions: Continuous glucose monitoring, Insulin Pump, Pacemakers: Artificial pacemaker and Implantable Cardiac Defibrillator.

Modern medical technology trends - Telemedicine: Smart phone applications that help patients keep their measurements diary and offer them advice and medical help: Glucose Buddy Diabetes Log, Blood Pressure (My Heart).

Adopting the Case Based Teaching method, we have planned the teaching process of the course week by week and we present it below:

#### **1st week:**

- Getting to know with the students
- Informing students about the course structure (lectures, assignments, assessment)
- Brief description of the course curriculum
- Lecture: Introduction to Biomedical Engineering

#### **2nd week:**

- **Lecture: Chapter\_ Biosignals and medical images processing**

Physiology of the Heart and Electrocardiogram (ECG): Myocardium, Rhythmical Excitation of the Heart, Normal cardiogram, Cardiac Arrhythmias and their interpretation, Equipment required to record the signal of the heart, Identification and analysis of ECG waveforms.

#### **3rd week**

- **Case: Heart Rates**

The first case is presented in the classroom so that the teacher can explain to the students how the platform (Casemaker: <http://prd-ioa-casemaker.cloudapp.net/>) works. The case is simple, in the form of a quiz, so that students will be able to easily understand the process and check if they can recall what they heard during the lecture.

- **Lecture: Chapter\_ Biosignals and medical images processing**

**Special ECG Systems:** Cardiotocography, Holter Monitor, Fetal ECG.

- **Case: Arrhythmias and ECG**



Graduate students of the Department of Computer Science and Informatics of the University of Ioannina in Greece were given this case for homework and we checked the students' participation through the platform.

- **Case: Holter Monitor**

Graduate students of the Department of Computer Science and Informatics of the University of Ioannina in Greece were given this case for homework and we checked the students' participation through the platform.

#### **4th week**

- **Lecture: Chapter\_ Biosignals and medical images processing**

Physiology of the Brain and Electroencephalography (EEG): Cerebral Neurophysiology, Electroencephalography function, EEG features, EEG processing and Information Extraction for Intracranial function.

- **Case: EEG**

Students are divided into groups and the case is solved in the platform and discussed simultaneously in the classroom.

#### **5th week**

- **Lecture: Chapter\_ Diabetes**

Types: Diabetes mellitus type 1, Diabetes mellitus type 2, Gestational diabetes

Clinical picture: Causes, Symptoms, Diagnosis, Treatment

Characteristic points: Glucose, Blood pressure, Cholesterol

Methods of Measuring and Monitoring Glucose: Glucose Meters and Continuous glucose Recording Devices using sensors.

#### **6th week**

- **Lecture: Chapter\_ Blood Pressure**

Types: Arterial, Venous and Pulmonary Blood Pressure, Systolic and Diastolic, Blood pressure waveform.

Methods of blood pressure measuring: Sphygmomanometer, 24-hour blood pressure monitor (Holter).



**7th week**

- **Lecture: Chapter\_Medical Imaging**

Imaging Categories and their uses:

Radiography: Description and Uses

Magnetic Resonance Imaging (MRI): Description, Why it is done, Risks

Ultrasound: Description, Uses, Biomedical applications, Types, Benefits

Tomography: Description, Types: Conventional Tomography and Computer assisted tomography

- **Case: Medical Imaging**

Students individually solve the case in the platform and they all discuss it in the classroom or is given for homework if there is not enough time.

**8th week**

- **Lecture: Chapter\_Surveillance Systems for vital functions and Helpful Applications**

Patients Surveillance Systems - Support Systems for vital functions: Continuous glucose monitoring, Insulin Pump, Pacemakers: Artificial pacemaker and Implantable Cardiac Defibrillator.

**9th week**

- **Case: Patient Support System**

The case presents the use of an ICD and also includes medical imaging knowledge. Students are divided into groups and the case is solved in the platform and discussed simultaneously in the classroom.

**10th week**

- **Lecture: Chapter\_Surveillance Systems for vital functions and Helpful Applications**

Modern medical technology trends - Telemedicine: Smart phone applications that help patients keep their measurements diary and offer them advice and medical help: Glucose Buddy Diabetes Log, Blood Pressure (My Heart).

- **Case: Diabetes**





The case concerns diabetes and the use of the Glucose Buddy Diabetes Log application. Students are divided into groups and the case is solved in the platform and discussed simultaneously in the classroom.

- **Case: Blood Pressure**

The case is given for homework and to be discussed in the classroom in the next lesson.

### **11th week**

- **Case: Blood Pressure**

Discussion.

- **Case: Patients Support System\_2**

The case concerns the Continuous glucose monitoring and Insulin Pumps. Students are divided into groups and the case is solved in the platform and discussed simultaneously in the classroom.

### **12th week**

- Discussion with the students, questions etc.

## **7.2. Case Study: Heart Rates**

Using the Casemaker platform, we built our first case in order to show to the students how the platform works, what the process includes as well as to check students' knowledge on heart rates and electrocardiogram. Below, we are going to describe the process that has been followed in order to create the case in Casemaker and then how it is going to be presented and solved by the students in the classroom.

First of all, we had to create a teacher account in the Casemaker platform (figure 55) and then login in order to write the case and publish it to the students that would take part in the course. After signing up, we can login and the Homepage appears, as we can see in figure 56. Then we were able to create a new case simply by clicking on the Create a new Case button.




Figure 55 Login page of the Casemaker platform

**Casemaker**

## Create and Analyse Cases online

Work easily, creatively and innovatively on the same case

### Welcome to casemaker



### Sign Up for Casemaker

First Name:  Last Name:

Email:

Account Type:

☒ Student ☐ Author / Teacher

By clicking Sign Up, you agree to our Terms of Use and you have read our Data Use Policy, including our Cookie Use.

[Sign Up and get started!](#)

### Welcome to casemaker

After Assange on Snowden: drilling Doc 16-09-2014 >

July finds CBS intruder podcasting plan 16-08-2014 >

Authors United wants Amazon's board inside 15-09-2014 >



Figure 56 Homepage of the teacher's account in Casemaker

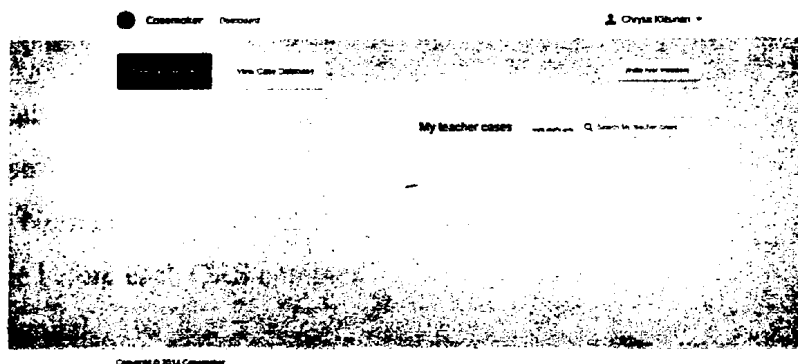
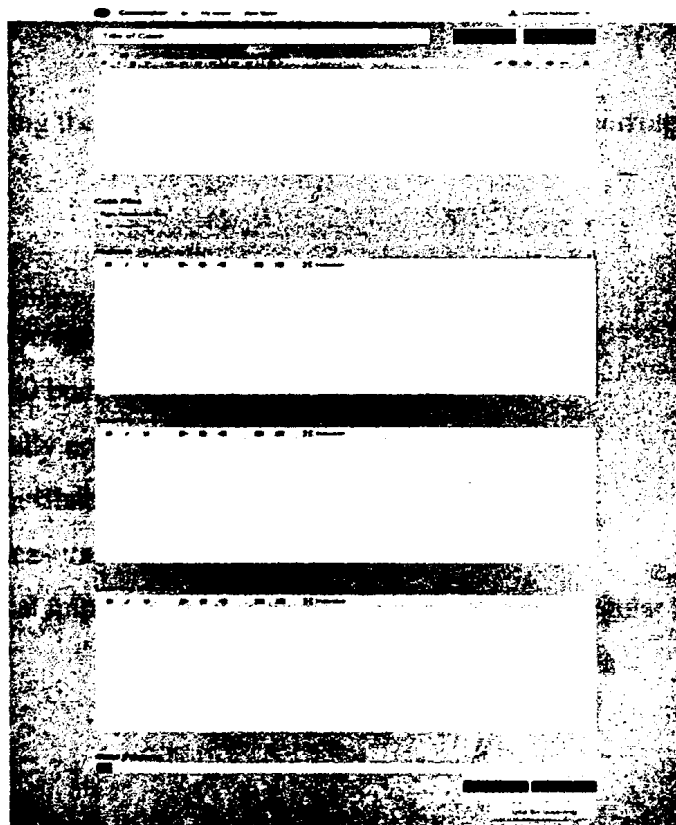


Figure 57 Create a new Case



In order to create our first case, we first gave it a title: Heart Rate, and we described the case content as it is shown in figure 58. In particular:

Four cases of heart rates are presented:

A.

Rhythm - Regular

Rate - (60-99 bpm)

QRS Duration - Normal

P Wave - Visible before each QRS complex

P-R Interval - Normal.

B.

Rhythm – Regular

Rate - More than 100 bpm

QRS Duration – Normal

P Wave - Visible before each QRS complex

P-R Interval – Normal

The impulse generating the heart beats are normal, but they are occurring at a faster pace than normal.

C.

Rhythm - Irregularly irregular

Rate - usually 100-160 bpm but slower if on medication

QRS Duration - Usually normal

P Wave - Not distinguishable as the atria are firing off all over

P-R Interval - Not measurable

The atria fire electrical impulses in an irregular fashion causing irregular heart rhythm

D.

Rhythm – Regular

Rate - 180-190 bpm

QRS Duration – Prolonged

P Wave - Not seen



Figure 58 Case title and description\_Heart Rate

**Casemaker** My cases New Case Chrysa Kirtsinari

Heart rate Add Co-Author Import Resources

**B I U S**

Four kinds of heart rates are presented:

**A**  
**Rhythm** - Regular, **Rate** - 60-99 bpm, **QRS Duration** - Normal, **P Wave** - Visible before each QRS complex, **P-R Interval** - Normal

**B**  
**Rhythm** - Regular, **Rate** - More than 100 bpm, **QRS Duration** - Normal, **P Wave** - Visible before each QRS complex, **P-R Interval** - Normal, the impulse generating the heart beats are slowed, but they are occurring at a faster pace than normal.

**C**  
**Rhythm** - Irregularly irregular, **Rate** - usually 100-160 bpm but slower if on medication, **QRS Duration** - Usually normal, **P Wave** - Not distinguishable as the atria are firing all over, **P-R Interval** - Not measurable. The atria fire electrical impulses in an irregular fashion causing irregular heart rhythm.

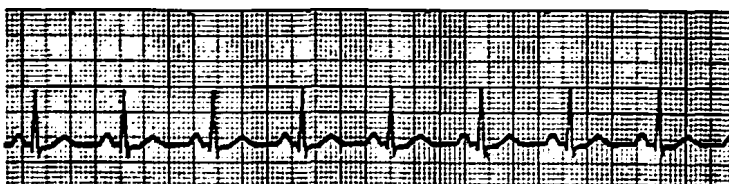
**D**  
**Rhythm** - Regular, **Rate** - 100-160 bpm, **QRS Duration** - Prolonged, **P Wave** - Not visible

We then attached a pdf file that would be necessary for the students to study and four images that students had to match with the questions. The pdf file, named Heart Rate, gives some basic information about various heart rates and it is cited below:

#### Normal Sinus Rhythm

- Rhythm - Regular
- Rate - (60-99 bpm)
- QRS Duration - Normal
- P Wave - Visible before each QRS complex
- P-R Interval - Normal

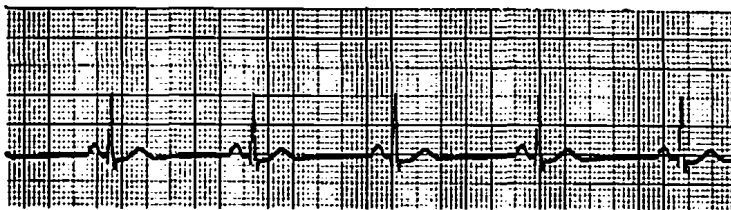
Figure 59 ECG\_Normal Sinus Rhythm



### Sinus Bradycardia

- Rhythm – Regular
- Rate - less than 60 beats per minute
- QRS Duration – Normal
- P Wave - Visible before each QRS complex
- P-R Interval – Normal

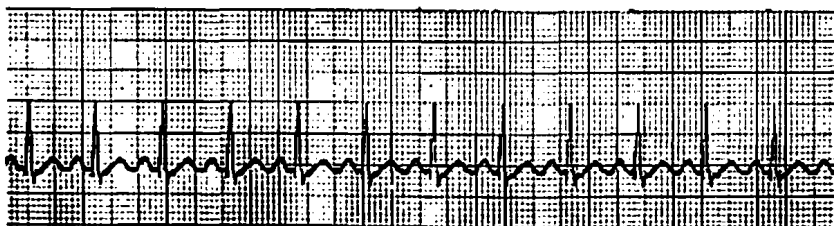
Figure 60 ECG\_ Sinus Bradycardia



### Sinus Tachycardia

- Rhythm – Regular
- Rate - More than 100 beats per minute
- QRS Duration – Normal
- P Wave - Visible before each QRS complex
- P-R Interval – Normal
- The impulse generating the heart beats are normal, but they are occurring at a faster pace than normal.

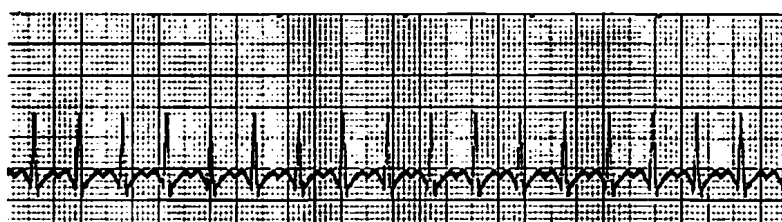
Figure 61 ECG\_ Sinus Tachycardia



### Supraventricular Tachycardia (SVT) Abnormal

- Rhythm – Regular
- Rate - 140-220 beats per minute
- QRS Duration - Usually normal
- P Wave - Often buried in preceding T wave
- P-R Interval - Depends on site of supraventricular pacemaker
- Impulses stimulating the heart are not being generated by the sinus node, but instead are coming from a collection of tissue around and involving the atrioventricular (AV) node

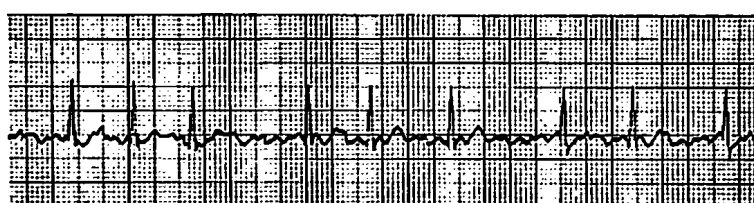
Figure 62 ECG\_Supraventricular Tachycardia (SVT) Abnormal



### Atrial Fibrillation

- Rhythm - Irregularly irregular
- Rate - usually 100-160 beats per minute but slower if on medication
- QRS Duration - Usually normal
- P Wave - Not distinguishable as the atria are firing off all over
- P-R Interval - Not measurable
- The atria fire electrical impulses in an irregular fashion causing irregular heart rhythm

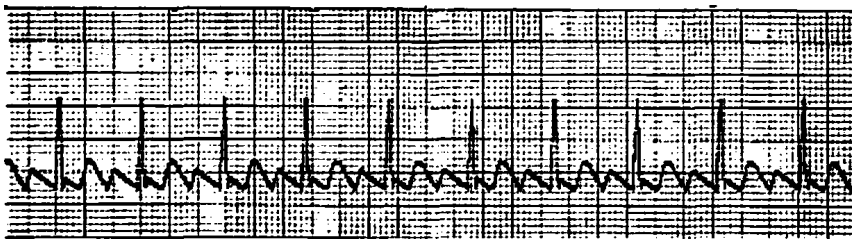
Figure 63 ECG\_Atrial Fibrillation



### Atrial Flutter

- Rhythm – Regular
- Rate - Around 110 beats per minute
- QRS Duration - Usually normal
- P Wave - Replaced with multiple F (flutter) waves, usually at a ratio of 2:1 (2F - 1QRS) but sometimes 3:1P
- Wave rate - 300 beats per minute
- P-R Interval - Not measurable

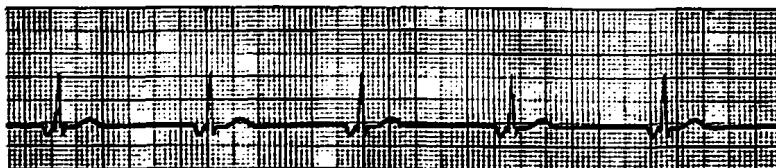
Figure 64 ECG\_Atrial Flutter



### Junctional Rhythms

- Rhythm – Regular
- Rate - 40-60 Beats per minute
- QRS Duration – Normal
- P Wave - Ratio 1:1 if visible. Inverted in lead II
- P Wave rate - Same as QRS rate
- P-R Interval – Variable

Figure 65 ECG\_Junctional Rhythms





### Ventricular Tachycardia (VT) Abnormal

- Rhythm – Regular
- Rate - 180-190 Beats per minute
- QRS Duration – Prolonged
- P Wave - Not seen

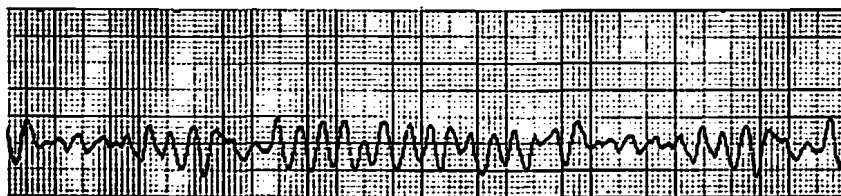
Figure 66 ECG\_Ventricular Tachycardia (VT) Abnormal



### Ventricular Fibrillation (VF) Abnormal

- Rhythm – Irregular
- Rate - 300+, disorganised
- QRS Duration - Not recognisable
- P Wave - Not seen
- This patient needs to be defibrillated!! QUICKLY

Figure 67 ECG\_Ventricular Fibrillation (VF) Abnormal



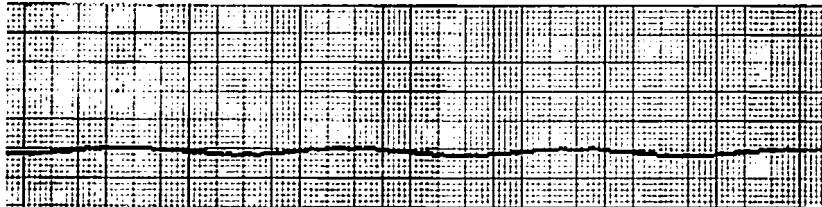
### Asystole - Abnormal

- Rhythm – Flat
- Rate - 0 Beats per minute
- QRS Duration – None



- P Wave – None
- Carry out CPR!!

Figure 68 ECG\_Asystole - Abnormal



More information about heart rates can be found in references [1] and [51].

The attached files are shown as in figure 69. The images we attached and asked students to match with the questions were the strips shown in Figures 59, 61, 63 and 66 previously.

Figure 69 Attached files of Heart Rate Case

#### Case Files

Type, Name and Size

|          |          |             |           |             |          |
|----------|----------|-------------|-----------|-------------|----------|
| Figure d | 41.56 KB | Figure c    | 34.3 KB   | Figure b    | 35.16 KB |
| Figure a | 47.28 KB | Heart Rates | 582.27 KB | Attach File |          |

Subsequently, we wrote the abstract of the case as we can see in figure 70. In particular:

Heart rate, or heart pulse, is the speed of the heartbeat measured by the number of heartbeats per unit of time - typically beats per minute (bpm).

A precise method of determining heart rate involves the use of an electrocardiograph, or ECG.

ECG is described by 1) waves: P, QRS, T and U

2) segments: time durations between waves, e.g. P-R

3) intervals: time durations that include waves and segments, e.g. P-R

interval is made up of the P-wave and the P-R segment.



## Figure 70 Heart Rate Case\_Abstract

## Abstract

B I U        Fullscreen

Heart rate, or heart pulse, is the speed of the heartbeat measured by the number of heartbeats per unit of time - typically beats per minute (bpm).

A precise method of determining heart rate involves the use of an electrocardiograph, or ECG.

ECG is described by 1) waves: P, QRS, T and U.

2) segments: time durations between waves, e.g. P-R

3) Intervals: time durations that include waves and segments, e.g. P-R interval is made up of the P-wave and the P-R segment.

Following, in the Teaching Notes field, we composed the questions that had to be answered (Figure 71). Specifically:

Question 1: Which type of heart rate is described in case A? Which one of the figures (a, b, c, d) in the attached files corresponds to it?

Question 2: Which type of heart rate is described in case B? Which one of the figures (a, b, c, d) corresponds to it?

Question 3: Which type of heart rate is described in case C? Which one of the figures (a, b, c, d) corresponds to it?

Question 4: Which type of heart rate is described in case D? Which one of the figures (a, b, c, d) corresponds to it?

## Figure 71 Heart Rate Case\_Teaching Notes

## Teaching Notes

B I U       Fullscreen

Question 1 Which type of heart rate is described in case A? Which one of the figures (a, b, c, d) in the attached files corresponds to it?

Question 2 Which type of heart rate is described in case B? Which one of the figures (a, b, c, d) in the attached files corresponds to it?

Question 3 Which type of heart rate is described in case C? Which one of the figures (a, b, c, d) in the attached files corresponds to it?

Question 4 Which type of heart rate is described in case D? Which one of the figures (a, b, c, d) in the attached files corresponds to it?





Figure 73 Heart Rate Case\_Splitcase to parts

Case creator 44 words Chrysa Kibben

### Heart rate

1 Add to A/B/C case parts 2 Assign files, files and tasks 3 Send to students

Four cases of heart rates are presented

**A**  
Rhythm - Regular Rate - (60-99 bpm) QRS Duration - Normal P Wave - Visible before each QRS complex P-R Interval - Normal

**B**  
Rhythm - Regular Rate - More than 100 bpm QRS Duration - Normal P Wave - Visible before each QRS complex P-R Interval - Normal The impulses generating the heart beats are normal but they are occurring at a faster pace than normal

**C**  
Rhythm - Irregularly irregular Rate - usually 100-199 bpm but slower if on medication QRS Duration - Usually normal P Wave - Not distinguishable as the atria are firing off all over P-R Interval - Not measurable The atria fire electrical impulses in an irregular fashion causing irregular heart rhythm

**D**  
Rhythm - Regular Rate - 180-190 bpm QRS Duration - Prolonged P Wave - Not seen

Disable from Teacher Assign Files, Files and Tasks

Copyright © 2014 Casecreator

Figure 74 Heart Rate Case\_Split A

### Split A

Four cases of heart rates are presented

**A**  
Rhythm - Regular Rate - (60-99 bpm) QRS Duration - Normal P Wave - Visible before each QRS complex P-R Interval - Normal

### Case Files

| Type, Name and Size                             |
|---|
| <input checked="" type="checkbox"/> Heart Rates |
| <input checked="" type="checkbox"/> Figure a    |
| <input checked="" type="checkbox"/> Figure b    |
| <input checked="" type="checkbox"/> Figure c    |
| <input checked="" type="checkbox"/> Figure d    |

### Assignment & Tasks

B / I / U = = = = = Filter

Question 1 Which type of heart rate is described in case A? Which one of the figures (a, b, c, d) in the attached files corresponds to it?



Figure 75 Heart Rate Case\_Split B

**Split B**

B.

Rhythm - Regular, —Rate - More than 100 bpm, —QRS Duration - Normal, —P Wave - Visible before each QRS complex, —P-R Interval - Normal, The impulse generating the heart beats are normal, but they are occurring at a faster pace than normal

**Case Files**

Type, Name and Size

|   |  |  |
|---|--|--|
| <input checked="" type="checkbox"/> Heart Rates ✓ | <input checked="" type="checkbox"/> Figure a ✓ | <input checked="" type="checkbox"/> Figure b ✓ |
| <input checked="" type="checkbox"/> Figure c ✓    | <input checked="" type="checkbox"/> Figure d ✓ |  |

**Assignment & Tasks**

B / U = = = = = Fullscreen

Question 2 Which type of heart rate is described in case B? Which one of the figures (a, b, c, d) in the attached files corresponds to it?

Figure 76 Heart Rate Case\_Split C

**Split C**

C

—Rhythm - Irregularly irregular, —Rate - usually 100-160 bpm but slower if on medication, —QRS Duration - Usually normal, —P Wave - Not distinguishable as the atria are firing off all over, —P-R Interval - Not measurable, —The atria fire electrical impulses in an irregular fashion causing irregular heart rhythm

**Case Files**

Type, Name and Size

|   |  |  |
|---|--|--|
| <input checked="" type="checkbox"/> Heart Rates ✓ | <input checked="" type="checkbox"/> Figure a ✓ | <input checked="" type="checkbox"/> Figure b ✓ |
| <input checked="" type="checkbox"/> Figure c ✓    | <input checked="" type="checkbox"/> Figure d ✓ |  |

**Assignment & Tasks**

B / U = = = = = Fullscreen

Question 3 Which type of heart rate is described in case C? Which one of the figures (a, b, c, d) in the attached files corresponds to it?



**Figure 77 Heart Rate Case\_Split D**

**Split D**

**D.**

—Rhythm – Regular, —Rate – 180-190 bpm, —QRS Duration – Prolonged, —P Wave – Not seen

**Case Files**

**File Name and Size**

|  |  |  |
|--|--|--|
| <input checked="" type="checkbox"/> Heart Rate ✓ | <input checked="" type="checkbox"/> Figure a ✓ | <input checked="" type="checkbox"/> Figure b ✓ |
| <input checked="" type="checkbox"/> Figure c ✓   | <input checked="" type="checkbox"/> Figure d ✓ |  |

**Download & Tools**

**B I U** **≡ ≡ ≡ ≡ ≡** **Fullscreen**

**Question 47** Which type of heart rate is described in case D? Which one of the figures (a, b, c, d) in the attached files corresponds to it?

Figure 78 Heart Rate Case\_ Release case to Students

Caseemaker My cases Chrys Kaban

## Heart rate

all changes saved 30-10-2014 13:17:35

1 Split to A/B/C case parts 2 Assign titles, files and tests 3 Send to Students

You can add Groups and students by Uploading CSV file or Adding them Manually

**Upload CSV file**

You can import groups through and CSV file. Click here to download an example of a compatible CSV file

Upload csv

**Add Group or Student Manually**

Enter the following details of the student of group and group members below to add them to the receivers list

Group/Student Name \*

Same Group Name

Group/Student Email \*

member1@example.co.uk, member2@example.co.uk

Next step

**Added students or groups**

Group1

student1@example.co.uk

**Release dates (A/B/C Cases)**

| Case    | Release date | End date   |
|---------|--------------|------------|
| Split A | 08-10-2014   | 31-10-2014 |
| Split B | 08-10-2014   | 31-10-2014 |
| Split C | 08-10-2014   | 31-10-2014 |
| Split D | 08-10-2014   | 31-10-2014 |

**Message**

Case Case Learning of

Heart Rate - Electrocardiography

Group1

Release Case to Students and Groups



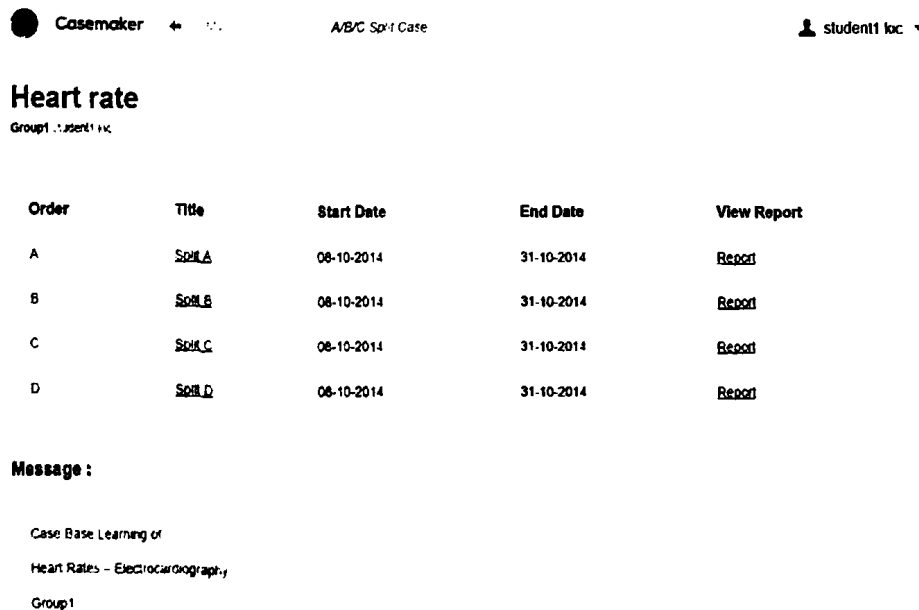


As for the discussion and solution of the case in the classroom, the Heart Rates case was planned to be presented in the classroom in the 3rd week of the course. At first, the teacher has to present the platform and explain how it works as well as how and why it is going to be used during the course.

Students would have already receive an e-mail that invites them to the platform after the invitation has been sent by the teacher. So, they would have visited Casemaker and signed up for it in order to be able to login each time they receive an e-mail that invites them to a new case. Students login the Casemaker platform using their e-mail and their dashboard with the cases they have been invited to will appear on the screen as shown in figure 79.

Subsequently, the teacher will divide students into groups which have already been formed through the platform as we have mentioned before. Students are encouraged to click on the Heart Rate case and see the four parts of the case, their title, their start and end date and the message of the teacher as shown below.

Figure 79 Hear Rate Case\_Student sees the case



The screenshot shows the Casemaker platform interface. At the top, there is a navigation bar with the Casemaker logo, a user profile icon labeled 'student1 loc', and a dropdown menu. Below the navigation bar, the main content area displays the title 'Heart rate' and a subtitle 'Group1 - student1 loc'. A table lists four cases (A, B, C, D) with columns for Order, Title, Start Date, End Date, and View Report. Below the table, there is a 'Message:' section containing text about Case Base Learning of Heart Rates - Electrocardiography.

| Order | Title   | Start Date | End Date   | View Report            |
|-------|---------|------------|------------|------------------------|
| A     | Spill A | 08-10-2014 | 31-10-2014 | <a href="#">Report</a> |
| B     | Spill B | 08-10-2014 | 31-10-2014 | <a href="#">Report</a> |
| C     | Spill C | 08-10-2014 | 31-10-2014 | <a href="#">Report</a> |
| D     | Spill D | 08-10-2014 | 31-10-2014 | <a href="#">Report</a> |

**Message :**

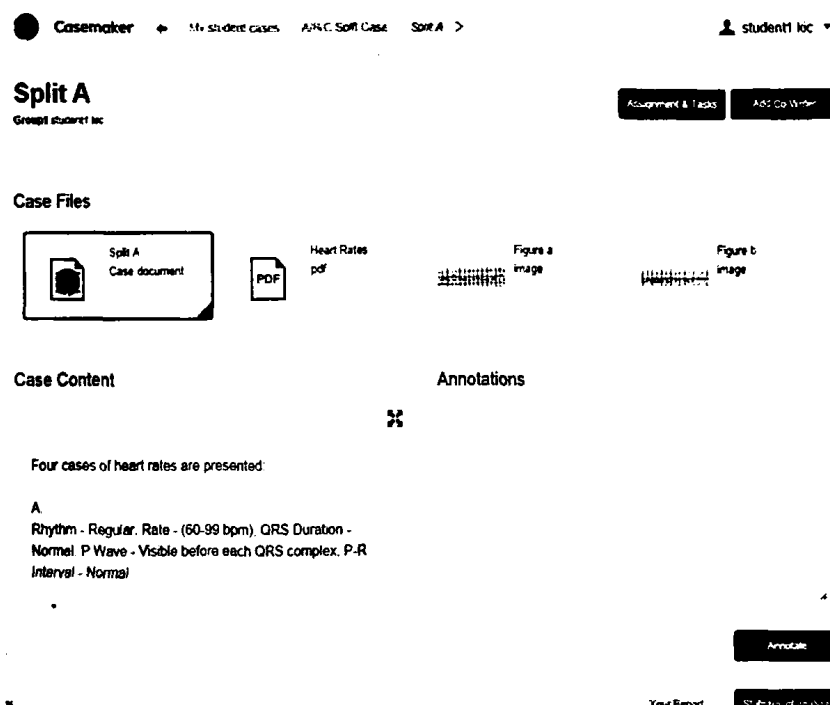
Case Base Learning of  
Heart Rates - Electrocardiography  
Group1

Then, students are asked to discuss the case in groups, seek relative information in the attached files and continue to the case solution. In order to solve the case, students click on



each split's title and after that they can read the case content as well as the attached files, as shown in figure 80, by clicking on them and they will be automatically downloaded to their laptop.

Figure 80 Heart Rate Case\_Student sees Split A



They then click on the assignments and tasks button in order to read what they have to do as it is shown in figure 81. They can click on the Annotations field where they can write some notes and then on the annotate button. Following, they click on Your Report button in order to compose their full answer to the case's tasks (figure 82).

Figure 81 Heart Rate Case\_Assignments and Tasks-Split A

### Assignment & Tasks

close

**Question 1:** Which type of heart rate is described in case A? Which one of the figures (a, b, c, d) in the attached files corresponds to it?



**Figure 82 Heart Rate Case\_ Student's Report-Split A**

CaseMaker

[My Student Cases](#)
[AP/IB Solutions](#)
[Split 1](#)
[Case Report](#)

student1 loc

# Split A

Group 1 student1 loc

[View Statistics](#)

All changes saved instantly

B
I
U
+
≡
≡
H
H
U
C
U

Since the rhythm is regular, the rate ranges from 58 to 99 beats per minute, the QRS duration and the P-R interval are normal and P wave is visible before each QRS complex, we are led to the conclusion that the rhythm we are looking for is the normal sinus rhythm.

The figure that agrees with this description Figure b.

We quote one possible right answer for split A:

Since the rhythm is regular, the rate ranges from 60 to 99 bpm, the QRS duration and the P-R interval are normal and P wave is visible before each complex, we are led to the conclusion that the rhythm we are looking for is the normal sinus rhythm. The figure that agrees with this description is figure b.

Likewise, students continue in order to solve splits B, C and D as it is presented in figures 83-91 below.

**Figure 83 Heart Rate Case Student sees Split B**

[illegible]



Figure 87 Hear Rate Case\_Assignment and Tasks-Split C

## Assignment &amp; Tasks

close

**Question 3:** Which type of heart rate is described in case C? Which one of the figures (a, b, c, d) in the attached files corresponds to it?

Figure 88 Heart Rate Case\_Student's Report-Split C

**Casemaker** My student cases A/B/C Split Case Split C Case Report student1 loc

**Split C**  
Group student1 loc

Work Student

All changes saved instantly

B I U + E H X C

Because of the fact that the rhythm is irregularly irregular, the rate ranges usually from 100 to 160 beats per minute, the QRS Duration is usually normal, P Wave is not distinguishable, P-R Interval is not measurable and the atria fire electrical impulses in an irregular fashion causing irregular heart rhythm, we believe this heart rate is Atrial Fibrillation. The figure that presents it is figure a.

Figure 89 Heart Rate Case\_Student sees Split D

**Casemaker** My student cases A/B/C Split Case Split D student1 loc

**Split D**  
Group student1 loc

Work Student

All changes saved instantly

**Case Files**

Figure c image

Figure c image

**Case Content**

**Annotations**

Figure c image

student1 loc 08-10-2018 13:01:17

VT

C

Figure Report





Figure 93 Heart Rate Case\_Teacher sees student's Report for Split B

**Casemaker** ← Case Analytics ABC Split Case Split D Case Report **Chrysa Kitsinani**

### Split B

Group1 student1: 100

#### Case Report

As the rhythm is regular, the rate is more than 100 beats per minute, QRS Duration and the P-R Interval are normal, P Wave is visible before each QRS complex and the impulse generating the heart beats are normal, but they are occurring at a faster pace than normal, it is likely that sinus tachycardia is described.

After checking the rest of the figures in the attached files, we arrived to the conclusion that the heart rate that is described in Sinus Tachycardia and the corresponding figure is Figure d.

Figure 94 Heart Rate Case\_Teacher sees student's Report for Split C

**Casemaker** ← Case Analytics ABC Split Case Split C Case Report **Chrysa Kitsinani**

### Split C

Group1 student1: 100

#### Case Report

Because of the fact that the rhythm is irregularly irregular, the rate ranges usually from 100 to 160 beats per minute, the QRS Duration is usually normal, P Wave is not distinguishable, P-R Interval is not measurable and the atria fire electrical impulses in an irregular fashion causing irregular heart rhythm, we believe that this heart rate is Atrial Fibrillation and the figure that presents it is Figure a.

Figure 95 Heart Rate Case\_Teacher sees student's Report for Split D

**Casemaker** ← Case Analytics ABC Split Case Split D Case Report **Chrysa Kitsinani**

### Split D

Group1 student1: 100

#### Case Report

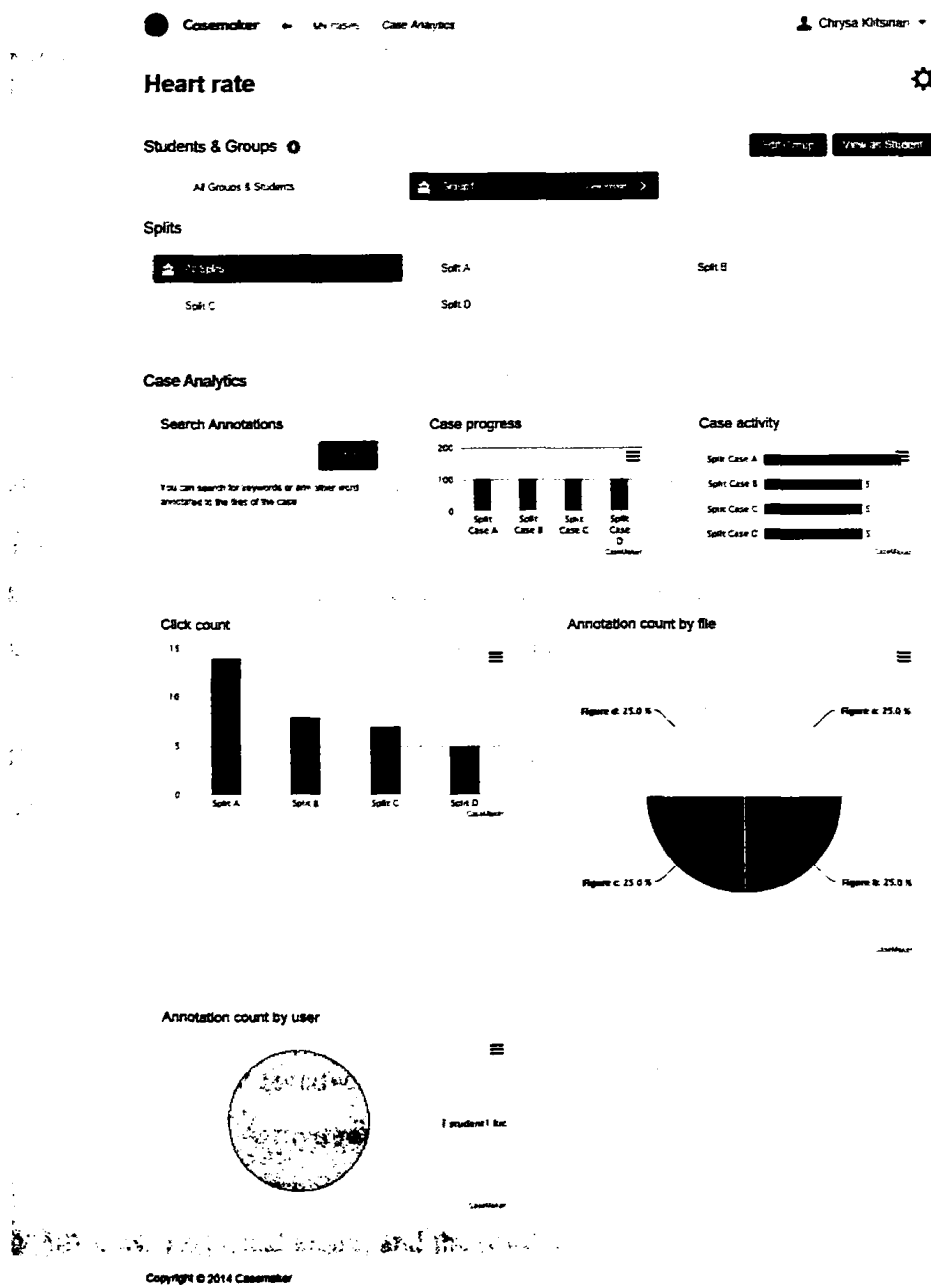
The answer is Ventricular Tachycardia (VT) Abnormal because the rhythm is regular, the rate ranges from 180 to 190 Beats per minute, the QRS duration is prolonged and P Wave cannot be seen.

The figure in which we can see a VT strip is Figure c.



Finally, students and teachers can view the analytics of the case as shown in figure 96.

Figure 96 Heart Rate Case\_Analytics





### 7.3. Case Study: Arrhythmias and ECG

The next case scenario that we created aimed at introducing arrhythmias and electrocardiogram to students within the framework of Biomedical Engineering. The case was planned to be given for homework at the end of the third week's lecture and the teacher would check the students' participation through the platform.

The case title is Arrhythmias and ECG and its content is the following:

Jack is a 42-year old male who is generally in good health, but he is an occasional smoker, a great coffee drinker (3-4 cups of coffee daily) and he enjoys some alcohol every now and then. About six months ago, he lost his full time job. He quickly found work again in a position that pays a lower salary. It has been hard for him to find time to exercise with his new work. He is going through a rough and really stressful period and he feels anxiety from time to time. He has also noticed that he sometimes experiences dizziness, shortness of breath or rapid pulse while he has also fainted once. So, he decided to visit a doctor. What the students were asked for, was to identify what type of arrhythmia Jack has. Having checked the background information attached, answer the following.

The case's attached files were: a pdf file with the needed background information, a pdf file with Jack's results and a png file with Jack's ECG. The first one gives some basic information about arrhythmias and is cited below:

#### Arrhythmias and ECG

An arrhythmia is a disorder of the heart rate (pulse) or heart rhythm, such as beating too fast (tachycardia), too slow (bradycardia), or irregularly. An arrhythmia can be silent and not cause any symptoms. Arrhythmias can be hard to diagnose, especially the types that only cause symptoms every once in a while. Doctors diagnose arrhythmias based on medical and family histories, a physical exam, and the results from tests and procedures.

When **symptoms** of an arrhythmia occur, they may include:

- Palpitations (a feeling of skipped heart beats, fluttering or "flip-flops," or feeling that your heart is "running away").
- Pounding in the chest.



- Dizziness or feeling light-headed.
- Fainting.
- Shortness of breath.
- Chest discomfort.
- Weakness or feeling very tired.
- Sweating.
- Paleness.
- In extreme cases, collapse and sudden cardiac arrest.

**Arrhythmias may be caused by:**

- Alcohol, caffeine, or stimulants such as amphetamines
- Beta-blockers
- Cigarette smoking (nicotine)
- Drugs that mimic the activity of your nervous system
- Medicines used for depression or psychosis
- Sometimes anti-arrhythmic medications, prescribed to treat one type of arrhythmia, will cause another type of arrhythmia.
- High blood pressure
- Infections that damage the heart muscle or the sac around the heart
- Diabetes, which increases the risk of high blood pressure and coronary heart disease
- Sleep apnea, which can stress the heart because the heart doesn't get enough oxygen
- An overactive or underactive thyroid gland (too much or too little thyroid hormone in the body)

**Some of the more common abnormal heart rhythms are:**

- Atrial fibrillation or flutter
- Atrioventricular nodal reentry tachycardia (AVNRT)
- Heart block or atrioventricular block
- Multifocal atrial tachycardia



- Paroxysmal supraventricular tachycardia
- Ventricular fibrillation or ventricular tachycardia
- Wolff-Parkinson-White syndrome

### Medical and Family Histories - Physical Exam

To diagnose an arrhythmia, a doctor may ask the patient to describe his symptoms. He also may ask whether the patient has other health problems and about the patient's family medical history. The doctor will likely want to know what medicines the patient is taking as well as for health habits. He then performs a physical exam.

### ECG (Electrocardiogram)

An ECG is a simple, painless test that detects and records the heart's electrical activity. It's the most common test used to diagnose arrhythmias. An ECG shows how fast the heart is beating and its rhythm (steady or irregular). It also records the strength and timing of electrical signals as they pass through the heart.

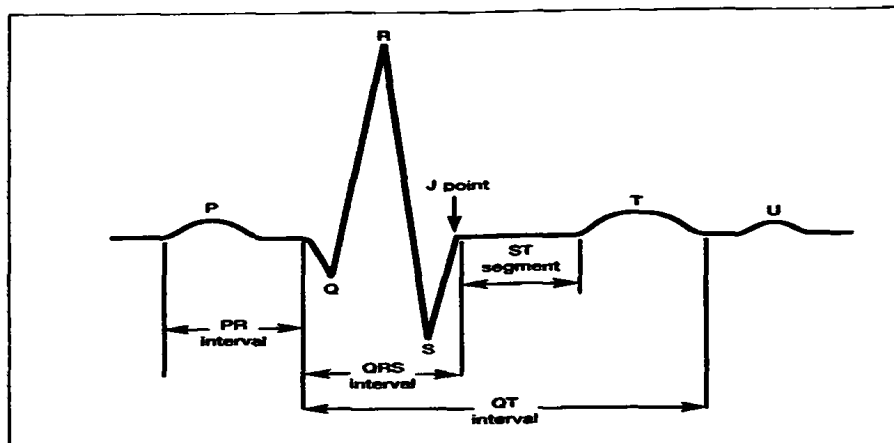
A standard ECG only records the heartbeat for a few seconds. It won't detect arrhythmias that don't happen during the test. To diagnose arrhythmias that come and go, a doctor may have the patient wear a portable ECG monitor. The two most common types of portable ECGs are Holter and Event Monitors.

**Three major waves** of electric signals appear on the ECG. Each one shows a different part of the heartbeat.

- The first wave is called the P wave. It records the electrical activity of the atria.
- The second and largest wave is the QRS wave. It records the electrical activity of the ventricles.
- The third wave is the T wave. It records the heart's return to the resting state.



### Figure 97 Major waves of an ECG



Doctors study the shape and size of the waves, the time between waves and the rate and regularity of beating. The major steps in the analysis of the ECG signals are:

- **Noise filter** removes and reduces the noise components from various sources in the ECG signal.
- **Cardiac cycle detection** involves detecting the QRS complex peak corresponding to each beat. QRS Complex detection is implemented using Tompkins QRS complex detection algorithm.
- **ECG characteristic points detection** involves determining of significant points on the ECG for feature extraction. It includes the detection of QRS complex onset and offset, ST segment detection and T peak detection.
- **Feature set formulation** includes formulation and selection of characteristic features such that they significantly relate to the abnormalities.
- Additional features are extracted by performing complexity analysis on the signal.

**ECG Examples**

Figure 98 Normal heart rate

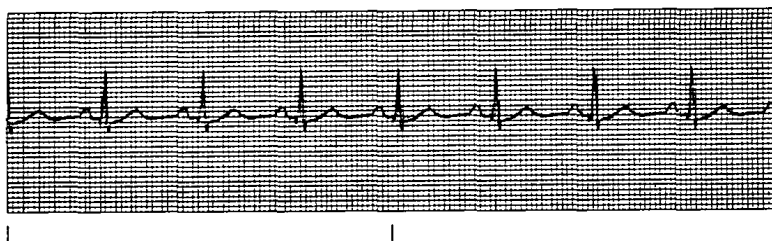


Figure 99 Atrial Fibrillation



Figure 100 Bradycardia

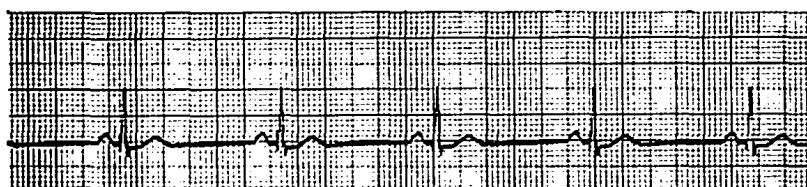
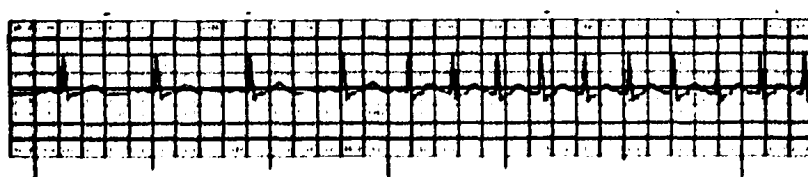


Figure 101 Paroxysmal Supraventricular Tachycardia



### Holter and Event Monitors

A Holter monitor records the heart's electrical signals for a full 24- or 48-hour period. The patient wears one while he does his normal daily activities. This allows the monitor to record his heart for a longer time than a standard ECG. An event monitor is similar to a Holter monitor. The patient wears an event monitor while doing his normal activities. However, an event monitor only records his heart's electrical activity at certain times while he is wearing it.

For many event monitors, the patient pushes a button to start the monitor when he feels symptoms. Other event monitors start automatically when they sense abnormal heart rhythms. Some event monitors are able to send data about the heart's electrical activity to a central monitoring station. Technicians at the station review the information and send it to the doctor. The patient also can use the device to report any symptoms he is having. He can wear an event monitor for weeks or until symptoms occur.

Blood tests. They check the level of substances in the blood, such as potassium and thyroid hormone. Abnormal levels of these substances can increase the chances of having an arrhythmia.

More information about arrhythmias and ECG can be found in references [1], [46], [47], [48] and [49].

The second pdf file that we attached contained Jack's exam results and they are shown below:

Table 3 Arrhythmias Case\_Jack's exam results

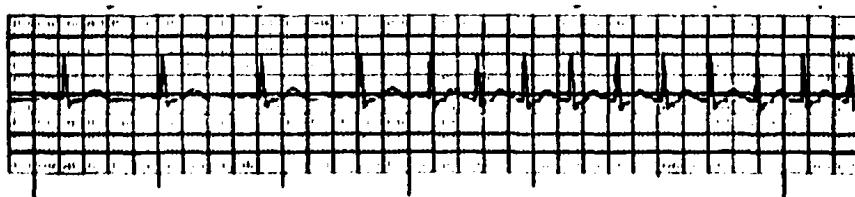
|   |  |                                  |                        |                |          |
|---|--|----------------------------------|------------------------|----------------|----------|
| <b>Symptoms</b>                         | anxiety  | dizziness                        | shortness of<br>breath | rapid<br>pulse | fainting |
| <b>Health<br/>problems</b>              | -  |                                  |                        |                |          |
| <b>Family's<br/>medical<br/>history</b> | His<br>grandmother<br>had high blood<br>pressure | His grandfather<br>died suddenly |                        |                |          |



|                        |   |                 |              |
|------------------------|---|-----------------|--------------|
| <b>Medicines</b>       | -   |                 |              |
| <b>Health habits</b>   | smoking                                       | Too much coffee | Some alcohol |
| <b>Stress or anger</b> | stress  |                 |              |
| <b>Physical exam</b>   | rapid heart rate, pounding pulses in his neck |                 |              |
| <b>Blood tests</b>     | Low magnesium levels                          |                 |              |
| <b>ECG</b>             | a very rapid but otherwise normal rhythm      |                 |              |

And the png file contains Jack's ECG and it is shown below:

Figure 102 Arrhythmias Case\_Jack's ECG strip



The questions that had to be answered by the students (in the Teaching Notes field) are the following:

Question 1: After asking for his medical and family histories, the doctor would perform a physical exam on Jack and then he would ask him to proceed with the most important examination for diagnosing heart problems. Which do you think is this exam and what kind of information does it reveal?

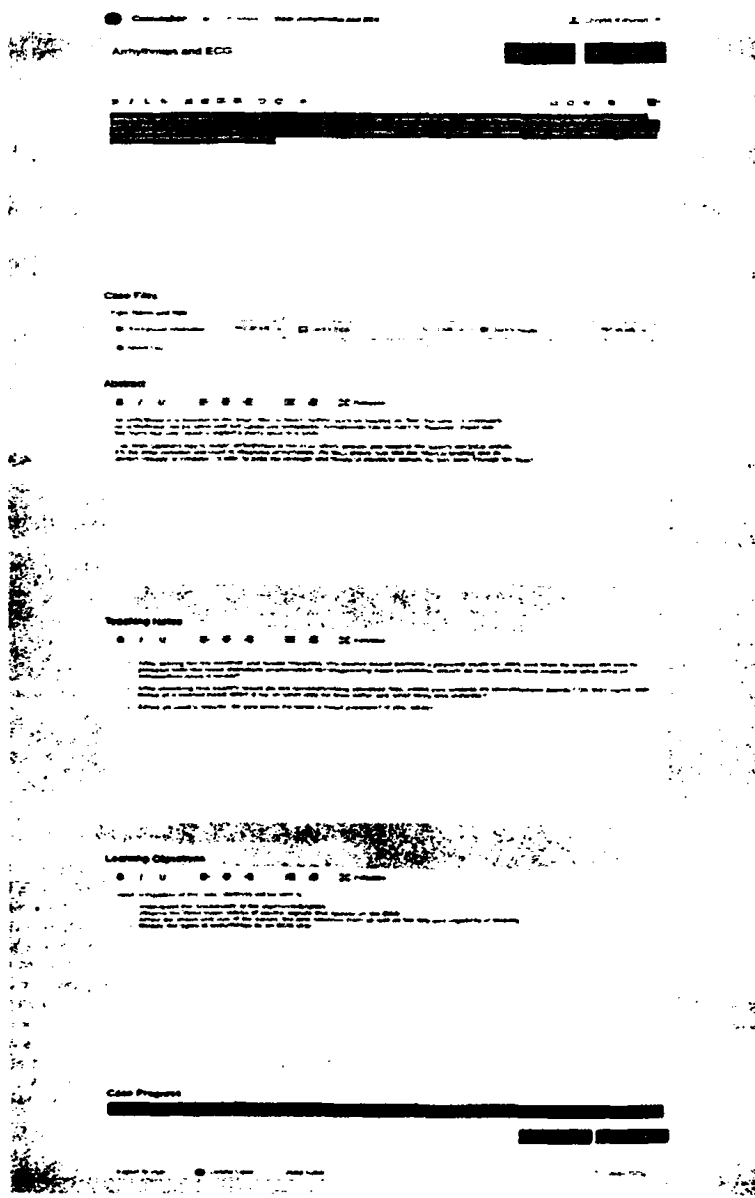


Question 2: After checking this exam's result (in the corresponding attached file), could you analyze its characteristic points? Do they agree with those of a normal heart rate? If no, in what way do they differ and what does this indicate?

Question 3: Given all Jack's results, do you think he faces a heart problem? If yes, what?

The whole case is shown in figure 103.

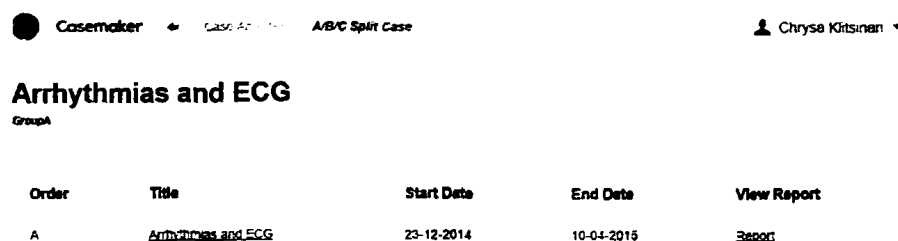
Figure 103 Case\_Arrhythmias and ECG





The students received the invitation e-mail and they had to login the Casemaker platform using their e-mail in order to be able to read and solve the case. After clicking on the case title they see the following:

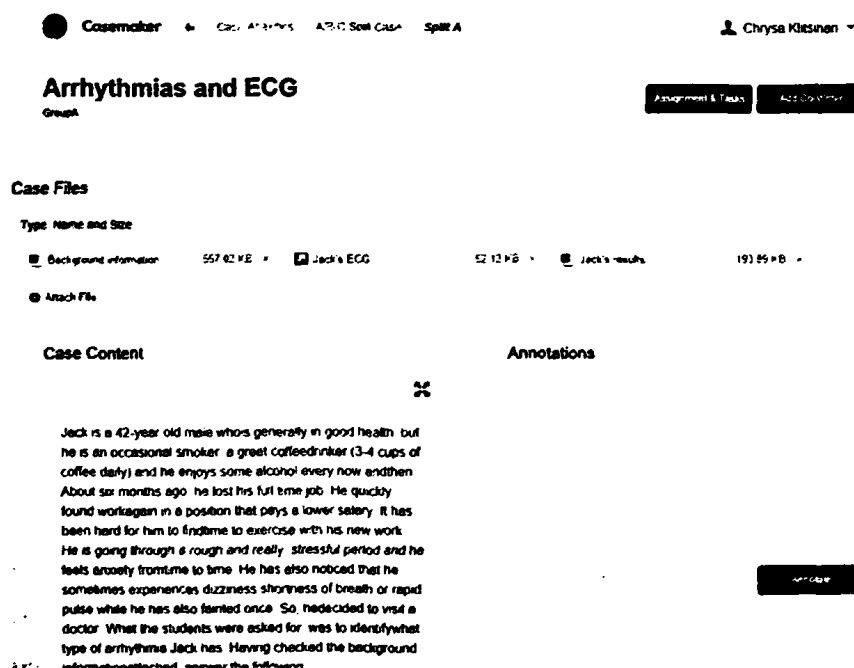
Figure 104 Case Arrhythmias and ECG\_Students of GroupA see the case



| Order | Title               | Start Date | End Date   | View Report            |
|-------|---------------------|------------|------------|------------------------|
| A     | Arrhythmias and ECG | 23-12-2014 | 10-04-2015 | <a href="#">Report</a> |

In order to solve the case, students clicked on the case title and after that they could read the case content as well as the attached files by clicking on them and they were automatically downloaded to his pc.

Figure 105 Arrhythmias Case\_Student reads the case



**Arrhythmias and ECG**

Group A

Assignment & Tasks Add Content

**Case Files**

| Type                   | Name and Size |
|------------------------|---------------|
| Background information | 557 KB        |
| Jack's ECG             | 52 KB         |
| Jack's results         | 191 KB        |

**Case Content**

Annotations

Jack is a 42-year old male who's generally in good health, but he is an occasional smoker, a great coffee drinker (3-4 cups of coffee daily) and he enjoys some alcohol every now and then. About six months ago, he lost his full time job. He quickly found work again in a position that pays a lower salary. It has been hard for him to find time to exercise with his new work. He is going through a rough and really stressful period and he feels uneasy from time to time. He has also noticed that he sometimes experiences dizziness, shortness of breath or rapid pulse while he has also fainted once. So, he decided to visit a doctor. What the students were asked for was to identify what type of arrhythmia Jack has. Having checked the background information attached, answer the following:



They then clicked on the assignments and tasks button in order to read what they had to answer to as it is shown in figure 106.

Figure 106 Arrhythmias and ECG Case\_Assignment and Tasks

#### Assignment & Tasks

close

1. After asking for his medical and family histories, the doctor would perform a physical exam on Jack and then he would ask him to proceed with the most important examination for diagnosing heart problems. Which do you think is this exam and what kind of information does it reveal?
2. After checking this exam's result (in the corresponding attached file), could you analyze its characteristic points? Do they agree with those of a normal heart rate? If no, in what way do they differ and what does this indicate?
3. Given all Jack's results, do you think he faces a heart problem? If yes, what?

Some of them made some notes in the Annotations field and then the clicked on Your Report button and composed their full answer to the case's tasks. We quote one possible right answer as well as the students real answers in the following figures (107, 108, 109).

Question 1: Blood tests: to look for abnormalities in electrolytes and thyroid function and ECG (Electrocardiogram): it detects and records the heart's electrical activity. It shows how fast the heart is beating and its rhythm (steady or irregular). It also records the strength and timing of electrical signals as they pass through the heart.

Question 2: It is obvious that there is a sudden change in the heart rate as it becomes faster, the QRS complex becomes narrower and P waves are less noticeable. His heart rate is about 180 beats per second. So, the ECG strip indicates PSVT.

Question 3: After the ECG, where we can see that rate changes suddenly in a single beat, QRS narrow, P waves may not be noticeable and considering also Jack's blood test results (low magnesium levels), his symptoms (anxiety, dizziness, shortness of breath, rapid pulse, fainting), his health habits (smoking, caffeine, alcohol) but also his stress, i believe that Jack has Paroxysmal Supraventricular Tachycardia.



Figure 107 Arrhythmias and ECG Case\_GroupA Report

Cosemaker Case Analytics AEC Soft Case Split A Case Report Chryse Kitsman

## Arrhythmias and ECG

Group A

### Case Report

2) The characteristics points of Jack's exam are:

1. Abrupt clinical presentation (episodes begin and end suddenly)
2. Narrow QRS complex
3. Irregular RR intervals and rapid rhythm

The aforementioned characteristics points don't match with those of a normal ECG. The main differences are:

1. In a normal ECG the heart is beating in a regular sinus rhythm
2. The shape of P wave is generally smooth
3. The PR interval remains constant

Figure 108 Arrhythmias and ECG Case\_GroupB Report

Cosemaker Case Analytics AEC Soft Case Split A Case Report Chryse Kitsman

## Arrhythmias and ECG

Group B

### Case Report

1. Ο γιατρός θα πρέπει να δει το ηλεκτροκαρδιογράφημα του ασθενή και ίσως θα ήταν καλύτερο να χρησιμοποιηθεί Holter ή Event Monitors που δίνουν αποτελέσματα για περισσότερη ώρα. Η εξέταση αυτή θα δείξει τον καρδιακό ρυθμό και θα δείξει αν υπάρχει κάποιο πρόβλημα αρρυθμίας.
2. Στο ηλεκτροκαρδιογράφημα ο ρυθμός της καρδιάς από ένα σημείο και μετά αυξάνεται. Αυτό δεν ταίριαζε με το φυσιολογικό ρυθμό και αυτό δείχνει ότι μπορεί να υπάρχει πρόβλημα αρρυθμίας.
3. Ο Jack το πιθανότερο είναι να έχει πρόβλημα ταχυκαρδίας (Paroxysmal Supraventricular Tachycardia)

Figure 109 Arrhythmias and ECG Case\_GroupD Report

Cosemaker Case Analytics AEC Soft Case Split A Case Report Chryse Kitsman

## Arrhythmias and ECG

Group D

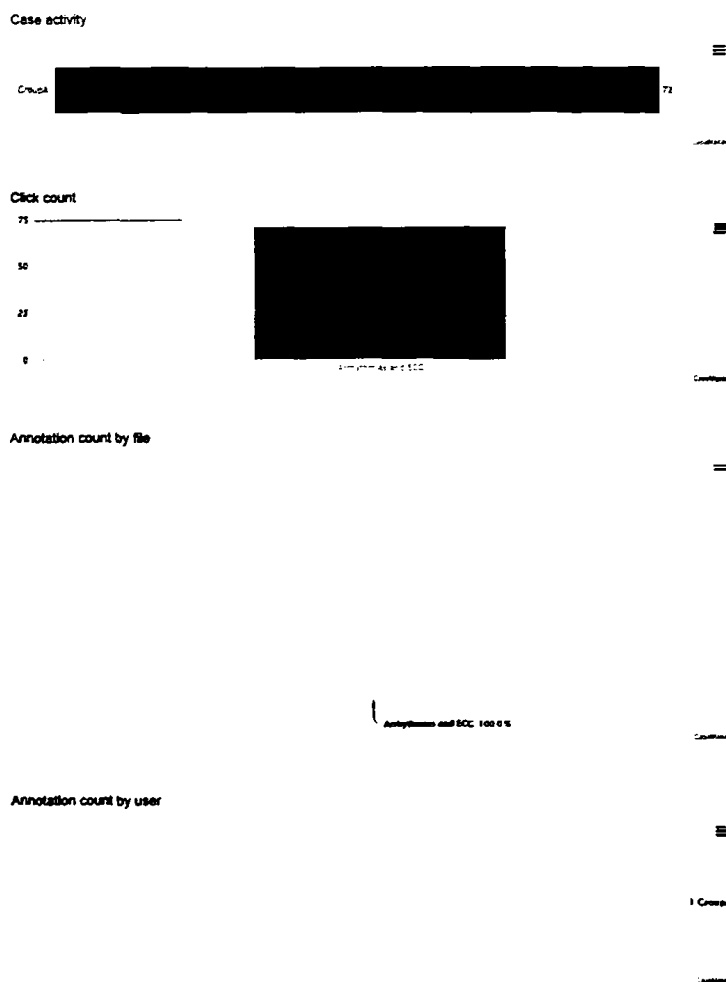
### Case Report

1. I think that this exam is ECG. It reveals information about heart rate and rhythm. It also reveals information about the amplitude of the electric signals which indicates how hard a beat is.
2. The characteristic points of Jack's ECG don't agree with those of a normal heart rate. In a normal heart rate, the rhythm of the heart is steady with not too big frequency. Jack's heart rate isn't steady because there are points with irregular rhythm with big frequency between normal rhythms. So this indicates some heart abnormality.
3. Yes, I believe that Jack faces a heart problem and I believe this is paroxysmal supraventricular tachycardia.



While students were dealing with the case we were able to view the case statistics of each group. In figures 110-113 we can see the case statistics after its completion.

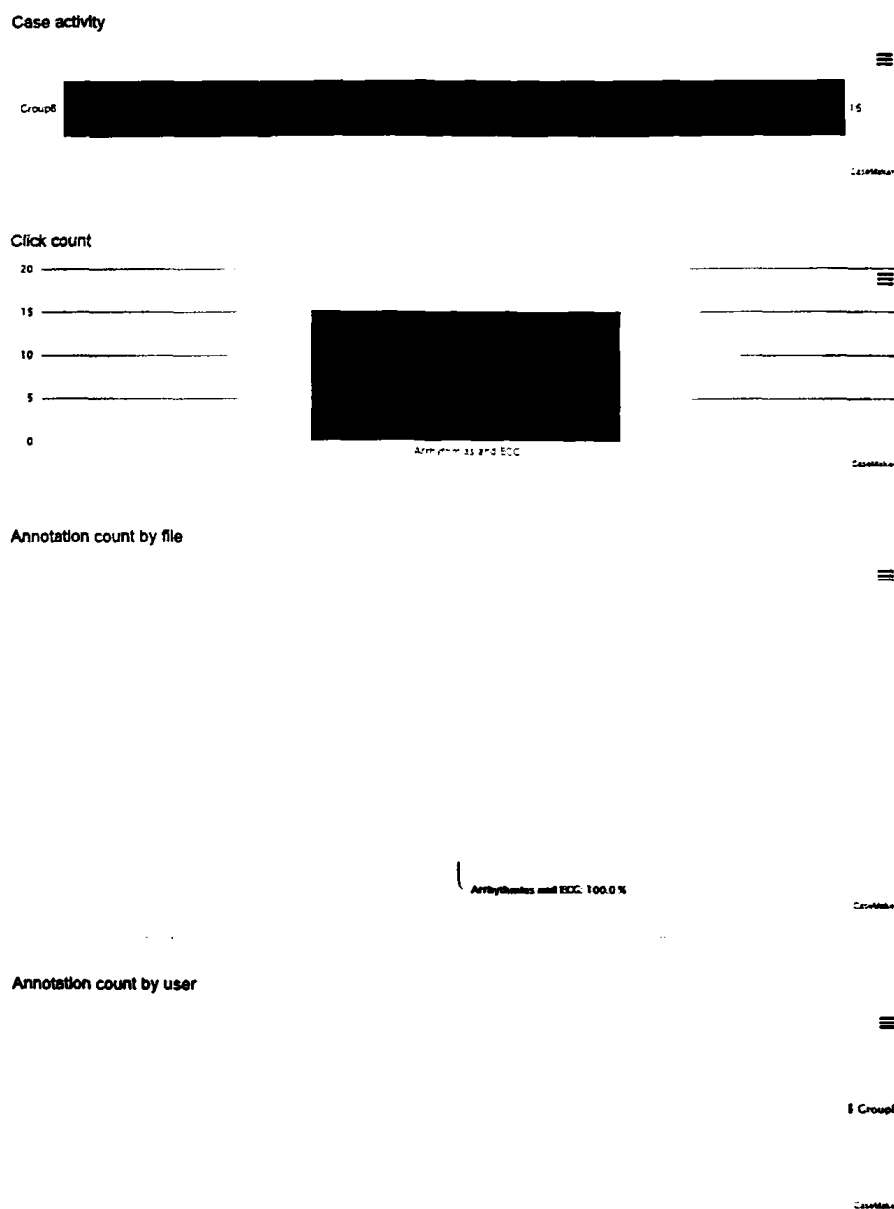
Figure 110 Arrhythmias and ECG Case\_Teacher views GroupA Statistics



In figure 110, in the case activity section of the case statistics we can see the annotations and clicks that took place by GroupA which were 72 in total. In the click count section we can see the total number of clicks that the case earned by all the members of the group and they were 71. It is obvious that students worked a lot and read several times the case and its files before giving their report. In the annotation count by file section, we can see how many annotations were made in this case and in the annotation count by user we can see how many users made annotations. In both cases, the number of annotations is one as only one student made an annotation.



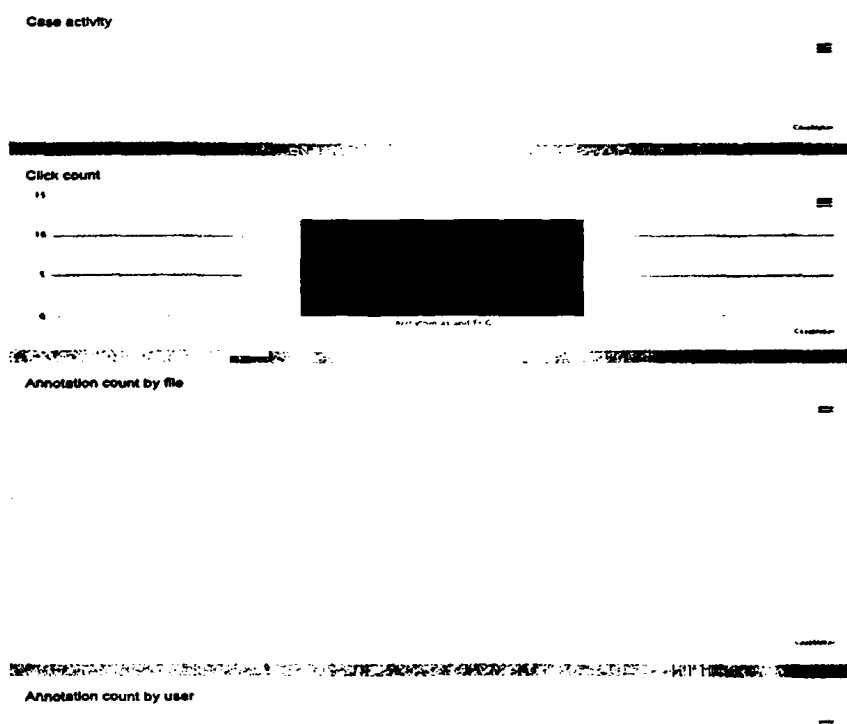
Figure 111 Arrhythmias and ECG Case\_Teacher views GroupB Statistics



In figure 111, in the case activity section of the case statistics we can see the annotations and clicks that took place by GroupB which were 16 in total. In the click count section we can see the total number of clicks that the case earned by all the members of the group and they were 15. This group worked as much as needed and quickly understood what they had to do. In the annotation count by file section and in the annotation count by user we can see that the number of annotations is one as only one student made an annotation.



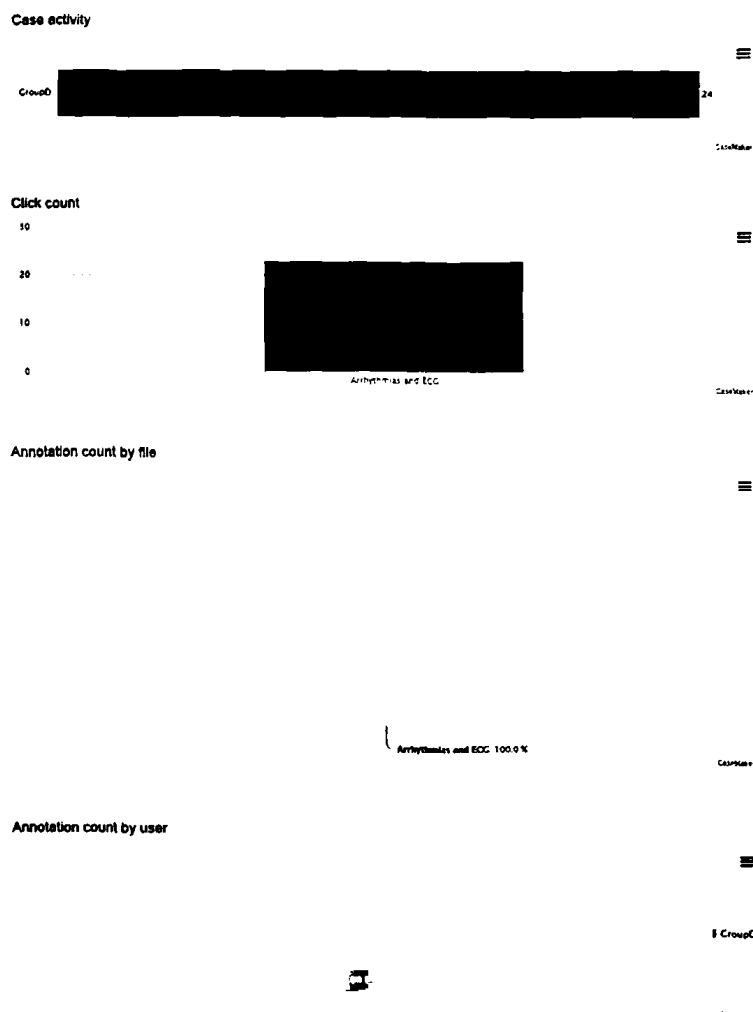
Figure 112 Arrhythmias and ECG Case\_Teacher views GroupC Statistics



In figure 112, there is no case activity as this group did not work on the case and did not give a report. We can see 12 clicks and no annotations which means that this group just read the case but did not work further.



Figure 113 Arrhythmias and ECG Case\_Teacher views GroupD Statistics



In figure 113, in the case activity section of the case statistics we can see the annotations and clicks that took place by GroupD which were 24 in total. In the click count section we can see the total number of clicks that the case earned by all the members of the group and they were 23. This group worked as much as needed and quickly understood what they had to do. In the annotation count by file section and in the annotation count by user we can see that the number of annotations is one as only one student made an annotation.



#### 7.4. Case Study: Holter Monitor

Our next case scenario introduced the use of Holter Monitor. The case was planned to be given for homework at the end of the third week's lecture along with previous case and the teacher would check the students' participation through the platform.

The case title is Holter Monitor and its content is the following:

A 77-year-old woman complained of recurrent episodes of a sudden loss of consciousness at rest lasting several minutes with complete spontaneous recovery after a few seconds. The patient had suffered multiple episodes in the previous weeks. She has not been taking any medication. A blood analysis was unremarkable and the ECG results are shown in the corresponding pdf attached file. Twenty-four hours ECG Holter recording was placed and the patient kept a diary with her activities and symptoms. Having checked the background information, answer the following.

The case's attached files were: a pdf file with the needed background information, a pdf file with the patient's diary, a png file with the patient's ECG and a png file with the patient's Holter reading. The first one gives some basic information about arrhythmias and is cited below:

A Holter monitor is a small of portable, battery-powered medical device that measures the heart's activity such as rate and rhythm. This testing is ordered when your doctor needs more information about the functioning of your heart than a routine electrocardiogram (ECG) can give him or her. Holter monitoring (24h) refers to a 24-hour, continuous test to record your heart rate and rhythm. This device has electrodes and electrical leads exactly like a regular electrocardiogram. A patient wears the Holter monitor for 12 to 48 hours as they go about their normal daily routines.

Electrodes (small conducting patches) are stuck onto the chest. These are attached by wires to a small recording monitor. The patient carries the Holter monitor in a pocket or pouch worn around his neck or waist. While he wears the monitor, it records his heart's electrical activity. He has to keep a diary of his activities while wearing the monitor, and how he feels. After 24





- 48 hours, he returns the monitor to his doctor's office. The doctor will look at the records and see if there have been any abnormal heart rhythms.

It is very important that the patient accurately records his symptoms and activities so the doctor can match them with the Holter monitor findings. Electrodes must be firmly attached to the chest so the machine gets an accurate recording of the heart's activity. While wearing the device, avoid electric blankets, high-voltage areas, magnets, metal detectors.

An electrocardiogram is a medical test that is typically ordered to measure heart rate and rhythm and to look for other abnormalities that may affect normal heart function. However, patients may experience heart rhythm irregularities that do not show up at the time the electrocardiogram is done. In these cases, if an irregular heartbeat (arrhythmia) is suspected, your doctor may order a Holter monitor test.

The Holter monitor lets your doctor see how your heart functions on a long-term basis. The recordings made by the monitor help your doctor determine if your heart is getting enough oxygen or if the electrical impulses in the heart are delayed. The doctor can also evaluate chest pain not reproduced with exercise testing as well as other signs and symptoms that may be heart-related, such as fatigue, shortness of breath, dizziness, or fainting.

More information about Holter Monitor can be found in references [27], [52] and [53].

The second pdf file that we attached contained the patient's diary as shown in Table 4:

Table 4 Holter Monitor Case\_The patient's diary

| Day       | Time  | Activity        | Symptoms  |
|-----------|-------|-----------------|-----------|
| Tuesday   | 8:00  | Waking up       | None      |
|           | 12:00 | Walking 1km     | Weakness  |
|           | 14:00 | Having lunch    | None      |
|           | 15:00 | Taking a nap    | None      |
|           | 20:00 | Having dinner   | None      |
|           | 21:00 | Went to bed     | None      |
| Wednesday | 8:00  | Waking up       | None      |
|           | 11:00 | Climbing stairs | Dizziness |



|  |       |                     |  |
|--|-------|---------------------|--|
|  | 14:00 | Having lunch        | None   |
|  | 19:33 | Sitting on armchair | Slow heart rate, Blur vision                     |
|  | 19:34 | Sitting on armchair | Gradual slowing beats, Faint                     |
|  | 19:36 | Sitting on armchair | Accelerated heart rhythm, Normal mental function |
|  | 20:00 | Went to bed         | None   |

And the png files contain the patient's ECG and his Holter reading and they are shown below:

Figure 114 Holter Monitor Case\_Patient's ECG

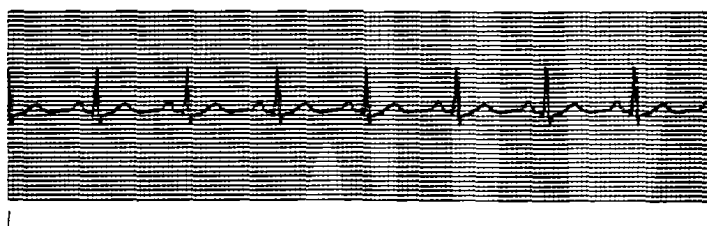
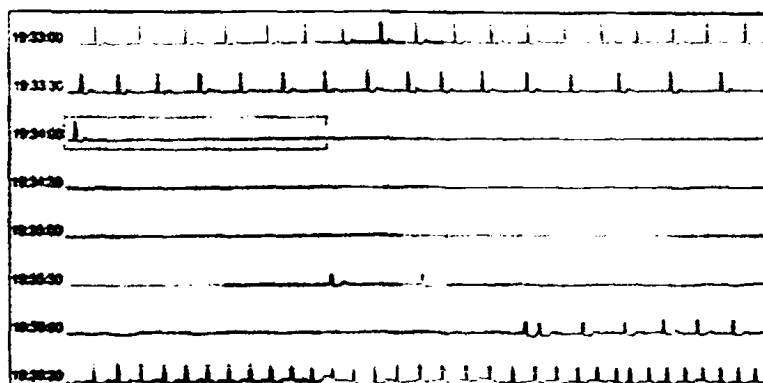


Figure 115 Holter Monitor Case\_Patient's diary



The questions that had to be answered by the students (in the Teaching Notes field) are the following:

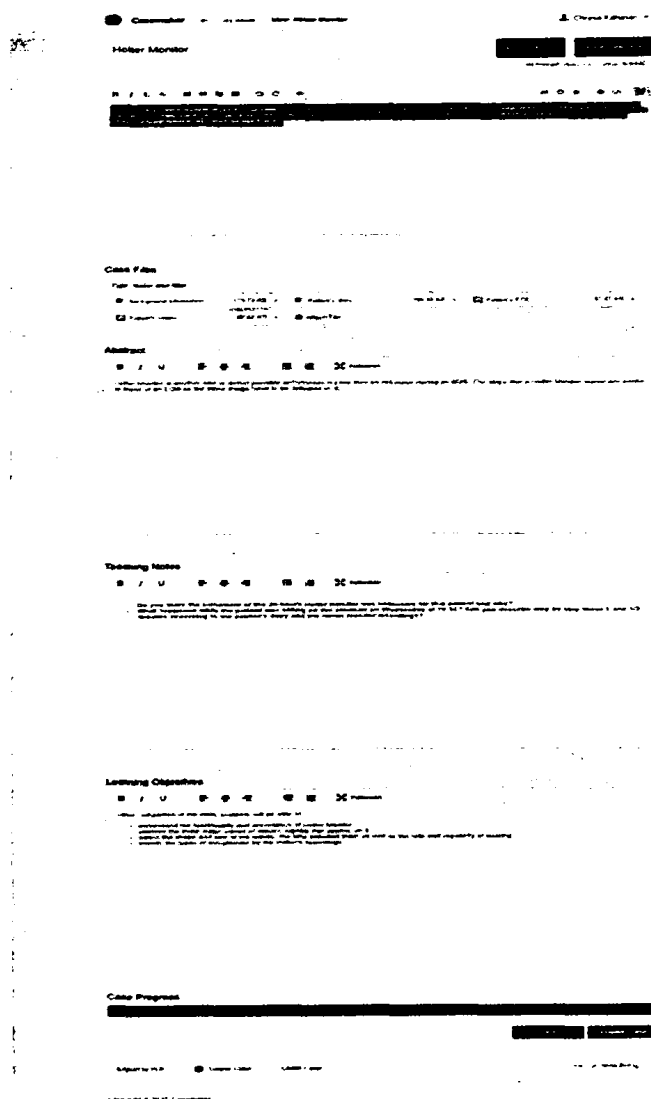
Question 1: Do you think the placement of the 24-hours Holter monitor was necessary for this patient and why?

Question 2: What happened while the patient was sitting on the armchair on Wednesday at 19:33? Can you describe step by step these 3 and 1/2 minutes according to the patient's diary and the Holter monitor recordings?



The whole case is shown in figure 116.

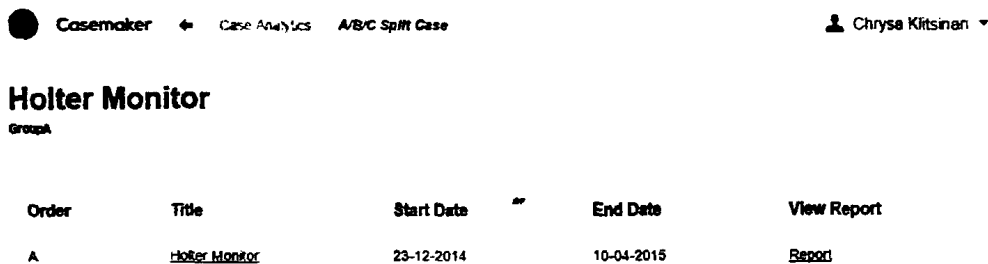
Figure 116 Holter Monitor Case



The students received the invitation e-mail and they had to login the Casemaker platform using their e-mail in order to be able to read and solve the case. After clicking on the case title they see the following:



Figure 117 Holter Monitor Case\_GroupA sees the case

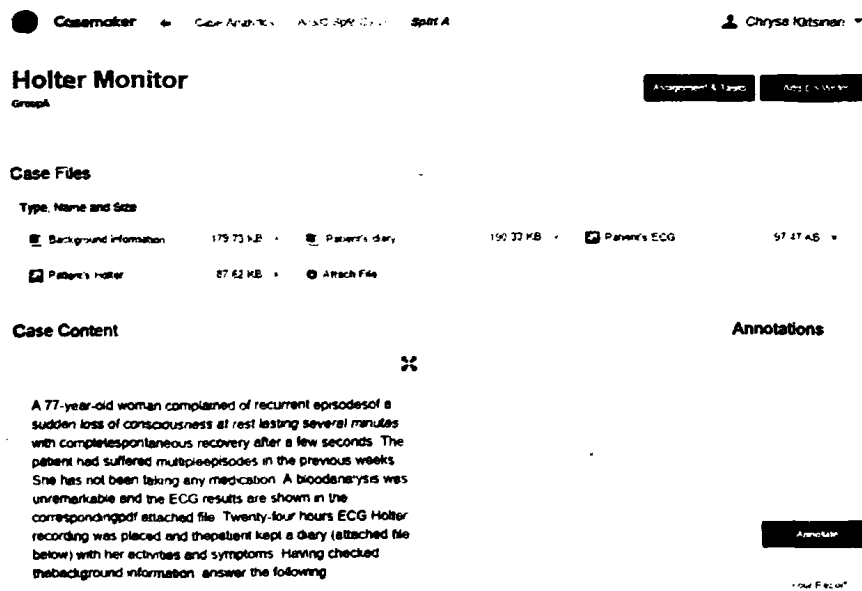


The screenshot shows the Casemaker interface. At the top, there is a navigation bar with 'Casemaker', 'Case Analytics', and 'A/B/C Split Case'. On the right, a user profile for 'Chryse Kitsinon' is visible. Below the navigation bar, the title 'Holter Monitor' is displayed with 'GroupA' underneath. A table lists the case details:

| Order | Title                          | Start Date | End Date   | View Report            |
|-------|--------------------------------|------------|------------|------------------------|
| A     | <a href="#">Holter Monitor</a> | 23-12-2014 | 10-04-2015 | <a href="#">Report</a> |

In order to solve the case, students clicked on the case title and after that they could read the case content as well as the attached files by clicking on them and they were automatically downloaded to his pc.

Figure 118 Holter Monitor Case\_GroupA reads the case



The screenshot shows the Casemaker interface with the 'Holter Monitor' case selected. The 'Case Files' section lists several attachments:

| Type                   | Name and Size |
|------------------------|---------------|
| Background Information | 175.73 KB     |
| Patient's diary        | 190.33 KB     |
| Patient's ECG          | 97.27 KB      |
| Patient's Holter       | 87.62 KB      |
| Attach File            |               |

The 'Case Content' section displays the following text:

A 77-year-old woman complained of recurrent episodes of a sudden loss of consciousness at rest lasting several minutes with complete spontaneous recovery after a few seconds. The patient had suffered multiple episodes in the previous weeks. She has not been taking any medication. A blood analysis was unremarkable and the ECG results are shown in the corresponding pdf attached file. Twenty-four hours ECG Holter recording was placed and the patient kept a diary (attached file below) with her activities and symptoms. Having checked the background information, answer the following:

The 'Annotations' section is empty.

They then clicked on the assignments and tasks button in order to read what they had to answer to as it is shown in figure 119.



Figure 119 Holter Monitor Case\_Assignment and Tasks

## Assignment &amp; Tasks

close


1. Do you think the placement of the 24-hours Holter monitor was necessary for this patient and why?
2. What happened while the patient was sitting on the armchair on Wednesday at 19:33? Can you describe step by step these 3 and 1/2 minutes according to the patient's diary and the Holter monitor recordings?

Some of them made some notes in the Annotations field and then they clicked on Your Report button and composed their full answer to the case's tasks. We quote one possible right answer as well as the students' real answers in the following figures (120, 121).


**Question 1:** Yes, because the patient's ECG showed normal sinus rhythm with no heart rhythm irregularities at the time the electrocardiogram is done. Both the PR interval and QRS duration are normal and a P wave is present, upright, and before every "QRS" complex. In these cases, if an irregular heartbeat is suspected, the patient has to wear a Holter monitor.

**Question 2:** The patient presented a syncopal episode while she was sitting on the armchair. Holter examination revealed sinus bradycardia (mean of 50 bpm) with no significant arrhythmia. At 19:34 pm, when she presented the syncopal attack, a gradual slowing of the beats was observed followed by a sudden drop of activity due to extremely prolonged sinus arrest (2 minutes) with two escape beats in between. The episode was terminated by 4 beats followed by an accelerated junctional rhythm. She recovered completely after the episode.


Figure 120 Holter Monitor Case\_GroupB Report

 CaseMaker

Case Report

 Chryse Kitsinani

Holter Monitor

 GroupB

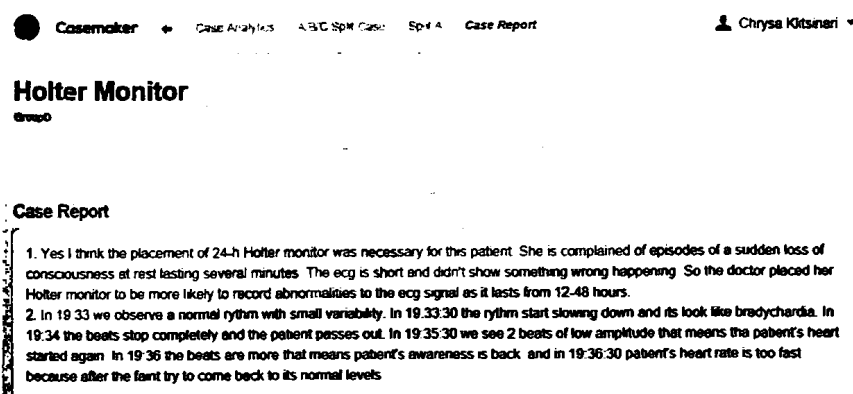
Case Report

1. Το Holter monitor είναι απαραίτητο για το συγκεκριμένο ασθενή γιατί το ηλεκτροκαρδιογράφημα δεν έδειξε τίποτα ενώ το Holter monitor δείχνει πως σταδιακά μειώνεται ο ρυθμός της καρδιάς τα λεπτά που ο ασθενής δε νιώθει καλά και λιποθυμεί και πως στη συνέχεια επανέρχεται.

2. Ο ρυθμός της καρδιάς του ασθενή άρχισε να μειώνεται και ο ασθενής άρχισε να βλέπει θάλα. Στη συνέχεια μειώνεται κι άλλο ο ρυθμός και ο ασθενής λιποθυμεί. Για κάποια δευτερόλεπτα η καρδιά σταματά και έπειτα αρχίζει να χτυπά αργά. Τέλος ο ασθενής συνέρχεται και ο καρδιακός ρυθμός γίνεται φυσιολογικός.

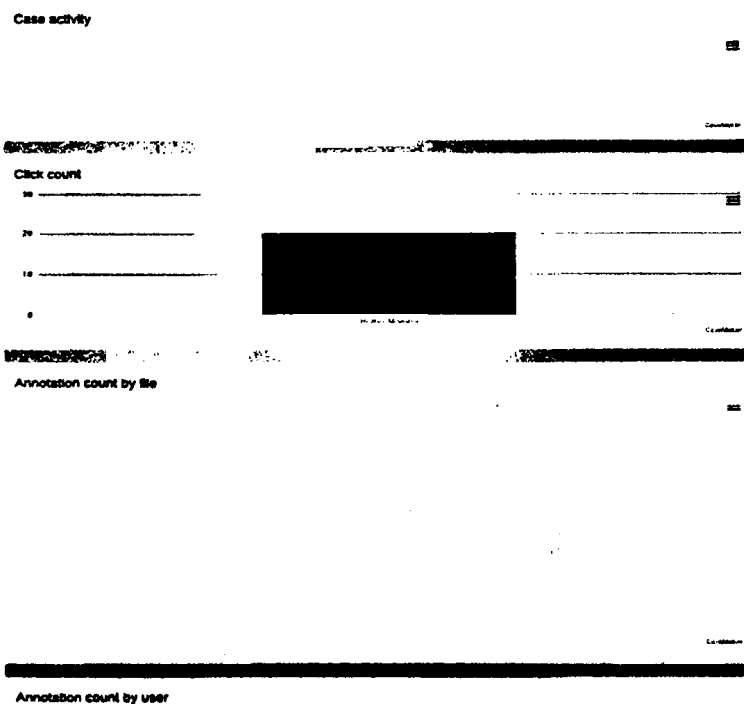


Figure 121 Holter Monitor Case\_GroupD Report



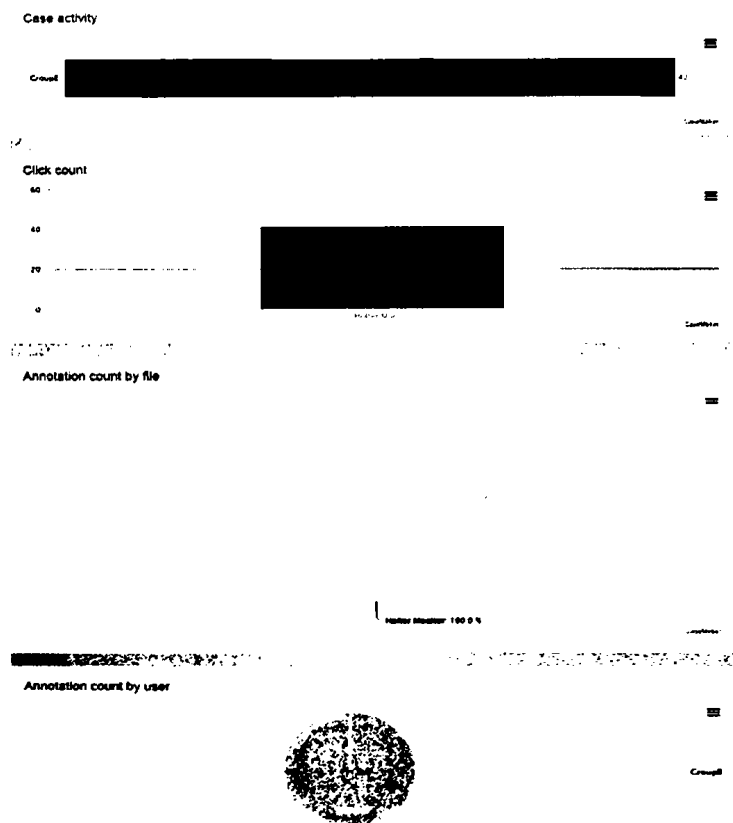
While students were dealing with the case we were able to view the case statistics of each group. In figures 122-125 we can see the case statistics after its completion.

Figure 122 Holter Monitor Case\_Teacher view GroupA Statistics



In figure 122, there is no case activity as this group did not work on the case and did not give a report. We can see 20 clicks and no annotations which means that this group just read the case but did not work further.

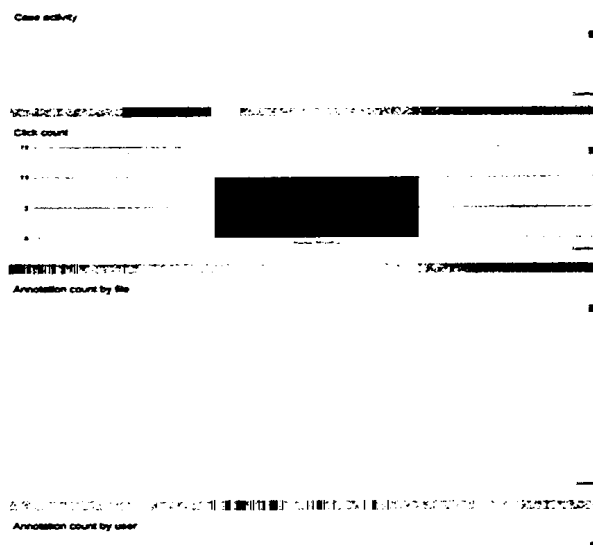
Figure 123 Holter Monitor Case\_GroupB Statistics



In figure 123, in the case activity section of the case statistics we can see the annotations and clicks that took place by GroupA which were 42 in total. In the click count section we can see the total number of clicks that the case earned by all the members of the group and they were 41. It is obvious that students worked a lot and read several times the case and its files before giving their report. In the annotation count by file section, we can see how many annotations were made in this case and in the annotation count by user we can see how many users made annotations. In both cases, the number of annotations is one as only one student made an annotation.

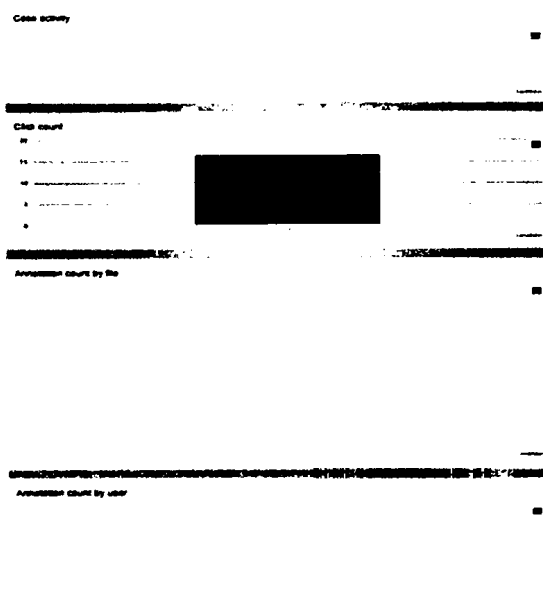


Figure 124 Holter Monitor Case\_GroupC Statistics



In figure 124, there is no case activity as this group did not work on the case and did not give a report. We can see 10 clicks and no annotations which means that this group just read the case but did not work further.

Figure 125 Holter Monitor Case\_GroupD Statistics





In figure 125, in the click count section we can see the total number of clicks that the case earned by all the members of the group and they were 16 and no annotations but this group gave their report.

### **7.5. Case Study: EEG of human sleep stages**

The next case scenario that we created introduces the human sleep stages and the EEG. The case was planned to be solved and discussed at the fourth week of the course. The process that has been followed for the case creation has already been described, so we are going to describe how it is going to be presented and solved by the students in the classroom.

Students would have already receive an e-mail that invites them to the platform after the invitation has been sent by the teacher. So, they would have visited Casemaker and signed up for it in order to be able to login each time they receive an e-mail that invites them to a new case.

The case title is EEG of human sleep stages and its content is the following:

Sleep is divided into NREM and REM. The NREM sleep is distinguished in stages 1, 2, 3 and then REM sleep occurs. Sleep staging is based on information drawn from the electroencephalogram (EEG) and the recording time in which it takes 30secs.

The questions that students have to answer in this case are the following:

Question 1: Awake: In pictures a and b, we see 2 EEGs while the person is awake having the eyes open in one and closed in the other. For each picture, answer if the person has open or closed eyes and what kind of brain waves are present.



Figure 126 EEG of human sleep stages Case\_Figure a

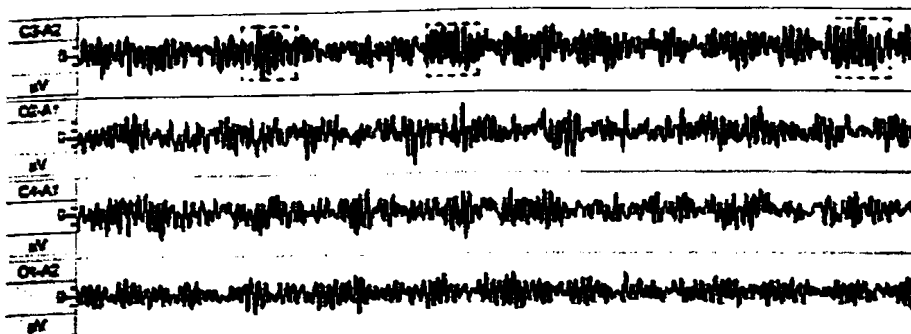
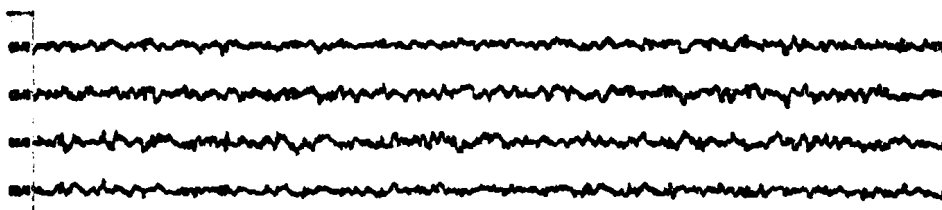
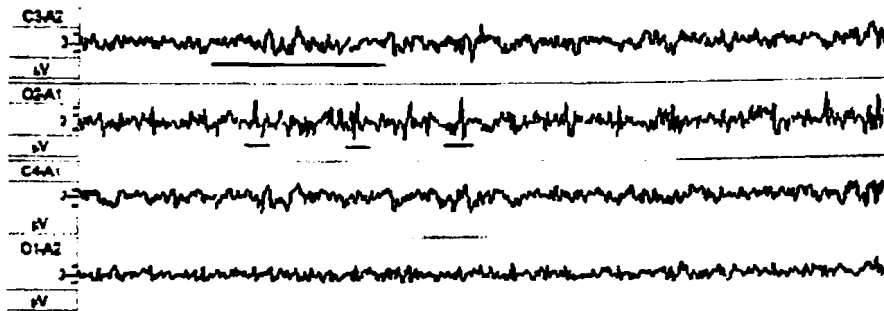


Figure 127 EEG of human sleep stages Case\_Figure b



Question 2: Stage 1: After the person has fallen asleep the EEG recorded the strip shown in picture c. Brain waves become smaller, slower, and somewhat irregular characterized by a low-voltage fast EEG. This portion of sleep is distinguished by drifting thoughts and dreams that move from the real to the fantastic, along with a kind of floating feeling. Being familiar with the form and description of the brain waves, which do you identify in the EEG?

Figure 128 EEG of human sleep stages Case\_Figure c



Question 3: Stage 2: Stage 2 is an intermediate stage of sleep. The sleeper will gradually descend deeper into sleep, becoming more and more detached from the outside world and progressively more difficult to awaken. Stage 2 is characterized by larger brain waves and occasional quick bursts of activity. What kind of waves characterize this stage of sleep and in which of the pictures d and e can you recognize them?

Figure 129 EEG of human sleep stages Case\_Figure d

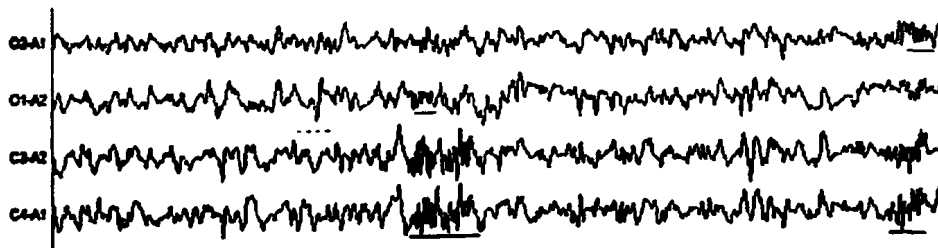
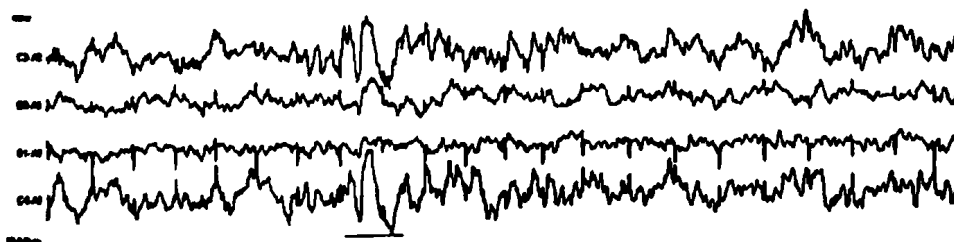
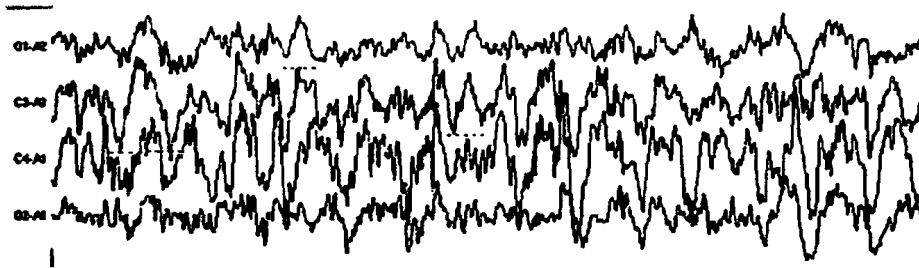


Figure 130 EEG of human sleep stages Case\_Figure e



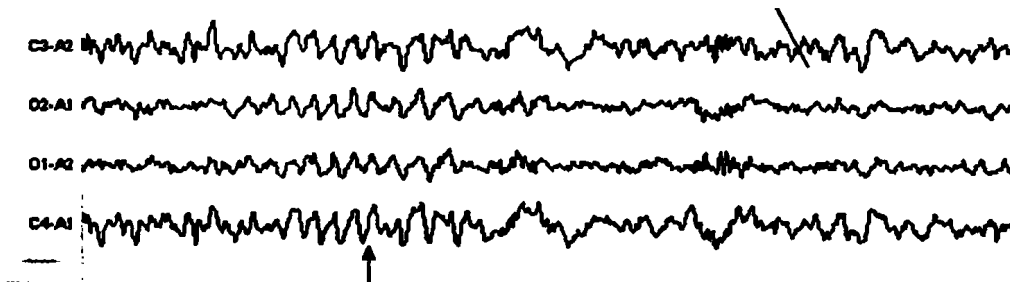
Question 4: Stage 3: The deep sleep occurs in this stage and the sleeper experience virtual oblivion. Brain waves are slow and quite large. Which ones do you identify in the EEG in picture f?

Figure 131 EEG of human sleep stages Case\_Figure f



Question 5: REM Sleep: Brain waves are small and irregular, with big bursts of eye activity. Describe what you see in the EEG in picture g.

Figure 132 EEG of human sleep stages Case\_Figure g



Students are given a pdf file with all the needed information for this case as well as the seven images above. The background information is cited below:

Electroencephalography, or EEG, is a neurological test that involves attaching electrodes to the head of a person to measure and record electrical activity in the brain over time. It can give useful conclusions for:

- Proper development of the Central Nervous System from birth to adulthood
- severity of encephalopathies (eg Alzheimer) and enhancing diagnosis and prediction



- epilepsy study: appearance of spikes and short waves (SSW), of high frequency, with duration of 20-70 msec and 70-200 msec respectively.
- Cases of traumatic brain injury, or coma
- Fainting spells or periods of memory loss that cannot be explained otherwise
- The main way of sleep study

The study of EEG is based on the existence of specific waveforms - rates, main feature of which is the frequency of the harmonics from which they constitute. Brain electrical activity has a certain number of waves per second (frequencies) that are normal for different levels of alertness. For example, brain waves are faster when you are awake, and slower in certain stages of sleep. There are also normal patterns to these waves.

Table 5 Main rates, frequencies and widths of EEG waves

| Waves                 | Frequency area<br>(cycles/sec) | Width (in $\mu V$ ) |
|-----------------------|--------------------------------|---------------------|
| Delta                 | 0.5-3.5                        | Up to 200           |
| Theta                 | 4-7.5                          | < 30                |
| Alpha                 | 8-12                           | 30-50               |
| Slow Beta             | 13-19                          | < 20                |
| Rapid Beta            | 20-30                          | < 20                |
| Sigma (Sleep Spindle) | 12-14                          |                     |
| K-complex             | 0.8                            | >100 $\mu V$        |
| Sawtooth              | 2-6                            |                     |

#### Rate $\alpha$ :

- The opposite of the beta.
- In a relaxed state. If you relax after taking an examination or take time to stop your work and meditate.
- Pre-sleep, pre-waking sleepiness.



- Closing (opening) of eyes causes an increased (decreased) rate.
- Sensory irritation or mental activity cause a decrease in rate  $\alpha$ .

Figure 133 EEG of human sleep Case\_Rate  $\alpha$  waveform

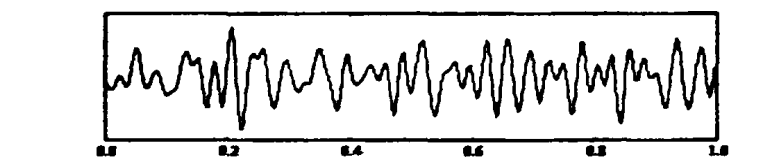


If a person is resting with closed eyes, a wave occurs. When he/she opens the eyes even in a dark room and without external stimulation, a rhythm is interrupted. An intense effort to solve a difficult problem interrupts a rate even if the eyes are closed, and the person goes to rate  $\beta$ .

#### Rate $\beta$ :

- In state of consciously alertness, concentration, anxiety or fear.
- It starts when engaging in mental activities.
- It is the feature of a strongly active mind. For example, if you are in a casual conversation, your beta is present. If you are taking an examination, your brain waves are mostly of this type.

Figure 134 EEG of human sleep Case\_Rate  $\beta$  waveform



Excited brain waves have a high frequency and low width. As the brain calms, width and frequency of the rate decreases.

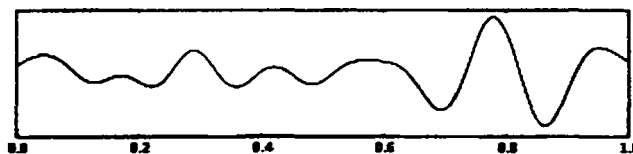
#### Rate $\delta$ :

- In deep dreamless sleep, unconsciousness, loss of body awareness or in catalepsy.
- The signals are in greatest width but of the slowest frequency.
- Main rate in newborns until the second year of life.



Figure 135 EEG of human sleep Case\_Rate  $\delta$  waveformRate  $\theta$ :

- Higher width but slower frequency.
- Dreaming sleep.
- Emotional experiences and subconscious mind as well as psychic experiences.
- Increased creativity, potential change of behavior, increased retention of learned material, deep meditation, access to unconscious mind.
- Occurs also in cases of mental disorders.

Figure 136 EEG of human sleep Case\_Rate  $\theta$  waveformSigma (Sleep Spindle):

- Represents periods where the brain is inhibiting processing to keep the sleeper in a tranquil state.
- Along with K-complexes sigma waves are characteristics of, and indicate the onset of, stage 2 sleep.
- Burst of activity immediately following muscle twitching.
- associated with the integration of new information into existing knowledge as well as directed remembering and forgetting (fast sleep spindles).

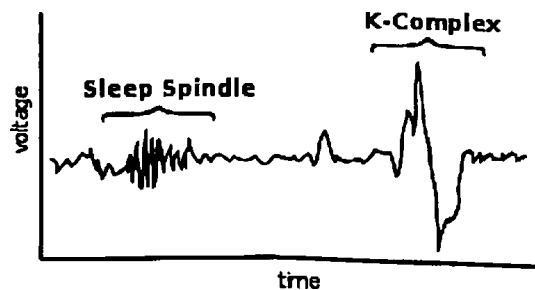
K-complex:

- Occurs during stage 2 of NREM sleep.



- Occurs in response to external stimuli such as sounds, touches on the skin and internal ones such as inspiratory interruptions.
- Protects sleep and also helps people to engage in information processing and consolidate their memory.

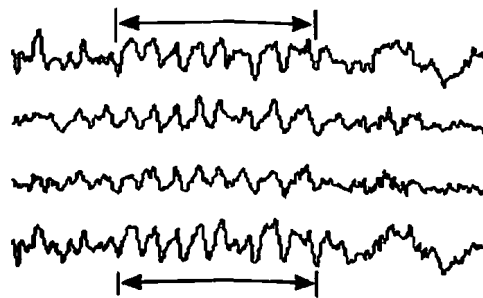
Figure 137 EEG of human sleep Case\_K-complex waveform



#### Sawtooth Waves:

- Indicate the REM sleep but they are not always present.

Figure 138 EEG of human sleep Case\_Sawtooth Waves waveform

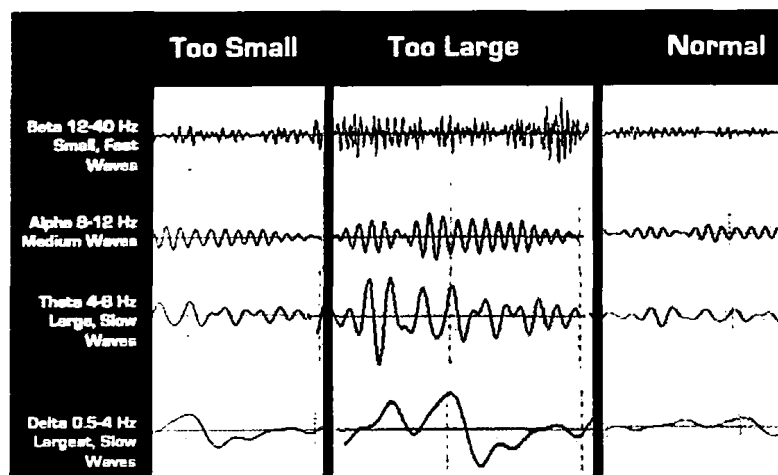


When the wave activity is either too large in size, or too small, the brain is malfunctioning away from normal, and needs to be returned to normal function. This usually shows up as some type of abnormal behavior in the person's life, such as problems paying attention, distractibility, learning disabilities, or loss of memory, as well as many others. Below, we see a wave scale.





Figure 139 EEG of human sleep Case\_Wave Scale



More information on EEG and brain waves can be found in references [27], [54] and [55].

The whole case containing the content, abstract, teaching notes, attached files and case objectives is shown in figure 140.



Figure 140 EEG of human sleep stages Case

Case File

Year: Henry and Ben

EEG of human sleep stages

Abstract

Teaching Notes

Learning Objectives

Case Progress

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EEG of human sleep stages

Case File

Year: Henry and Ben

EEG of human sleep stages

Abstract

Teaching Notes

Learning Objectives

Case Progress

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Students login the Casemaker platform using their e-mail and they can see the new case. They are divided into groups and they are encouraged to click on the case and start studying, solving and discussing it. Working the case in groups, they can collaborate and be led to a conclusion in a more easy and creative way. So, they discuss the case in groups, they write their reports and then they discuss the case altogether in the classroom with the teacher as a facilitator. We quote one possible right answer for each one of the questions:

Question 1: In the first picture we see alpha waves and the person is awake with closed eyes and in the second the person is awake with open eyes and beta waves occur.

Question 2: Theta waves because of the slower frequency and the fact that we know they appear in dreaming sleep.

Question 3: This stage is characterized by spindles which are present in the first picture and also by K-complexes which are found in the second picture.

Question 4: Delta waves are identified in this picture and we know that they appear in deep dreamless sleep, unconsciousness, loss of body awareness and their signals are in greatest width but of the slowest frequency.

Question 5: There are obvious sawtooth waves as it is common in the REM sleep and the brain wave activity at this time resembles waking more than it does sleeping as alpha waves might appear as here.

### **7.6. Case Study: Medical Imaging**

The next case scenario was planned to be solved and discussed at the seventh week of the course at the end of the lecture about Medical Imaging. The process that has been followed for the case creation has already been described, so we are going to describe how it is going to be presented and solved by the students in the classroom.



Students would have already receive an e-mail that invites them to the platform after the invitation has been sent by the teacher. So, they would have visited Casemaker and signed up for it in order to be able to login each time they receive an e-mail that invites them to a new case.

The case title is Medical Imaging and it is like an online quiz:

1. Describe in a few words what is medical imaging and which are its categories?
2. Which of the following are examples of types of examinations in which radiography is used?
  - a. Dental examination
  - b. Mammography
  - c. Orthopedic evaluations
  - d. Chiropractic examinations
  - e. Pregnancy
3. Are there any risks for someone who needs to have magnetic resonance imaging? If yes, what are they?
4. Give some examples of cases that someone may need to have ultrasound tests as well as some of their biomedical applications.
5. Which of the following is/are correct. Ultrasounds offer many advantages:
  - a. They are generally painless and do not require needles, injections, or sections.
  - b. Patients are exposed to ionizing radiation.
  - c. It is a safer procedure than diagnostic techniques such as X-rays and CT scans
  - d. Ultrasound captures images of soft tissues that don't show up well on X-rays.
  - e. Ultrasounds are not widely accessible and they are very expensive.
6. What are the types of tomography, which one is superior to the other and why?

Students are given a pdf file with all the needed information for this case which is cited below:

**Medical imaging** is the technique, process and art of creating visual representations of the interior of a body for clinical analysis and medical intervention. Medical imaging tries to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to



make it possible to identify abnormalities. Although imaging of removed organs and tissues can be performed for medical reasons, such procedures are usually considered part of pathology instead of medical imaging.

As a field of scientific investigation, medical imaging constitutes a sub-discipline of biomedical engineering, medical physics, or medicine depending on the context: Research and development in the area of instrumentation, image acquisition (e.g. radiography), modeling and quantification are usually the preserve of biomedical engineering, medical physics and computer science. Research into the application and interpretation of medical images is usually the preserve of radiology and the medical sub-discipline relevant to medical condition or area of medical science under investigation.

### Imaging Categories

**Radiography:** Radiography is an imaging technique that uses electromagnetic radiation other than visible light, especially X-rays, to view the internal structure of an object such as the human body. It is used to diagnose or treat patients by recording images of the internal structure of the body to assess the presence or absence of disease, foreign objects, and structural damage or anomaly. To create the image, X-rays are produced by an X-ray generator and projected toward the object. A certain amount of X-ray is absorbed by the object, which is dependent on the particular density and composition of that object. The X-rays that pass through the object are captured behind the object by a detector. The detector can then provide a layered 2D representation of all the object's internal structures.

Radiography is used in many types of examinations and procedures where a record of a static image is desired. Some examples include:

- Dental examination
- Verification of correct placement of surgical markers prior to invasive procedures
- Mammography
- Orthopedic evaluations
- Spot film or static recording during fluoroscopy
- Chiropractic examinations



**Magnetic resonance imaging (MRI)** is a technique that uses a magnetic field and radio waves to create detailed images of the organs and tissues within human body. Most MRI machines are large, tube-shaped magnets. The MRI machine can be used to produce 3-D images that may be viewed from many different angles. An MRI scan can be done for the: head, chest, blood vessels, bones and joints, spine, internal organs.

There are no known harmful effects from the strong magnetic field used for MRI. But the magnet is very powerful. The magnet may affect pacemakers, artificial limbs, and other medical devices that contain iron. The magnet will stop a watch that is close to the magnet. Any loose metal object has the risk of causing damage or injury if it gets pulled toward the strong magnet.

**Ultrasound:** Diagnostic ultrasound, also called sonography or diagnostic medical sonography, is an imaging method that uses high-frequency sound waves to produce relatively precise images of structures within human body. The images produced during an ultrasound examination often provide valuable information for diagnosing and treating a variety of diseases and conditions. Most ultrasound examinations are done using a sonar device outside of the body, though some ultrasound examinations involve placing a device inside the body.

Ultrasound imaging has many uses in medicine, from confirming and dating a pregnancy to diagnosing certain conditions and guiding doctors through precise medical procedures:

**Pregnancy:** Ultrasound images have many uses during pregnancy. Early on, they may be used to determine due dates, reveal the presence of twins or other multiples, and rule out ectopic pregnancies. They also are valuable screening tools in helping to detect potential problems. Many expectant parents look forward to learning the sex of their babies via ultrasound. And later in pregnancy, doctors can even use ultrasounds to estimate how large a baby is just before delivery.

**Diagnostics:** Doctors use ultrasound imaging in diagnosing a wide variety of conditions affecting the organs and soft tissues of the body, including the heart and blood vessels.



Ultrasounds do have some diagnostic limitations, though, sound waves do not transmit well through dense bone or parts of the body that may hold air or gas.

Use during medical procedures: Ultrasound imaging can help doctors during procedures such as needle biopsies, which require the doctor to remove tissue from a very precise area inside the body for testing in a lab.

#### Biomedical applications

Ultrasound also has therapeutic applications, which can be highly beneficial when used with dosage precautions. Relatively high power ultrasound can break up stony deposits or tissue, accelerate the effect of drugs in a targeted area, assist in the measurement of the elastic properties of tissue, and can be used to sort cells or small particles for research.

Ultrasound technology has advanced to allow for different types of imaging:

- Doppler is a special type of ultrasound that creates images of blood flow through vessels.
- Bone sonography helps doctors diagnose osteoporosis.
- Echocardiograms are used to view the heart.
- 3D imaging adds another dimension to the ultrasound image, creating three-dimensional interpretations rather than the flat two-dimensional images that are made with traditional ultrasound.
- 4D ultrasounds show 3D images in motion.

Ultrasounds offer many advantages:

- They are generally painless and do not require needles, injections, or sections.
- Patients aren't exposed to ionizing radiation, making the procedure safer than diagnostic techniques such as X-rays and CT scans. In fact, there are no known harmful effects when used as directed by your health care provider.
- Ultrasound captures images of soft tissues that don't show up well on X-rays.
- Ultrasounds are widely accessible and less expensive than other methods.



**Tomography:** Tomography is the method of imaging a single plane, or slice, of an object in a tomograph. There are two principal methods of obtaining such images, conventional and computer assisted tomography. Conventional tomography uses mechanical means to record an image directly onto X-ray film, while in computer assisted tomography, a computer processes information fed to it from detectors then constructs a virtual image which can be stored in digital format and can be displayed on a screen, or printed on paper or film.

In **conventional tomography**, mechanical movement of an X-ray source and film in unison generates a tomogram using the principles of projective geometry. Synchronizing the movement of the radiation source and detector which are situated in the opposite direction from each other causes structures which are not in the focal plane being studied to blur out. It is now considered obsolete (except for certain dental applications), having been replaced with computer assisted tomographic techniques.

In **computer-assisted tomography**, a computer processes data received from radiation detectors and computationally constructs an image of the structures being scanned. Imaging techniques using this method are far superior to conventional tomography as they can readily image both soft and hard tissues (while conventional tomography is quite poor at imaging soft tissues). The following techniques exist:

- X-ray computed tomography
- Magnetic resonance imaging

More information about Medical Imaging can be found in references [27], [56] and [57].

The whole case containing the content, abstract, teaching notes, attached files and case objectives is shown in figure 141.





### Figure 141 Medical Imaging Case

[illegible]

Students login the Casemaker platform using their e-mail and they can see the new case. They are divided into groups and they are encouraged to click on the case and start studying, discussing and answering the questions. Working the case in groups, they can collaborate and be led to a conclusion in a more easy and creative way. So, they discuss the case in groups, they write their reports and then they discuss the case altogether in the classroom with the teacher as a facilitator. We quote one possible right answer for each one of the questions:

Question 1: Medical imaging is the technique, process and art of creating visual representations of the interior of a body for clinical analysis and medical intervention. Medical imaging tries to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. Its categories include: Radiography, Magnetic Resonance Imaging, Ultrasound and Tomography.

Question 2: It is used in all of the examples except from pregnancy.

Question 3: There are no known harmful effects from the strong magnetic field used for MRI. But the magnet is very powerful. The magnet may affect pacemakers, artificial limbs, and other medical devices that contain iron. The magnet will stop a watch that is close to the magnet. Any loose metal object has the risk of causing damage or injury if it gets pulled toward the strong magnet.

Question 4: Some cases that someone may need to have ultrasound are the following: during pregnancy, in diagnostics and during medical procedures. Ultrasound also has biomedical applications, which can be highly beneficial when used with dosage precautions. Relatively high power ultrasound can break up stony deposits or tissue, accelerate the effect of drugs in a targeted area, assist in the measurement of the elastic properties of tissue, and can be used to sort cells or small particles for research.

Question 5: The correct answers are: a, c and d.



Question 6: The types of tomography are: conventional tomography and computed tomography. Imaging techniques using computer-assisted tomography are far superior to conventional tomography as they can readily image both soft and hard tissues (while conventional tomography is quite poor at imaging soft tissues).

### 7.7. Case Study: Patient Support System

The next case scenario presents the use of an Implantable Cardioverter Defibrillator and also includes medical imaging knowledge. Students are divided into groups and the case is solved on a platform and discussed simultaneously in the classroom at the ninth week. The process that has been followed for the case creation has already been described, so we are going to describe how it is going to be presented and solved by the students in the classroom.

Students would have already received an e-mail that invites them to the platform after the invitation has been sent by the teacher. So, they would have visited Casemaker and signed up for it in order to be able to login each time they receive an e-mail that invites them to a new case.

The case title is Patient Support System and its content is the following:

A 70 year old man experienced some serious symptoms last night so he was admitted to hospital immediately. He felt strong chest pain and rapid heartbeat. The doctors had his heart monitored and realized that his heart was beating unpredictably. They also had his pulse checked and there was no pulse. These results indicated that he may have ventricular fibrillation. So the patient needed to have some additional tests.

The questions that students have to answer in this case are the following:

Question 1: Which do you think these tests are?

Question 2: After checking the results in the corresponding attached file, can you identify what they indicate? What is the patient's heart problem?

Question 3: As doctors found that the patient's heart problem is caused by a change in the structure of the heart, they recommended that he has a medical procedure performed to reduce



the risk of future ventricular fibrillation episodes. Which treatment procedure would you recommend?

Question 4: What should the patient be aware of and careful in his everyday life after the treatment procedure?

Students are given a pdf file with all the needed information for this case as well as a pdf file with the patient's results. They are both cited below:

#### Pacemakers: Artificial pacemaker and Implantable Cardiac Defibrillator

An **artificial pacemaker** is a medical device that uses electrical impulses, delivered by electrodes contracting the heart muscles, to regulate the beating of the heart. It senses when the heart is beating irregularly or too slow. It sends a signal to the heart that makes it beat at the correct pace.

The primary **purpose** of a pacemaker is to maintain an adequate heart rate, either because the heart's natural pacemaker is not fast enough, or there is a block in the heart's electrical conduction system. Modern pacemakers are externally programmable and allow the cardiologist to select the optimum pacing modes for individual patients.

An artificial pacemaker's lead and pulse generator can also be used to sense the heart's natural rhythm. If the heart is beating normally by itself, the artificial pacemaker will switch off and let the heart's natural pacemaker work. It will turn back on when it senses the heart is no longer beating normally.

Pacemakers may be **used for** people who have heart problems that cause their heart to beat too slowly. A slow heartbeat is called bradycardia. Two common problems that cause a slow heartbeat are sinus node disease and heart block. When the heart beats too slowly, the body and brain may not get enough oxygen. Symptoms may be lightheadedness, tiredness, fainting spells, and shortness of breath.

Some, pacemakers can be used to stop a heart rate that is too fast (tachycardia) or that is irregular. Other types of pacemakers can be used in severe heart failure. These are called



biventricular pacemakers. They match up the beating of both sides of the heart. Most biventricular pacemakers implanted today can also work as implantable cardio-defibrillators (ICD), which restore a normal heartbeat.

An **implantable cardioverter-defibrillator (ICD)** is a device implantable inside the body, able to perform both cardio version, defibrillation and pacing of the heart. The device is therefore capable of correcting most life threatening cardiac arrhythmias. The ICD is the first-line treatment and prophylactic therapy for patients at risk for sudden cardiac death due to ventricular fibrillation and ventricular tachycardia. Current devices can be programmed to detect abnormal heart rhythms and deliver therapy via programmable antitachycardia pacing in addition to low-energy and high-energy shocks.

The ICD is capable of monitoring the heart rhythm. When the heart is beating normally, the device remains inactive. If the heart develops a life-threatening tachycardia, the ICD can attempt pacing to bring the heart's rhythm back to normal, or it can deliver an electrical "shock" to the heart to terminate the abnormal rhythm and return the heart rhythm to normal.

When the patient experiences a rapid heartbeat, the wires from the heart to the device transmit signals to the ICD to send electrical pulses to regulate the heartbeat. Depending on the problem with the heartbeat, the ICD could be programmed for these therapies:

- Low-energy pacing therapy. The patient may feel either nothing or a painless fluttering in the chest when the ICD responds to mild disruptions in the heartbeat.
- Cardio version therapy. A higher energy shock is delivered to deal with a more serious heart rhythm problem. The patient might feel as if he is being thumped in the chest.
- Defibrillation therapy. This is the strongest form of electrical therapy used to restore a normal heartbeat. During this therapy the patient may feel as if he is being kicked in the chest. It may knock him off his feet. The pain from this therapy typically lasts only a second. There should be no discomfort after the shock is over.
- Anti-tachycardia pacing. If the patient experiences an unusually fast heart rate, the ICD delivers painless, low-energy impulses that pace or stimulate the heart to beat at a rate that prompts it to return to a normal rhythm. This can prevent the need for cardio version or defibrillation.



- **Anti-bradycardia pacing.** When the heartbeat is abnormally slow (bradycardia) because of a heart condition or medication, a standard pacemaker is the typical treatment advised. People with ICDs, however, sometimes develop bradycardia as a result of the shock the ICD delivers in response to ventricular tachycardia or ventricular fibrillation. In this situation, the ICD can sense the slow heart rate and function as a pacemaker, delivering low-energy impulses that stimulate the heart to beat normally.
- **Recording heart activity.** The ICD records information about variations in the heart's electrical activity and rhythm. This information helps doctors evaluate the heart rhythm problem and, if necessary, reprogram the ICD.
- **Biventricular pacing.** Unlike a standard pacemaker, which stimulates only one side of the heart's main pumping chamber (the right ventricle), a biventricular pacemaker stimulates both the right and left ventricles to make the heart beat more efficiently. A special type of ICD - a combined biventricular pacemaker with ICD - can do the same thing. Biventricular pacing is particularly valuable for some people with heart failure whose hearts' electrical systems don't work normally.

Patients at risk of developing sudden cardiac arrests due to ventricular tachycardia's and fibrillations are candidates for ICDs. ICDs do not prevent the occurrence of life-threatening rhythms, but can quickly terminate them when they occur. Ventricular fibrillation is a heart rhythm problem that occurs when the heart beats with rapid electrical impulses. This causes pumping chambers in the heart (the ventricles) to tremble uselessly, instead of pumping blood. Signs and symptoms of ventricular tachycardia include: chest pain, rapid heartbeat (tachycardia), dizziness, nausea, shortness of breath and loss of consciousness. It is always diagnosed in an emergency situation. Doctors will know if someone is in ventricular fibrillation based on results from heart monitoring and pulse check (there will be no pulse). To find out what caused ventricular fibrillation, the patient will have additional tests, which can include: Electrocardiogram (ECG), Blood tests, Chest X-ray, Cardiac computerized tomography (CT) or Magnetic resonance imaging (MRI).

A person with a device like this can live a normal life and can still perform moderate to intense activities such as driving a car, swimming and playing non-contact sports. If one has



an artificial pacemaker, they will need to see their doctor regularly to have tests to make sure it works properly. Patients will need to have their pacemaker checked about every six months.

Patients should also follow some instructions:

- Do not lift objects that weigh more than 5 kg.
- Do not hold the arm above shoulder level for a long time.
- Avoid activities that require pushing or pulling heavy objects.
- Stop any activity before they become overtired.
- Try to walk as much as possible for exercise.
- Ask their doctor when you can resume more intense activities.
- Their doctor will tell them when they can go back to work, usually within a week after they go home.
- Electric blankets, heating pads, and microwave ovens can be used and will not interfere with the function of the pacemaker.
- A cell phone should be used on the side opposite of where the pacemaker was implanted.
- They will need to avoid strong electric or magnetic fields, such as some industrial equipment, high intensity radio waves (found near large electrical generators, power plants, or radiofrequency transmission towers).
- Do not undergo any tests that require magnetic resonance imaging.
- X-rays, computed tomography (CT) scans and most medicines will not affect the pacemaker.
- As a precaution, do not put the cell phone or MP3 player (if they are turned on) close to the ICD.
- Keep headphones at least 6 inches away from any ICD.
- If they travel, let airport or other screeners know you have an ICD.
- Anti-theft systems or electronic article surveillance used in department stores may interact with an ICD.

More information about Medical Imaging can be found in references [27], [58] and [59].

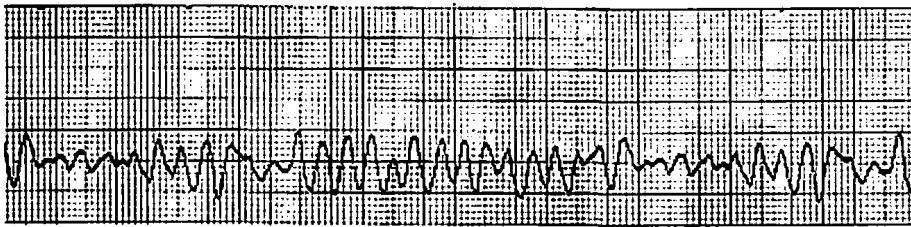
The patient's results of the case include the following:

The ECG showed:



- Rhythm – Irregular
- Rate - 300+, disorganised
- QRS Duration - Not recognisable
- P Wave - Not seen

Figure 142 Patient Support System Case\_Patient's ECG



#### X-ray

The X-ray image of the patient's chest showed a heart enlargement.

#### CT

Cardiac computed tomography suggested that localized, minor structural abnormalities of the right ventricle.

The whole case containing the content, abstract, teaching notes, attached files and case objectives is shown in figure 143.



### Figure 143 Patient Support System Case

[illegible]

Students login the Casemaker platform using their e-mail and they can see the new case. They are divided into groups and they are encouraged to click on the case and start studying, solving and discussing it. Working the case in groups, they can collaborate and be led to a conclusion in a more easy and creative way. So, they discuss the case in groups, they write their reports and then they discuss the case altogether in the classroom with the teacher as a facilitator. We quote one possible right answer for each one of the questions:

**Question 1:** To find out if it is really ventricular fibrillation, the doctors will have the patient to have additional tests, which can include: Electrocardiogram (ECG), Blood tests, Chest X-ray, Cardiac computerized tomography (CT) or magnetic resonance imaging (MRI).

**Question 2:** The ECG showed that the heart rhythm is irregular, its rate is disorganized, the QRS duration is not recognizable and the P wave is not obvious. This description along with the ECG strip indicate ventricular fibrillation. The X-ray image of the patient's chest showed a heart enlargement and cardiac computed tomography suggested localized, minor structural abnormalities of the right ventricle. So, the patient probably has ventricular fibrillation.

**Question 3:** After the patient's condition stabilizes, the doctor is likely to recommend implantation of an Implantable Cardioverter Defibrillator. An ICD is capable of monitoring the heart rhythm. When the heart is beating normally, the device remains inactive. If the heart develops a life-threatening tachycardia, the ICD can attempt pacing to bring the heart's rhythm back to normal, or it can deliver an electrical "shock" to the heart to terminate the abnormal rhythm and return the heart rhythm to normal.

**Question 4:** The patient with an ICD can live a normal life and can still perform moderate to intense activities such as driving a car, swimming and playing non-contact sports. He will need to see his doctor regularly to have tests to make sure it works properly. He should also follow some instructions:

- Do not lift objects that weigh too much.
- Stop any activity before he becomes overtired.
- Do not undergo any tests that require magnetic resonance imaging.
- Do not put the cell phone or MP3 player close to the ICD.



- Keep headphones at least 6 inches away from the ICD.
- If he travels, let airport or other screeners know he has an ICD.
- He will need to avoid strong electric or magnetic fields and high intensity radio waves.
- Anti-theft systems or electronic article surveillance used in department stores may interact with an ICD.

### 7.8. Case Study: Diabetes

The case concerns diabetes and the use of the Glucose Buddy Diabetes Log application. Students are divided into groups and the case is solved in the platform and discussed simultaneously in the classroom. The case was planned to be solved and discussed at the tenth week of the course. The process that has been followed for the case creation has already been described, so we are going to describe how it is going to be presented and solved by the students in the classroom.

Students would have already receive an e-mail that invites them to the platform after the invitation has been sent by the teacher. So, they would have visited Casemaker and signed up for it in order to be able to login each time they receive an e-mail that invites them to a new case.

The case title is Diabetes and its content is the following:

A 20 year old girl decided to do some tests in order to check if she has diabetes because she has high blood pressure and HDL cholesterol levels about 30 mg/dl and also her mother has diabetes. She also noticed increased thirst and hunger.

The questions that students have to answer in this case are the following:

Question 1: At first sight do you think she has diabetes and why? What tests do you think she has to do?

Question 2: What do the results indicate? What do you diagnose eventually?

Question 3: Now that you have reached your decision, what would you recommend for her lifestyle from now on?



Question 4: Her doctor has advised her to buy a glucose meter in order to determine the approximate concentration of glucose in the blood several times a day as well as to keep diary of her measurements. How often would you advise her to take measurements during a day and why? Could you also suggest a way to organize her diabetes diary?

Students are given a pdf file with all the needed information for this case as well as a pdf file with the patient's results. They are both cited below:

**Diabetes** is usually a lifelong disease in which there is a high level of sugar in the blood. Symptoms of high blood sugar include frequent urination, increased thirst and increased hunger. Insulin is a hormone produced by the pancreas to control blood sugar. Diabetes can be caused by too little insulin, resistance to insulin, or both.

To understand diabetes, it is important to first understand the normal process by which food is broken down and used by the body for energy. Several things happen when food is digested:

- A sugar called **glucose** enters the bloodstream. Glucose is a source of fuel for the body.
- An organ called the pancreas makes insulin. The role of insulin is to move glucose from the bloodstream into muscle, fat, and liver cells, where it can be used as fuel.

People with diabetes have **high blood sugar** because their body cannot move sugar into fat, liver, and muscle cells to be stored for energy. This is because either:

- Their pancreas does not make enough insulin
- Their cells do not respond to insulin normally
- Both of the above

There are two major **types** of diabetes. The causes and risk factors are different for each type:

- Type 1 diabetes can occur at any age, but it is most often diagnosed in children, teens, or young adults. In this disease, the body makes little or no insulin. Daily injections of insulin are needed. The exact cause is unknown.
- Type 2 diabetes makes up most diabetes cases. It most often occurs in adulthood. But because of high obesity rates, teens and young adults are now being diagnosed with it. Many people with type 2 diabetes do not know they have it.



- There are other causes of diabetes, and some patients cannot be classified as type 1 or type 2.

Gestational diabetes is high blood sugar that develops at any time during pregnancy in a woman who does not have diabetes.

High blood sugar level can cause several **symptoms**, including:

- Blurry vision
- Excess thirst
- Fatigue
- Hunger
- Urinating often
- Weight loss

Someone should be tested if he/she:

- Has a parent or sibling with diabetes
- Is overweight (Body Mass Index higher than 25)
- Had gestational diabetes or a baby weighing over 9 pounds
- HDL cholesterol levels about 35 mg/dl or less, and/or their triglyceride level is 250 mg/dl or above
- Has high blood pressure
- Has polycystic ovarian syndrome
- On previous testing, had impaired glucose tolerance or impaired fasting tolerance

A urine analysis may show high blood sugar. But a urine test alone does not diagnose diabetes. A health care provider may suspect that someone has diabetes if his blood sugar level is higher than 200 mg/dL. To confirm the diagnosis, one or more of the following tests must be done.

Blood tests:

- Fasting blood glucose level - diabetes is diagnosed if it is higher than 126 mg/dL twice. Levels between 100 and 126 mg/dL are called impaired fasting glucose or pre-diabetes. These levels are risk factors for type 2 diabetes.



- Hemoglobin A1c test
  - Normal: Less than 5.7%
  - Pre-diabetes: 5.7% - 6.4%
  - Diabetes: 6.5% or higher
- Oral glucose tolerance test - diabetes is diagnosed if glucose level is higher than 200 mg/dL 2 hours after drinking a glucose drink. (This test is used more often for type 2 diabetes.)

Screening for type 2 diabetes in people who have no symptoms is recommended for:

- Overweight children who have other risk factors for diabetes, starting at age 10 and repeated every 2 years
- Overweight adults (BMI greater than 25) who have other risk factors
- Adults over age 45, repeated every 3 years

With type 2 diabetes, the disease may be reversed with lifestyle changes, especially losing weight through exercising and eating healthier foods. Also, some cases of type 2 diabetes can be improved with weight-loss surgery. There is no cure for type 1 diabetes. Treating both type 1 diabetes and type 2 diabetes involves medicines, diet, and exercise to control blood sugar level.

Getting better control over your blood sugar, cholesterol, and blood pressure levels helps reduce the risk of kidney disease, eye disease, nervous system disease, heart attack, and stroke. To prevent diabetes complications, one has to visit his health care provider at least two to four times a year and talk about any problems they are having.

**Insulin pumps** are small computerized devices that deliver insulin in two ways:

- In a steady measured and continuous dose (the "basal" insulin)
- As a surge ("bolus") dose, at patient's direction, around mealtime.

Doses are delivered through a flexible plastic tube called a catheter. With the help of a small needle, the catheter is inserted through the skin into the fatty tissue and is taped in place.



The insulin pump is not an artificial pancreas (because the patient still has to monitor his blood glucose level), but pumps can help some people achieve better control, and many people prefer this continuous system of insulin delivery over injections. Pumps can be programmed to release small doses of insulin continuously (basal), or a bolus dose close to mealtime to control the rise in blood glucose after a meal. This delivery system most closely mimics the body's normal release of insulin.

It is important for patients to keep a measurements diary in order to be able to understand the factors that affect their levels and to adjust them accordingly. Patients can watch their blood glucose using a glucose meter several times per day. A suggestion of times and reasons of measurements are shown below:

Table 6 Diabetes Case\_Diabetes Measurements

| Measurement time                                   | Measurement reason  |
|--|---|
| When waking up                                     | To check if her blood glucose is under control while sleeping |
| Before meals or big snacks                         | To know the blood glucose levels before eating                |
| 2 hours after the beginning of the meals or snacks | To see how food affects your blood glucose                    |
| Before and 15 minutes after physical exercise      | To see how physical exercise affects your blood glucose       |

Continuous glucose monitoring (CGM) is a system that tracks blood sugar levels day and night. The device collects readings automatically every 5 minutes. Along with finger sticks, this device can help detect trends and patterns and give the patient and the doctor a more complete picture of your diabetes. The data can help in finding ways to better manage the condition.

CGM uses a tiny sensor that is typically put under the skin on the belly. The patient can put it in quickly and it's usually not painful. It measures the amount of sugar, called glucose, in the fluid inside the body. A transmitter on the sensor then sends the information to a wireless



pager-like monitor that the patient can clip on their belt. The monitor displays sugar levels at 1-, 5- and 10-minute intervals. If sugar drops to a dangerously low level or a high preset level, the monitor will sound an alarm.

In the past, only doctors could see the readings CGM systems collected. Now anyone can use the devices as part of at-home diabetes care. Patients can download data on their computer, tablet, or smartphone to see patterns and trends in their glucose levels. The information can help them and their doctor make the best plan for **managing** their **diabetes**, including:

- How much insulin they should take
- An exercise plan that's right for them
- The number of meals and snacks they need each day
- The correct types and doses of medications

CGM doesn't replace home monitors or need for finger sticks. Patient's still need to measure their blood sugar with a regular glucose meter a few times a day to help the monitor stay accurate. They should also replace the sensor under their skin every 3 to 7 days. If they use an insulin pump, they can also link it to their CGM system for continuous care. They won't need to manually program the pump as with the other finger-prick methods. This is called a "sensor-augmented pump."

Unlike traditional glucose meters, CGM records blood sugar levels throughout the entire day and night, showing your highs and lows throughout the whole week. The system can help:

- Record dangerously low overnight blood sugar levels, which often go undetected
- Track high levels between meals
- Show early morning spikes in blood sugar
- Evaluate how diet and exercise affect the patient
- Determine if his treatment plan works on a day-to-day basis

A doctor may recommend CGM if someone has:

- Major highs and lows in blood sugar levels for no clear reason
- Gestational diabetes, which happens during pregnancy
- An insulin pump





- Blood sugar levels that are very low, called hypoglycemia, or very high, called hyperglycemia

### Glucose Buddy: Diabetes Log Application

Glucose Buddy is a data storage utility for people with diabetes. Users can log their:

- BG
- Carbs (Food)
- Medication (Insulin Dosages)
- Activities
- A1C
- Blood Pressure
- Weight

Remembering to test blood sugar is always a problem, that's why in GB there are reminders that are associated with events so users will never forget to test again. Great visualization with calendar day by day quick view and be able to add multiple items all at once. Below, we present some images of the main features of the application.

Figure 144 Diabetes Case\_Glucose Buddy: Diabetes Log Application Menu

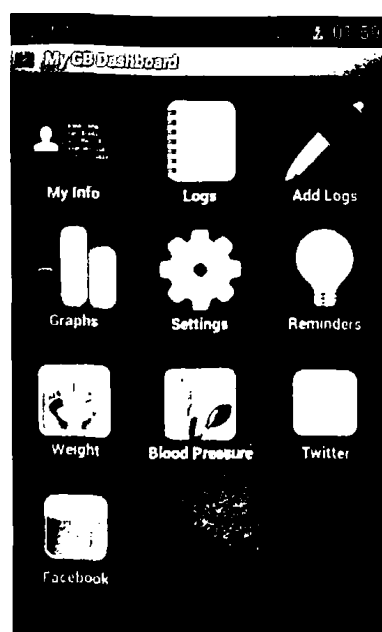
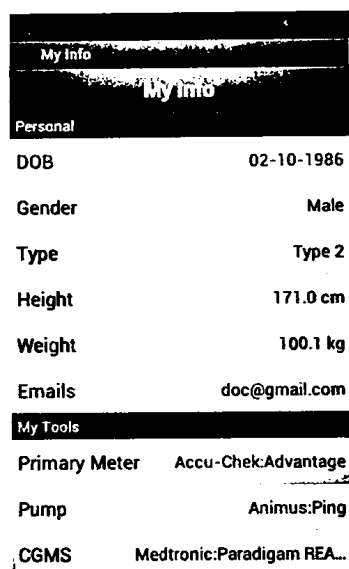


Figure 145 Diabetes Case\_Glucose Buddy: Diabetes Log Application \_Personal Information



**My Info**

**Personal**

DOB 02-10-1986

Gender Male

Type Type 2

Height 171.0 cm

Weight 100.1 kg

Emails doc@gmail.com

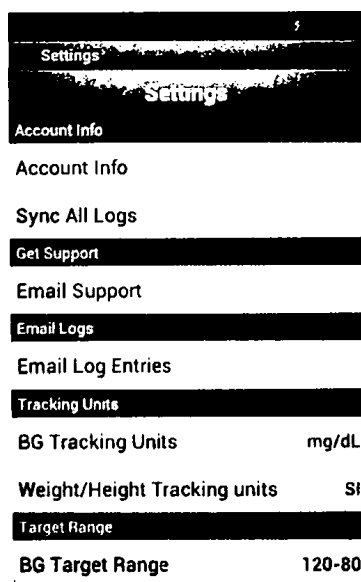
**My Tools**

Primary Meter Accu-Chek:Advantage

Pump Animus:Ping

CGMS Medtronic:Paradigam REA...

Figure 146 Diabetes Case\_Glucose Buddy: Diabetes Log Application \_Settings



**Settings**

**Account Info**

Account Info

Sync All Logs

Get Support

Email Support

Email Logs

Email Log Entries

**Tracking Units**

BG Tracking Units mg/dL

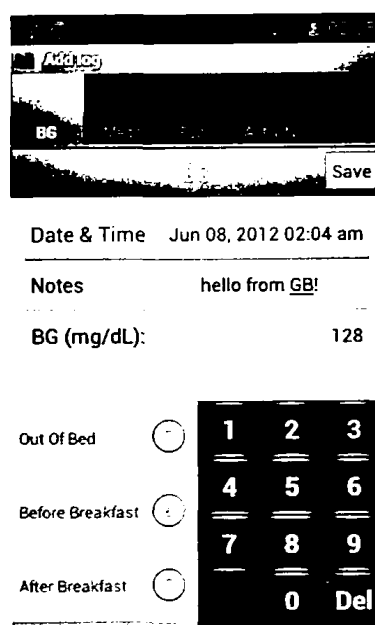
Weight/Height Tracking units SI

**Target Range**

BG Target Range 120-80



Figure 147 Diabetes Case\_Glucose Buddy: Diabetes Log Application \_Add measurement



**Add Log**

BG: 128

Notes: hello from GB!

Date & Time: Jun 08, 2012 02:04 am

Out Of Bed: ☐

Before Breakfast: ☐

After Breakfast: ☐

BG (mg/dL): 128

1 2 3

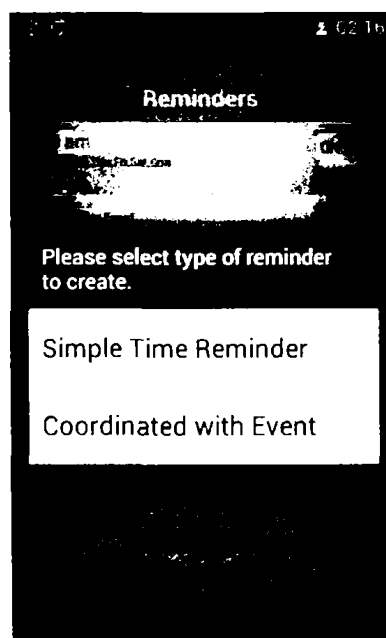
4 5 6

7 8 9

0 Del

Save

Figure 148 Diabetes Case\_Glucose Buddy: Diabetes Log Application \_Reminder



**Reminders**

Please select type of reminder to create.

Simple Time Reminder

Coordinated with Event



Figure 149 Diabetes Case\_Glucose Buddy: Diabetes Log Application \_List of measurements

| Logs                   |       |          |          |
|------------------------|-------|----------|----------|
| List                   | Month | Type     | All      |
| 120 mg/dL              |       | BG       | 02:09 am |
| 06/11 Out Of Bed       |       |          |          |
| 140 mg/dL              |       | BG       | 01:43 am |
| 06/11 Before Breakfast |       |          |          |
| 120 mg/dL              |       | BG       | 01:28 am |
| 06/11 Out Of Bed       |       |          |          |
| 6.8%                   |       | A1C      | 01:27 am |
| 06/11 Lab Test         |       |          |          |
| 125 mg/dL              |       | BG       | 01:26 am |
| 06/11 Out Of Bed       |       |          |          |
| 123.0 units            |       | meds1    | 01:26 am |
| 06/11 Out Of Bed       |       |          |          |
| 147.0 grams            |       | foods1   | 01:26 am |
| 06/11 Breakfast        |       |          |          |
| 36.0 mins              |       | activity | 01:26 am |
| 06/11 Before Breakfast |       |          |          |
| 169 mg/dL              |       | BG       | 02:03 am |
| 06/10 Out Of Bed       |       |          |          |
| 90 mg/dL               |       | BG       | 02:00 am |
| 06/10 Out Of Bed       |       |          |          |
| 250 mg/dL              |       | BG       | 02:04 am |

Figure 150 Diabetes Case\_Glucose Buddy: Diabetes Log Application \_Month measurements

Logs

Today

List

Month

+

June 2012

| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
|-----|-----|-----|-----|-----|-----|-----|
|     |     |     |     |     | 1   | 2   |
| 3   | 4   | 5   | 6   | 7   | 8   | 9   |
| 10  | 11  | 12  | 13  | 14  | 15  | 16  |
| 17  | 18  | 19  | 20  | 21  | 22  | 23  |
| 24  | 25  | 26  | 27  | 28  | 29  | 30  |

120 mg/dL

BG

02:09 am

06/11 Out Of Bed

140 mg/dL

BG

01:43 am

06/11 Before Breakfast

120 mg/dL

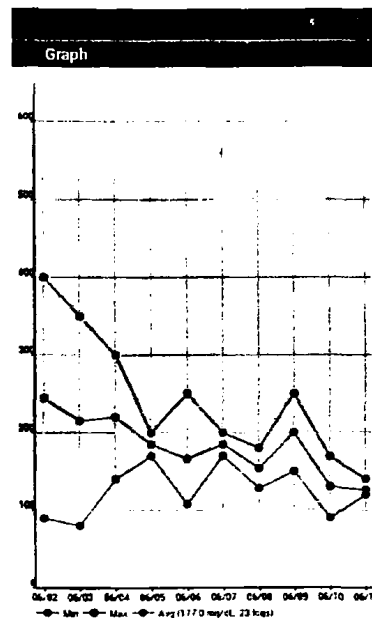
BG

01:28 am

06/11 Out Of Bed



Figure 151 Diabetes Case\_Glucose Buddy: Diabetes Log Application\_Measurements Graph



More information about diabetes can be found in references [27], [60], [61], [62], [63] and [64].

The patient's results that can be found by the students in the pdf named Results and they are shown in the following table.

Table 7 Diabetes Case\_Patient's Results

|                             |            |
|-----------------------------|------------|
| Blood sugar test            | >126 mg/dL |
| Hemoglobin A1c test         | 7%         |
| Oral glucose tolerance test | >200 mg/dL |

The whole case containing the content, abstract, teaching notes, attached files and case objectives is shown in figure 152.



Figure 152 Diabetes Case

Case File  
 This case file is for the patient's case. It contains the patient's history, physical examination, laboratory tests, and treatment.

Abstract  
 This is a summary of the patient's case. It contains the patient's history, physical examination, laboratory tests, and treatment.

Teaching Notes  
 This is a summary of the patient's case. It contains the patient's history, physical examination, laboratory tests, and treatment.

Learning Objectives  
 This is a summary of the patient's case. It contains the patient's history, physical examination, laboratory tests, and treatment.

Case Progress  
 This is a summary of the patient's case. It contains the patient's history, physical examination, laboratory tests, and treatment.

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Students login the Casemaker platform using their e-mail and they can see the new case. They are divided into groups and they are encouraged to click on the case and start studying, solving and discussing it. Working the case in groups, they can collaborate and be led to a conclusion in a more easy and creative way. So, they discuss the case in groups, they write their reports and then they discuss the case altogether in the classroom with the teacher as a facilitator. We quote one possible right answer for each one of the questions:

Question 1: I think it is very likely that she has diabetes because of her high blood pressure and her cholesterol levels as well as her young age and the fact that her mother has diabetes. In order to confirm the diagnosis, she has to do the following tests: Blood sugar test, Hemoglobin A1c test and Oral glucose tolerance test.

Question 2: The blood sugar test indicates diabetes as it is higher than 126 mg/dL which is a risk factor for type 2. As it is known the Hemoglobin A1c test's levels are the following:

- Normal: Less than 5.7%
- Pre-diabetes: 5.7% - 6.4%
- Diabetes: 6.5% or higher

So, the result 7% means diabetes. And finally, the oral glucose tolerance test which is higher than 200 mg/dL, indicates type 2 diabetes. Taking into account all the facts, we are led to the conclusion that the 20 year old girl has type 2 diabetes.

Question 3: Type 2 diabetes may be reversed with lifestyle changes, especially losing weight through exercising and eating healthier foods. She will also have to visit her health care provider at least two to four times a year and talk about any problems she is having. She can follow good nutrition which can achieve a normal body weight, and sensible exercise, with the goal of keeping both short-term and long-term blood glucose levels within acceptable levels.

Question 4: Generally, it is suggested for a diabetic to check her cholesterol levels when waking up in order to check if her blood glucose is under control while sleeping. It is also good to check the levels before eating meals so as to know the blood glucose levels before eating. She can also take a measurement 2 hours after the beginning of the meals in order to



see how food affects your blood glucose. Finally, it is suggested that she checks her blood glucose before and 15 minutes after exercising in order to see how physical exercise affects your blood glucose.

As it is difficult for someone to keep a diary, i would recommend her to use the Smartphone Application " Glucose Buddy: Diabetes Log ", as it is one of the most useful diabetes applications and it is free for someone to download it to her Smartphone device. Glucose Buddy is a data storage utility for people with diabetes. Users can log their BG, Carbs (Food), Medication (Insulin Dosages), Activities, A1C, Blood Pressure, Weight. The app helps people remember to test blood sugar as there are reminders that are associated with events so users will never forget to test. It also offers great visualization with calendar day by day quick view.

First of all, she will have to enter her personal information such as gender, weight, height, diabetes type and the tool she uses for her measurements. Every time she checks her blood glucose levels she can add a log into the application by clicking on the Add Log menu option. The date and time is automatically saved and she can choose from a menu if the measurement is: out of bed, before/after breakfast, before/after lunch, before/after dinner, before bed, during night, after bed, before/after snack, before/during/after activity or other and she can also keep a note for the specific measurement. In the same menu section, there are categories such as medication, food, activity, A1c where she can keep the corresponding information.

In the main menu there is also the option Logs where she can find all her measurements listed by month and in the Graphs option she can see them in a graph where minimum, maximum and average measurements are shown in different colors. There is also the Blood Pressure option where she can store her systolic, diastolic pressure and her heart rates as well as keep a measurements history and graphs. She can do the same process for her body weight changes in the Weight menu option. Last but not least, she can set a reminder in order to always remember to check her blood glucose levels.





### 7.9. Case Study: Blood Pressure

The next case scenario that we created is called Blood Pressure and was planned to be given for homework at the end of the tenth week and to be discussed in the classroom in the next lesson (11th week). The process that has been followed for the case creation has already been described, so we are going to describe how it is going to be presented and solved by the students in the classroom.

Students would have already receive an e-mail that invites them to the platform after the invitation has been sent by the teacher. So, they would have visited Casemaker and signed up for it in order to be able to login each time they receive an e-mail that invites them to a new case.

The case title is Blood Pressure and its content is the following:

A 50 year old man discovered unusual blood pressure readings (140/90) as part of a routine doctor's appointment.

The questions that students have to answer in this case are the following:

Question 1: In which Blood Pressure Category he may belong to?

Question 2: What may his doctor ask for a more accurate evaluation?

Question 3: After his 24-hour results that indicated hypertension, what kind of lifestyle changes do you think his doctor advised him to adapt?

Question 4: Except from the lifestyle changes, his doctor recommended that he should take everyday measurements of his blood pressure and keep a diary using a really useful smart phone application: Blood Pressure (My Heart). Please explain to the 50 year old man how to use the app trying to reassure him that it will make his everyday life much easier.

Students are given a pdf file with all the needed information for this case and it is cited below:

**Blood pressure** is the pressure exerted by circulating blood upon the walls of blood vessels and is one of the principal vital signs. When used without further specification, "blood pressure" usually refers to the arterial pressure of the systemic circulation, usually measured at a person's upper arm. A person's blood pressure is usually expressed in terms of the



systolic pressure over diastolic pressure. Normal resting blood pressure for an adult is approximately 120/80 mm Hg.

When your heart beats, it contracts and pushes blood through the arteries to the rest of the body. This force creates pressure on the arteries. This is called **systolic** blood pressure. A normal systolic blood pressure is below 120. A systolic blood pressure of 120 to 139 means you have prehypertension, or borderline high blood pressure. A systolic blood pressure number of 140 or higher is considered to be hypertension, or high blood pressure.

The **diastolic** blood pressure number or the bottom number indicates the pressure in the arteries when the heart rests between beats. A normal diastolic blood pressure number is less than 80. A diastolic blood pressure between 80 and 89 indicates prehypertension. A diastolic blood pressure number of 90 or higher is considered to be hypertension or high blood pressure.

Blood pressure is **measured** with a sphygmomanometer. The systolic blood pressure number is always said first, and then the diastolic blood pressure number is given. For example, your blood pressure may be read as "120 over 80" or written as 120/80. The ranges are:

Table 8 Blood Pressure Case\_Blood Pressure Categories

| Blood Pressure Category                       | Systolic mm Hg<br>(upper) |     | Diastolic mm Hg<br>(lower) |
|---|---------------------------|-----|----------------------------|
| Normal  | Less than 120             | And | Less than 80               |
| Prehypertension                               | 120-139                   | Or  | 80-89                      |
| High blood pressure (Hypertension)<br>Stage 1 | 140-159                   | Or  | 90-99                      |
| High blood pressure (Hypertension)<br>Stage 2 | 160 or higher             | Or  | 100 or higher              |
| High blood pressure in people over age<br>60  | 150 and above             | and | 90 and above               |



|   |                 |    |                 |
|---|-----------------|----|-----------------|
| Hypertensive Crisis (Emergency care needed) | Higher than 180 | Or | Higher than 110 |
|---|-----------------|----|-----------------|

The exact **causes** of high blood pressure are not known, but several factors and conditions may play a role in its development, including:

- Smoking
- Being overweight or obese
- Lack of physical activity
- Too much salt in the diet
- Too much alcohol consumption (more than 1 to 2 drinks per day)
- Stress
- Older age
- Genetics
- Family history of high blood pressure
- Chronic kidney disease
- Adrenal and thyroid disorders

Some high blood pressure symptoms may be the following:

- headaches
- blurred or double vision
- shortness of breath
- nose bleeding
- irregular heartbeat

If a person's blood pressure reading is higher than normal, their doctor may take several readings over time and/or have them monitor their blood pressure at home before **diagnosing** them with high blood pressure.

- 90 over 60 (90/60) or less: They may have low blood pressure.
- More than 90 over 60 (90/60) and less than 120 over 80 (120/80): Their blood pressure reading is ideal and healthy. They have to follow a healthy lifestyle to keep it at this level.

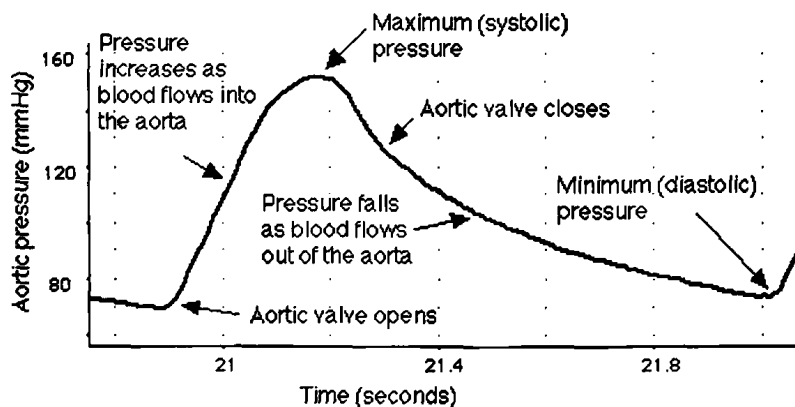


- More than 120 over 80 and less than 140 over 90 (120/80-140/90): They have a normal blood pressure reading but it is a little higher than it should be, and they should try to lower it. They have to make healthy changes to their lifestyle.
- 140 over 90 (140/90) or higher (over a number of weeks): They may have high blood pressure (hypertension). They have to change their lifestyle - see their doctor or nurse and take any medicines they may give them.

So:

- if their top number is 140 or more - then they may have high blood pressure, regardless of their bottom number.
- if their bottom number is 90 or more - then they may have high blood pressure, regardless their top number.
- if their top number is 90 or less - then they may have low blood pressure, regardless of their bottom number.
- if their bottom number is 60 or less - then they may have low blood pressure, regardless of their top number.

Figure 153 Blood Pressure Case \_Arterial pressure waveform



#### Classification

- Systemic arterial
- Mean arterial pressure
- Pulse pressure
- Systemic venous pressure
- Pulmonary pressure



The only way to find out whether one has high blood pressure is by having their blood pressure measured. Blood pressure is measured by **sphygmomanometers** and/or 24-hour blood pressure monitors (**Holter**). Doctors may also ask people some blood tests in order to check cholesterol and blood sugar levels, as well as the condition of kidneys as well as an ECG.

The Blood Pressure Monitor is a small computerized device used to regularly test blood pressure over the course of the day. To attach the monitor there is a cuff placed onto the arm, a rubber cable comes from this cuff and is attached to the front of the blood pressure monitor itself. Once attached, the Blood Pressure Monitor is placed within a small pouch and then worn around the waist by way of a belt. The monitor will inflate the cuff and perform a blood pressure recording every 30 minutes on a continual basis over the 24 hours.

If the doctor has discovered some unusual blood pressure readings he may ask for the blood pressure to be monitored over a 24 hour period. The 24 Hour Blood Pressure Monitor will monitor blood pressure over this period. The results will allow the doctor to know if the blood pressure requires medication to allow tighter control, or if further investigation is required.

People are given a diary to help with the analysis and to make a more accurate evaluation of the 24 hour blood pressure recording. They have to keep a brief note of their activities as well as recording any symptoms they may have during the recording, along with their time, duration and circumstance.

Figure 154 Blood Pressure Case\_ Normal blood pressure limit values (mmHg) based on different measurement modes

|                    | Systolic | Diastolic |
|--------------------|----------|-----------|
| Doctor's office    | 140      | 90        |
| 24-hour monitoring | 125-130  | 80        |
| Day                | 130-135  | 85        |
| Night              | 120      | 70        |
| At home            | 130-135  | 85        |



Changing a lifestyle can help in controlling high blood pressure. Doctors may recommend a healthy low fat diet with less salt, exercise regularly, quit smoking/drinking alcohol, drink less coffee/tea and maintain a healthy weight. But sometimes lifestyle changes aren't enough. In addition to lifestyle changes, doctors may recommend medication to lower blood pressure.

Patient's choice of treatment will depend on their blood pressure level and their risk of developing a cardiovascular disease, , such as a heart attack, stroke or kidney failure.

- If their blood pressure is consistently above 140/90mmHg (or 135/85mmHg at home) but their risk of cardiovascular disease is low – they should be able to lower their blood pressure by making some changes to their lifestyle. They may be offered yearly blood pressure assessments.
- If their blood pressure is consistently above 140/90mmHg (or 135/85mmHg at home) but below 160/100mmHg – they will be offered medication to lower their blood pressure if they have existing or high risk of cardiovascular disease.
- If their blood pressure is consistently above 160/100mmHg – they will be offered medication to lower their blood pressure.

### **Blood Pressure (My Heart) Application**

This application helps to control blood pressure and improves the method of dealing with hypertension. With it users can easily store and analyze all of their blood pressure readings. It also produces incidental information necessary for the proper treatment of hypertension, which can be directly sent to a doctor as a report. Its main characteristics include:

- Very easy to use user interface
- Save measuring blood pressure
- Edit and update the measurements
- Describing measurements:
  - Tags - type short description and use them repeatedly
  - Date and time of measurement of blood pressure
  - The values of blood pressure - systolic, diastolic, and pulse weight
  - Description
- Support for multiple users.
- Interactive charts visualization of trends in blood pressure



- Statistics: Pressure Heart rate, MAP - Medium Blood Pressure blood pressure index, mean arterial pressure
- Export data to a file:
  - CSV
  - XML
  - PDF - detailed reports
- Reminders for measuring blood pressure
- Appearance - Customize the appearance of the application to your needs

Figure 155 Blood Pressure Case\_Blood Pressure (My Heart) Application

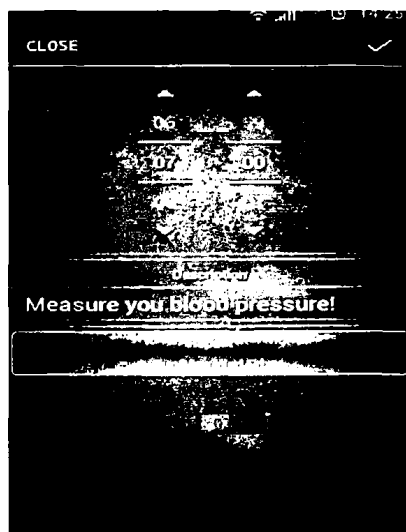


Figure 156 Pressure Case\_Blood Pressure (My Heart) Application\_Add measure

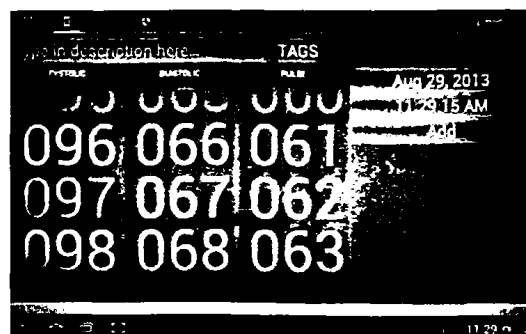


Figure 157 Pressure Case\_Blood Pressure (My Heart) Application\_Measurements

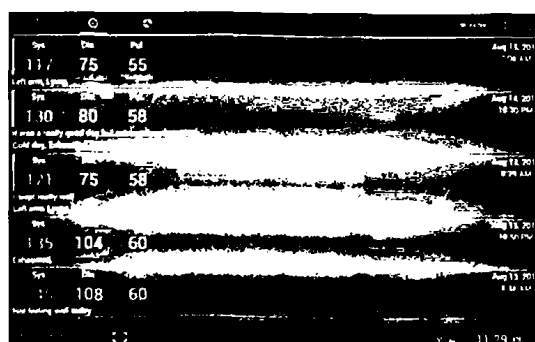


Figure 158 Pressure Case\_Blood Pressure (My Heart) Application\_Measurements

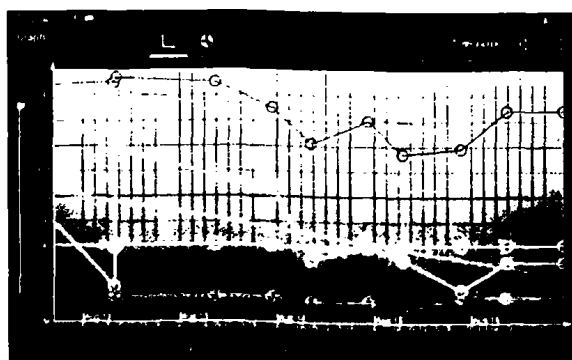




Figure 159 Pressure Case\_Blood Pressure (My Heart) Application\_Category I

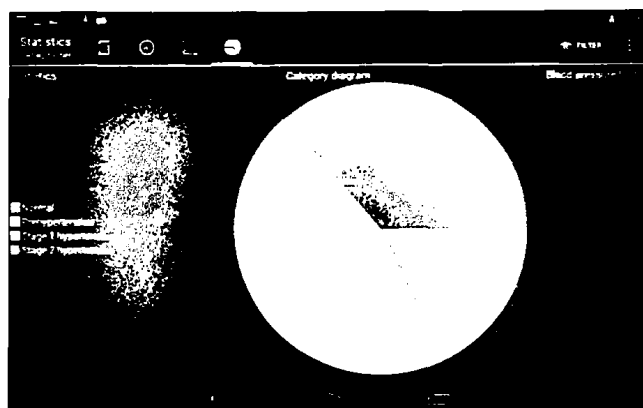
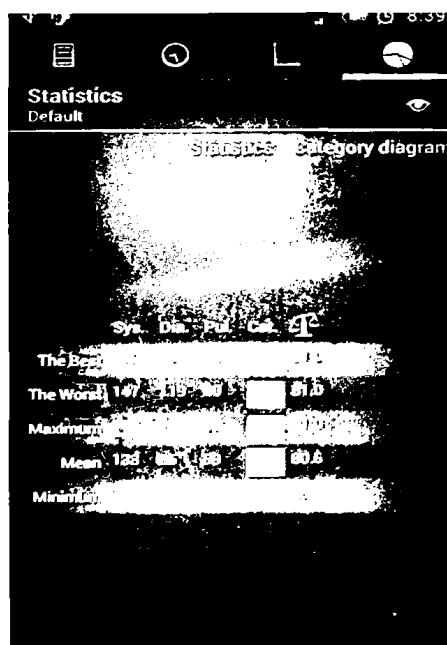


Figure 160 Pressure Case\_Blood Pressure (My Heart) Application\_Statis



More information about diabetes can be found in references [27], [65], [66] and [67].

The whole case containing the content, abstract, teaching notes, attached file objectives is shown in figure 161.



### Figure 161 Blood Pressure Case

[illegible]

Students login the Casemaker platform using their e-mail and they can see and solve the new case at home. They are still divided into groups and encouraged to collaborate through the platform. So, they write their reports and then they can discuss the case altogether in the next classroom lesson. We quote one possible right answer for each one of the questions:

Question 1: Having 140 over 90, it is possible that he may have high blood pressure (Hypertension Stage 1).

Question 2: He may ask for the patient's blood pressure to be monitored over a 24 hour period. The 24 Hour Blood Pressure Monitor will monitor blood pressure over this period. The results will allow the doctor to know if the blood pressure requires medication to allow tighter control, or if further investigation is required.

Question 3: Changing a lifestyle can help in controlling high blood pressure. I think his doctor would recommend a healthy low fat diet with less salt, regular exercise, not smoking/drinking alcohol, drink less coffee/tea and maintain a healthy weight.

Question 4: This application helps people control their blood pressure and improves the method of dealing with hypertension. With it, users can easily store and analyze all of their blood pressure readings. It also produces information necessary for the right treatment of hypertension, which can directly be sent to a doctor as a report.

First of all, simply by touching the application icon he will be able to select from a number menu his systolic and diastolic blood pressure as well as his heart pulse. The moment he does so, a colored bar is shown underneath informing him about the blood pressure category. In particular:

- Green - Normal
- Blue - Hypotension
- Yellow - Prehypertension
- Orange - Stage 1 Hypertension
- Red - Stage 2 Hypertension



He can also write a description of how he feels at that time, for example, tired, lying, if he took medicine, rested etc. He then clicks on "Add" and his measurement is saved and so is the date and time. That is what a user has to do every time he measures his blood pressure.

All his measurements are listed and can be found under the menu option History (the clock icon), where the user can find all his measurements along with their description and colored in the corresponding color as we explained above. Next to the History, there is the Graph menu option, where the user can see his systolic, diastolic, weight and pulse points and trends over time in different colors.

The user can also view his statistics where he is informed about his best and worst, minimum and maximum as well as mean measurements accompanied with the appropriate color. He also has the chance to view a category diagram, a mean arterial diagram, a pulse pressure diagram, a blood pressure factor diagram. So he is always and very easily aware of his blood pressure trends.

The application has a reminder that the user can set the dates and times he wants to take his measurements, so he never forgets it. Finally, the user's data can be exported and shared via e-mail or other social media with his doctor, so he can have an immediate and accurate advice whenever he needs it.

#### **7.10. Case Study: Patients Support System 2**

The case concerns the Continuous glucose monitoring and Insulin Pumps. Students are divided into groups and the case is solved in the platform and discussed simultaneously in the classroom at the eleventh week of the course. The process that has been followed for the case creation has already been described, so we are going to describe how it is going to be presented and solved by the students in the classroom.

Students would have already receive an e-mail that invites them to the platform after the invitation has been sent by the teacher. So, they would have visited Casemaker and signed up for it in order to be able to login each time they receive an e-mail that invites them to a new



case. This case has no attached files because it is the sequel of the diabetes case and students will have to re-check that case in order to recall information.

The case title is Patients Support Systems 2 and its content is the following:

The 20 year old girl that we met in a previous case scenario (for more information check that case again), visited her doctor one month later to have routine tests in order to check if the levels of her blood glucose have been better. Her doctor informed her that there was no significant improvement because she didn't follow all the instructions (didn't have all the finger stick readings she had to) and that she had to wear an insulin pump.

The questions that students have to answer in this case are the following:

Question 1: The girl is not so excited about the insulin pump, so could you talk her into its advantages?

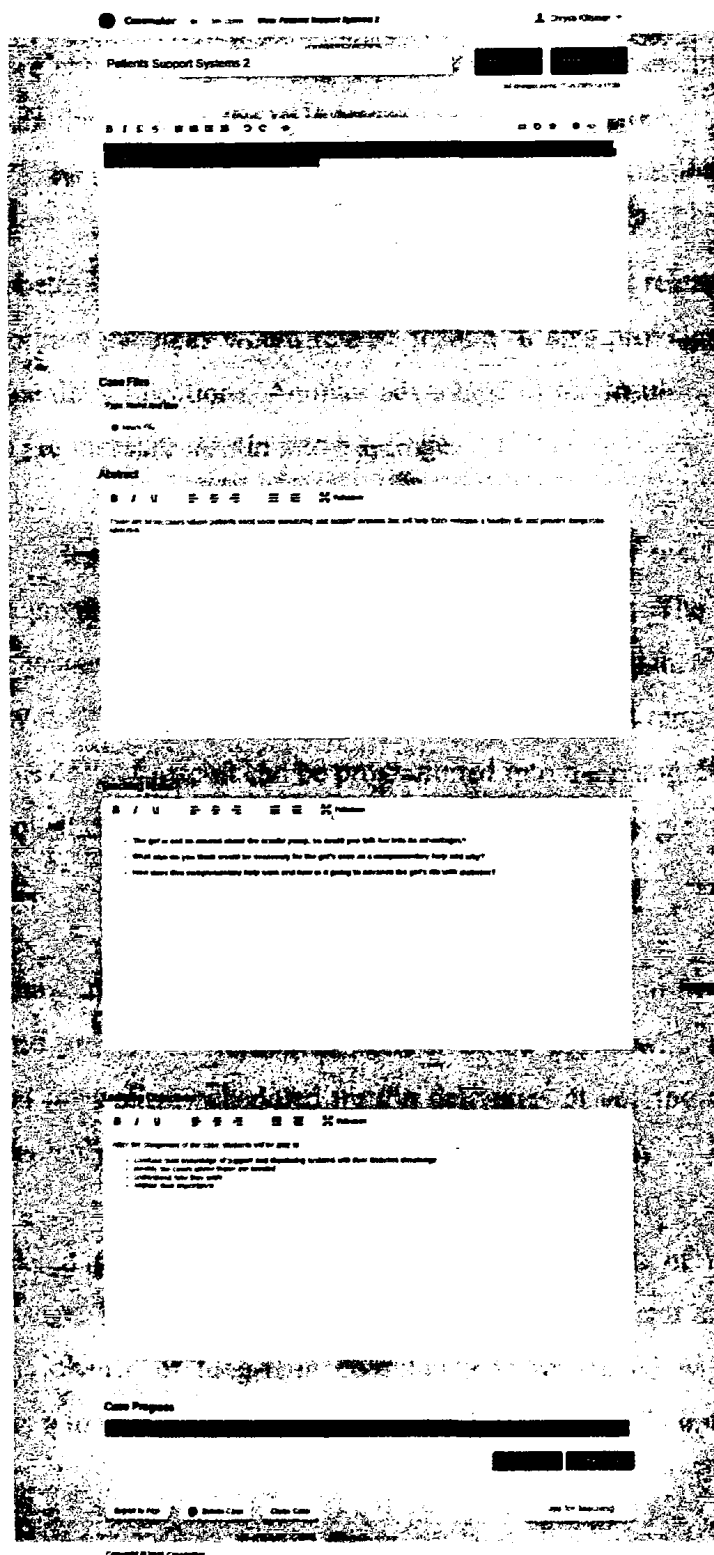
Question 2: What else do you think would be necessary for the girl's case as a complementary help and why?

Question 3: How does this complementary help work and how is it going to advance the girl's life with diabetes?

The whole case containing the content, abstract, teaching notes, attached files and case objectives is shown in figure 162.



Figure 162 Patients Support Systems 2 Case



Students login the Casemaker platform using their e-mail and they can see the new case. They are divided into groups and they are encouraged to click on the case and start studying, solving and discussing it. Working the case in groups, they can collaborate and be led to a conclusion in a more easy and creative way. So, they discuss the case in groups, they write their reports and then they discuss the case altogether in the classroom with the teacher as a facilitator. We quote one possible right answer for each one of the questions:

Question 1: For diabetes, insulin pump is preferred because its slow release of insulin mimics how a normally working pancreas would release insulin. It also provides better blood sugar control than multiple daily injections. Another advantage of the insulin pump is that it frees patients from having to measure insulin into a syringe.

The insulin pump is designed to deliver a continuous amount of insulin, 24 hours a day according to a programmed plan unique to each pump wearer. The amount of insulin delivered can be changed by the user. Between meals and overnights, a small amount of insulin is constantly delivered to keep the blood sugar in the target range (basal rate). When food is eaten, a bolus dose of insulin can be programmed into the pump. Patients can measure how much of a bolus you need using calculations based on the grams of carbohydrates consumed.

The use of rapid-acting insulin for basal needs offers relative freedom from a structured meal and exercise regime previously needed to control blood sugar with slow-acting insulin. Programmable basal rates allow scheduled insulin deliveries of varying amounts at different times of the day which is more convenient and discreet than injection.

Insulin pumps make it possible to deliver more precise amounts of insulin than can be injected using a syringe. This supports tighter control over blood sugar and Hemoglobin A1c levels, reducing the chance of long-term complications associated with diabetes. This is predicted to result in a long-term cost savings relative to multiple daily injections.



Question 2: Doctors usually recommend Continuous Glucose Monitoring along with use of an insulin pump. Unlike traditional glucose meters, CGM records blood sugar levels throughout the entire day and night, showing highs and lows throughout the whole week.

Question 3: CGM uses a tiny sensor that is typically put under the skin on the belly. The patient can put it in quickly and it's usually not painful. It measures the amount of glucose in the fluid inside the body. A transmitter on the sensor then sends the information to a wireless monitor that the patient can clip on their belt. The monitor displays sugar levels at 1-, 5- and 10-minute intervals. If sugar drops to a dangerously low level or a high preset level, the monitor will sound an alarm. Patient still need to measure their blood sugar with a regular glucose meter but fewer times a day.

The information that a CGM collects, can help patients and their doctor make the best plan for managing their diabetes, including:

- How much insulin they should take
- An exercise plan that's right for them
- The number of meals and snacks they need each day
- The correct types and doses of medications

Patient still need to measure their blood sugar with a regular glucose meter but fewer times a day. The system can also help:

- Record dangerously low overnight blood sugar levels, which often go undetected
- Track high levels between meals
- Show early morning spikes in blood sugar
- Evaluate how diet and exercise affect the patient
- Determine if his treatment plan works on a day-to-day basis.

### **7.11. Applying the case based learning method to Graduate students**

The goal of our cases was to let students experience studying, analyzing and proposing solutions to real-life information related to biomedical engineering problems. The results





showed that the students were able to identify significant issues, identify alternative solutions and communicate findings through the case method and the platform we used. They were also capable of analyzing complicated and unfamiliar problems. Case based learning encouraged students to develop their critical thinking, learn to work in teams, sharpen their thinking and writing skills. Most of the participants thought that the approach was helpful and that they enjoyed it, became familiar with something new and knew where they could apply the knowledge and skills.

There were eleven participants, all of them Graduate students of the Department of Computer Science and Engineering of the University of Ioannina in Greece. They suited our study as they were students of the graduate course of Biomedical Engineering. The cases that were developed were about the types of arrhythmias and the use of ECG and Holter Monitor. It concerned the identification of ECG and Holter waveforms as well as their necessity. The methodology used and issues faced when developing the case has been discussed previously, so we are going to describe how we performed the cases with the help of the students.

At first, we presented in the classroom the subject of our Master Thesis and the Casemaker platform. We also explained the students the theme of the two cases as well as how they would participate in our research. Students agreed on taking part in our research so we then collected their e-mails in order to invite them as new members into the platform and release our cases to them. There were eleven students and we divided them into four groups of three people so that they could collaborate and solve the case. So, we had to release the case four times, one for each group.

The participants were given two weeks to work on the cases and produce their reports. The students received the invitation e-mails and they had to login the Casemaker platform using their e-mail in order to be able to read and solve the case. While students were dealing with the case we were able to view the case statistics of each group which concerned the progress of the case as well as the number of clicks and annotations that each team made.



### 7.12. Assessing students' acceptance of the case based learning method

Case based learning is an active and student-centric learning method that provides a mechanism for learning concepts, skills, tools and techniques in a context where the instructor and students are engaged in a meaningful manner. Our experience showed that case based learning enabled students to relate their knowledge to the learning process and improve the learning through problem solving activities. It enhanced students' practical activity by arousing their interest and attracting them to participate. It was also a pleasant learning method that helped them read, analyze cases, execute discussions with peers and gain new knowledge.

After the completion of the two cases that students were asked to participate in, we provided them with a questionnaire of ten questions concerning the case based learning method and their own experience of it. The objective of the questionnaire was to assess students' degree of acceptance towards the use of case based learning method in teaching and learning Biomedical Engineering. The results indicate that case based learning is more effective than lecture approach as it is seen as more interesting which confirms the hypothesis in our study. Furthermore, it can improve communication skills, ability to apply concepts and skills learned in class and help to visualize realistic Biomedical Engineering scenarios. We are going to present both quantitative and qualitative analysis of the results.

#### Question 1. Do you prefer this kind of exercise or the conventional way? Why?

As for the first question, the participants preferred the case method because they could gain knowledge and improve understanding of the subject matter, exchange ideas and opinions among peers as well as enhance their interpersonal skills such as critical thinking and problem solving. They also mentioned that they were keen in using this method because of the 'realness' of the problem and situation. A few excerpts from the qualitative feedback received from the participants are as follows:

Participant: This way is better because it is more modern and we can give the answer immediately and understand the concepts of the course.

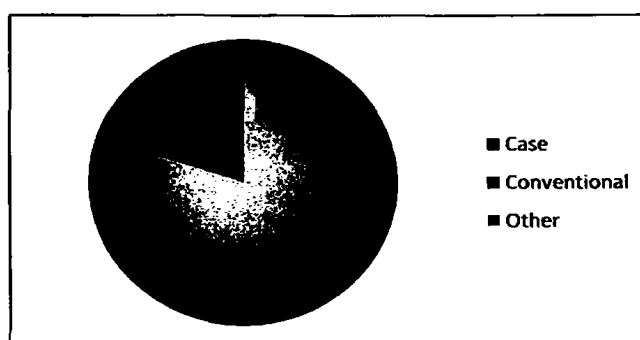
Participant: That kind of exercise is better because we can check in the Internet for more information, we can cooperate and solve a real problem.



Table 9 Quantitative data of question 1

| Case | Conventional | Other | Total |
|------|--------------|-------|-------|
| 4    | 1            | 0     | 11    |

Graph 1 Visualization of question 1



Question 2. Is this exercise useful to you? Yes or No? In what aspects it is useful/not useful?

As for Question 2, all participants found that the case method was useful. Some positive reasons given include they can map theory to practical and gain more Biomedical Engineering knowledge and concepts. More importantly, they felt that the cases equip them for the future.

Below are some examples of the responses:

Participant: It was a very good exercise for me because there are a lot of things that I didn't know about the heart and what happens when we have stress in our life, drink or smoke.

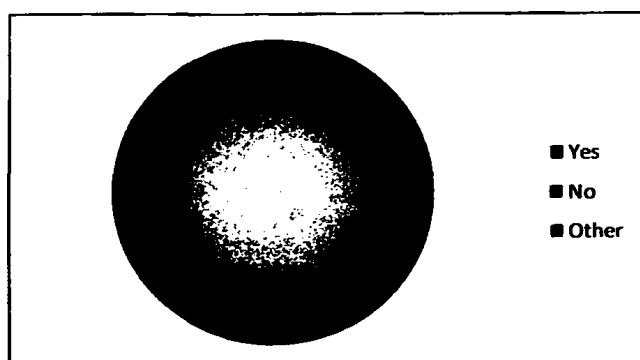
Participant: It was useful because you learn some medical conditions and it has to do with the course to graduate. It also offered very useful knowledge for the future.

Table 10 Quantitative data of question 2

| Yes | No | Other | Total |
|-----|----|-------|-------|
| 5   | 0  | 0     | 11    |



Graph 2 Visualization of question 2



**Question 3. What if this kind of exercise is included in the examination? Do you like it or not? Why?**

When asked if this kind of exercise is included in the examination, they all liked the idea. One of the reasons why the case based learning method is suitable for the examination is because it involves giving one's own opinion and judgments based on previous lessons. Moreover, students are offered a rich course material which makes the whole process interesting. Below are some of the responses:

Participant: It is a good way because it provides pictures and data along with a story-case, so it's pretty interesting.

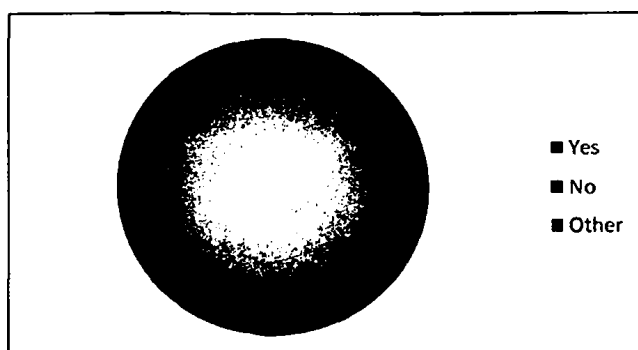
Participant: Yes, of course. It would be great to have that kind of exams. Because it is useful to know such things and give our opinion based on things we have learned.

Table 11 Quantitative data of question 3

| Yes | No | Other | Total |
|-----|----|-------|-------|
| 5   | 0  | 0     | 11    |



Graph 3 Visualization of question 3



Question 4. Do you prefer to have this exercise as a take-home assignment (i.e. prepare at home and submit the report) or as a classroom-based activity (i.e. prepare at home and discuss in class, instructor gives marks based on participation)? Which one? Why?

The answers to the question whether the exercise should be a take-home or classroom based assignment showed that the take-home assignment was preferred because they would have more time to search additional information and solve the cases. Some actual quotes are as follows:

Participant: It would be better to have this exercise as a take-home assignment because I had to search for more information in the internet.

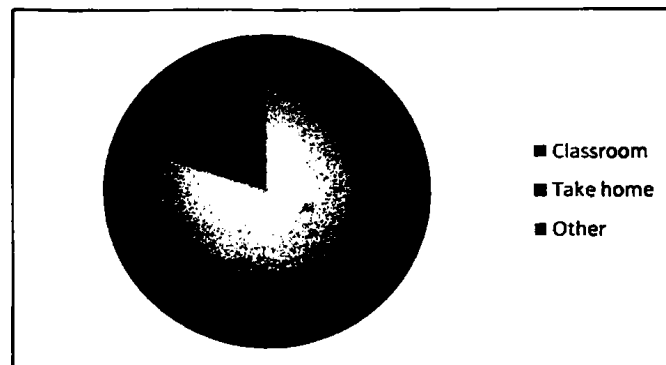
Participant: I would prefer the first way, because there is time to prepare your answers and study data.

Table 12 Quantitative data of question 4

| Classroom | Take home | Other | Total |
|-----------|-----------|-------|-------|
| 4         | 1         | 0     | 11    |



Graph 4 Visualization of question 4

Question 5. Do you gain knowledge or skills from this exercise?

As for the question if they gained knowledge or skills from the cases, all students answered that they gained knowledge and learned to think and evaluate their options. In particular:

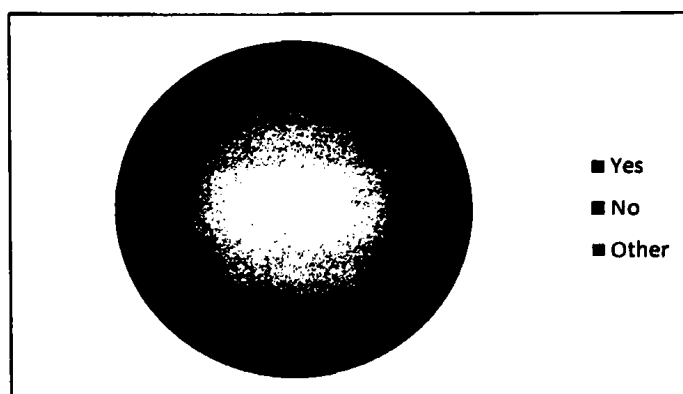
Participant: Yes, I gained more knowledge on the subject of the cases.

Participant: Yes, I learned to think over a lot of options and that there are many real cases of arrhythmias.

Table 13 Quantitative data of question 5

| Yes | No | Other | Total |
|-----|----|-------|-------|
| 5   | 0  | 0     | 11    |

Graph 5 Visualization of question 5



**Question 6. Do you think the Case Method is suitable for teaching and learning Biomedical Engineering? Why?**

When asked if the Case Method is suitable for teaching and learning Biomedical Engineering and why, students answered that it is suitable as it helped them in cooperating with peers and find easier a solution as well as in studying and evaluating all the data and reach a decision. Some answers are cited below:

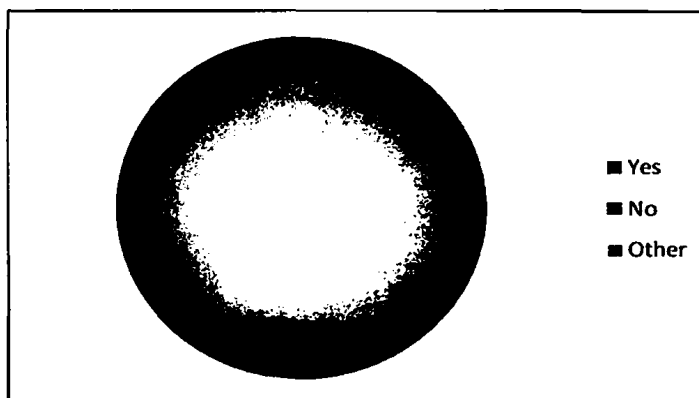
Participant: It is appropriate, because you can see both images and theory and decide appropriate for every case.

Participant: Yes, it is very good because we can work as a team to learn more things that way.

Table 14 Quantitative data of question 6

| Yes | No | Other | Total |
|-----|----|-------|-------|
| 5   | 0  | 0     | 11    |

Graph 6 Visualization of question 6



**Question 7. In which language do you prefer the case to be written in? English or Greek? Why?**

As for the language that the cases were presented to the students, they favored the use of both languages but especially the English one. Some felt that a Greek version would help them understand the context of the terminology better while others felt that the English presentation



was better as they could find more resources in English than in Greek. Some of their answers are:

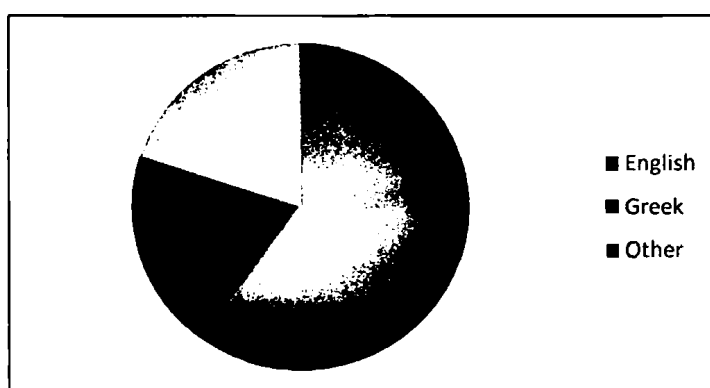
Participant: I would prefer the Greek language because some medical conditions are unknown in English. But English wasn't a big problem.

Participant: It is great in both languages but I think English is better because there are more research files and repots in English than in Greek.

Table 15 Quantitative data of question 7

| English | Greek | Other | Total |
|---------|-------|-------|-------|
| 3       | 1     | 1     | 11    |

Graph 7 Visualization of question 7



Question 8. Were you comfortable with the length of the case given to you? Why?

As for the length of the cases, students reported that they were comfortable with it as it was enough so they could understand the case conditions. In particular, they answered:

Participant: Yes, I think it was pretty good, the text wasn't too large, but it was enough in order to be understood.

Participant: We split the cases equally in my team so enough the length of every case was good.

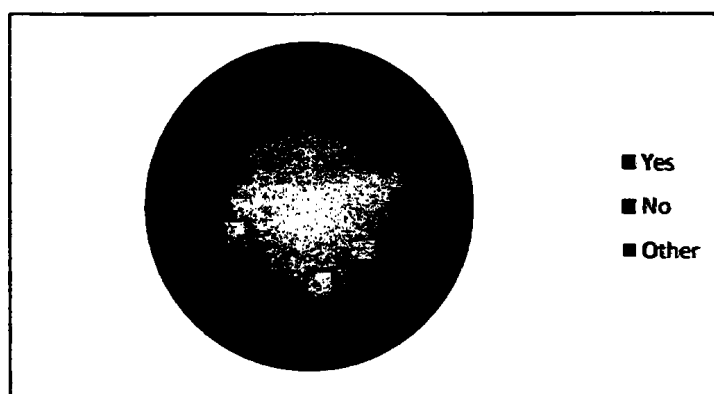




Table 16 Quantitative data of question 8

| Yes | No | Other | Total |
|-----|----|-------|-------|
| 5   | 0  | 0     | 11    |

Graph 8 Visualization of question 8

**Question 9. Did you like the platform the case was presented to you? Why?**

When asked if they liked the platform that the case was presented to them, they thought that it was a very good idea as it was very convenient and manageable. We quote some of their responses:

Participant: Yes, it was quite convenient and easy to use.

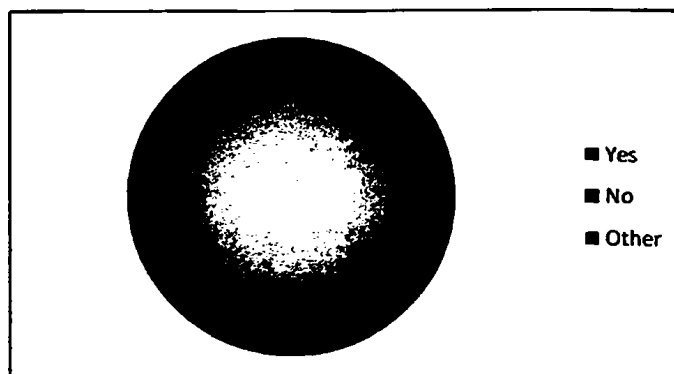
Participant: Yes, it was very good. I didn't use the annotations but it is a very good idea.

Table 17 Quantitative data of question 9

| Yes | No | Other | Total |
|-----|----|-------|-------|
| 5   | 0  | 0     | 11    |



Graph 9 Visualization of question 9



Question 10. Would you prefer the Case Method to be used as the only teaching and learning method throughout the semester? Why?

The last question was if students prefer the Case Method to be used as the only teaching and learning method throughout the semester and why. Some of them were supportive but they all concluded that it should be used as a auxiliary method along with the teacher's lecture. Some answers are cited below:

Participant: I would not prefer it as the only method, because some issues need more analysis. Instead, I would prefer more assignments like these for further understanding of the lecture material.

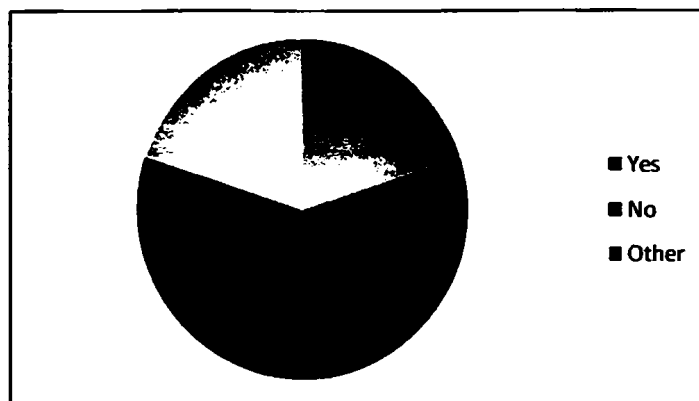
Participant: It would be great but I still think that teaching in class is the best to have, because we can ask the teacher for questions but it would be a great supportive method.

Table 18 Quantitative data of question 10

| Yes | No | Other | Total |
|-----|----|-------|-------|
| 1   | 3  | 1     | 11    |



Graph 10 Visualization of question 10



Based on the above, it can be seen that case based learning is accepted among Graduate Biomedical Engineering students for teaching and learning the subject matter. The method is perceived as useful since it offers values other than what can normally be obtained from the conventional way. The findings can be used to identify and confirm the critical factors for using the case method in Biomedical Engineering. For example, this survey seems to indicate that case, student and learning environment influence the success of the case method.

Generally, our study confirms most findings of previous studies on case based learning and its impact on students. Besides determining the degree and why it is accepted, the survey provides insights into what conditions the method can be useful. The results can be refined further by replicating the study in different contexts. Future research may investigate how the factors and criteria or characteristics influence each other. Later, the findings can be used to formulate as a framework that can guide Biomedical Engineering educators to use the case based learning method in teaching.



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