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## From the editor...

Welcome to the July 2008 issue of Learning Technology.

This newsletter focuses on bringing emerging technologies in education to the readers. New developments and practices with learning technologies are the core of this newsletter. This issue covers topics ranging from use of simulators, use of podcasts, communication technologies and eLearning platforms.

Revilla looks at the problems teachers with disabilities face in using eLearning platforms. Revilla argues that usually eLearning platforms focus on the learner needs and neglects teachers' perspectives, especially teachers with disabilities. Hence, a set of requirements for eLearning platforms to support disabled teachers are provided.

Bennett investigates the use of supplementary podcasts and how they enhance university courses. She looked at the use of supplementary podcasts in 5 faculties at the University of Portsmouth and the results are discussed in this paper. Loyo et. al. studies the reading performance of a group of students who has similar learning styles and preferences and works in an integrated technology learning environment. They looked at the how the performance is effected multiple style technology integrated environments.

Paliokas discusses a learning tool that was developed to demonstrate CPU scheduling algorithms and principles through graphical representation of the processes and the CPU workflow.

This newsletter focuses publishing new and emerging technologies in education focussing on advanced learning technologies and its usage in different contexts. Please feel free to bring forward your ideas and views.

Besides, if you are involved in research and/or implementation of any aspect of advanced learning technologies, I invite you to contribute your own work in progress, project reports, case studies, and events announcements in this newsletter. For more details, please refer author guidelines at [http://lttf.ieee.org/learn\\_tech/authors.html](http://lttf.ieee.org/learn_tech/authors.html).

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# Ten requirements for eLearning platforms to support disabled teachers

**Abstract.** Requirements for eLearning platforms have usually focused on the learners' needs. However, very little studies analyze the required support from the teachers' perspective, especially when the teachers have one or more disabilities. I have analyzed the problems disabled teachers face at the workplace and identified ten requirements for eLearning platforms to overcome them.

## Introduction

Some administrations (e.g. the Training and Development Agency for Schools of the UK <sup>[1]</sup>) are launching campaigns for recruiting disabled teachers because their "ability to change students' views of disabled people and the part they can play in society is particularly worthwhile". However, the reality is that disabled teachers find it very difficult to manage in their off-line jobs. In this sense, it is expected that technology can make them easier to work as on-line teachers. I have done a research study to find out how people with disabilities work as teachers and which problems they face when trying to carry out their tasks. From the problems outlined, I will discuss 10 requirements an eLearning platform should have to facilitate the on-line job of disabled teachers.

## Problems of teachers with disabilities

There are no official data of teachers with disabilities but the problems they face can be deduced by analyzing the following facts.

### *P1. Accessing to the job*

Most of the elementary and secondary schools are held by the government, so teachers have to sit a competitive examination to access to their job. If they want, they can compete for a special quota: the only thing they have to do is to prove a committee that they are capable for the job of teacher. This point is critical because there are not clear rules about how to evaluate if a person is capable or not. Due to privacy rules, there are not public documents of these committees. In Spain, the only known case is Mr. J.C. Sainz, who claimed for help as he was denied to be qualified to be an elementary teacher [2]. He was told that his disability (blindness) was not compatible with 'the control, surveillance, assistance and attention of children from 3 to 12 years'.

### *P2. Mental disorders*

According to reports by the main Spanish trade unions [3], stress, depression and anxiety are very common in elementary teachers (12,2% of the sick leaves). The reasons are social relationships and moral values changes; diversity and the problem students; transfer of responsibilities from families to teachers; and lack of social recognition. Teachers who may suffer from cognitive and neurological disabilities may get worse due to their job duties.

### ***P3. Violence***

According the Spanish trade union ANPE, the 65% of teachers suffer violence problems [4]. In this sense, eLearning can benefit both disabled and non-disabled teachers, as there is no need to physical contact with students.

### ***P4. Educational material and tutoring support***

As disabled teachers are not ‘the usual’ users, almost everything is not accessible: books, posters, audiovisual material, etc. Moreover, teachers have to be able not only to access the material for the classes, but to select the most appropriate for each student.

### ***P5. Infrastructures and mobility***

Legislation forces schools to be adapted to physical disabilities, but not to other disabilities. Many teachers do not live close to their schools. If they cannot drive and public transport facilities are not adapted, they have to be driven to the workplace.

### ***P6. Isolation in their job***

If disabled teachers are not properly supported, they can become isolated from the rest of the staff.

## **Requirements for eLearning platforms**

From the problems analyzed in the previous section, I have identified 10 requirements for learning platform to support disabled teachers.

<b>Requirement (problem addressed)</b>	<b>Explanation</b>
<b>1. Help teachers to guarantee the control, surveillance, assistance and attention of the students (P1)</b>	Continuous tracking of the learners’ activity, so teachers can know what the students are doing in the platform
<b>2. Generate confidence and well-being (P2)</b>	According to the World Health Organization, health is the state of complete physical, mental and social well-being. Thus, the eLearning platform should follow ergonomics and usability guidelines.
<b>3. No face-to-face teaching (P3)</b>	Student can be guided trough the platform activities under the surveillance of the tutor, but with no need of physical contact or communication.

<b>Requirement (problem addressed)</b>	<b>Explanation</b>
<b>4. Automatic validation of contributions against WCAG checkpoints (P4)</b>	W3C Web Content Accessibility Guidelines should be followed not only when the contents are created, but when learners and tutors contribute to the platform (e.g. posting forum messages, adding comments in blogs or entries in wikis).
<b>5. The administration space of the eLearning platform has to be accessible (P4)</b>	User Agent Accessibility Guidelines should be followed in both the front-end and the back-end of the platform functionalities.
<b>6. Offer different types of activities (P4)</b>	The platform must provide different modules so teachers select the appropriate one to make students work a particular learning goal and considering the learners' needs and preferences.
<b>7. Personalization the effort for each student (P4)</b>	Artificial intelligence methods based on user modeling enables teachers in tutoring different students, as the platform guides them through the individual best way.
<b>8. The platform should be available on the Internet (P5)</b>	In this way, teachers can access it from any place, and do not need to move to a specific building.
<b>9. The platform should be device independent (P5)</b>	eLearning platforms should be accessed from any type of device, which may have some assistive technology on it.
<b>10. Improve the communication among the others teachers and the administration (P6)</b>	eLearning platforms should be a place where teachers coordinate efforts, support and exchange experiences. Collaboration facilities are required to promote social relationships.

## References

1. <http://www.tda.gov.uk/about/mediarelations/2008/240608.aspx>
2. <http://www.elmundo.es/elmundo/2007/07/17/madrid/1184692887.html>
3. <http://comunidad-escolar.pntic.mec.es/715/info5.html>
4. <http://www.consumer.es/web/es/educacion/2006/02/12/149320.php>

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# Using supplementary podcasts to enhance campus-based courses: Students' perceptions and usage

**Abstract:** This project investigated the benefits of using 'supplementary' podcasts to enhance university courses. All 5 faculties at the University of Portsmouth (UK) participated in the project. An audio podcast was setup and run for 1 unit in each faculty. At the end of the semester, the students' perceptions and usage was evaluated. It was found that 56% of the students listened to one or more podcast episode and 14% of the students listened to more than half of them. A large proportion of the students who listened to the podcasts found them useful and the podcasts did not adversely affect lecture attendance.

## Introduction

A podcast is a *series* of digital media files (audio or video) that are distributed over the internet for playback on either a portable media player (eg, an iPod) or on a PC. A podcast is updated on a regular basis (eg, weekly) by adding new files (referred to as '*podcast episodes*'). For further information, see Deal (2007) or Patterson (2006).

This project investigates the benefits using short supplementary audio podcasts to enhance courses that follow a format popular in universities; namely, campus-based courses that use both weekly face-to-face classes and online learning resources (eg, lecture notes) provided on a virtual learning environment (eg, WebCT).

## Method

All 5 faculties at the University of Portsmouth participated in the project. An audio podcast was setup for one unit in each faculty. The 5 lecturers recorded and released (approximately) one pre and one post-lecture episode every week for a semester. The post-lecture episodes included; outlining key points and fundamental concepts, explaining the links between the parts of the course (eg, lectures, tutorials and assessments) and real life, and giving feedback and answering frequently asked questions. Whereas pre-lecture episodes included; giving students a 'taster' of the following lecture, trying to remove any incorrect preconceptions or anxieties about the subject, and raising questions in students' minds to generate interest. Each episode was approximately 4-6 minutes long.

Students could access the podcast by either listening online from within their WebCT course or by subscribing (using a RSS feed) from within their WebCT course or through free 'podcatching' software, such as iTunes. Subscribing to the podcast meant that students automatically received new episodes without having to return to WebCT, and these updates were automatically copied to their PC and portable mp3 player.

At the end of the semester, the students' perceptions and usage was evaluated using an anonymous survey.

## Results and discussion

A total of 256 students completed the survey, which represents a participation rate of 51%. Broken down by faculty: 29 Science students; 14 Technology students; 40 Humanities students; 24 Creative and Cultural Industries students; 148 Business School students.

It was found that 56% of the students listened to one or more podcast episode and only 14% of the students listened to more than half. Although the podcasts were not extensively used, a large proportion of the students who listened to them found them useful; 51% said the podcast helped their understanding of their course, 44% said the summary the podcast gave was useful and 40% said the podcast helped them catch up when they got behind. Additionally, only 5% of students said the podcast did not help their understanding of the course. These positive findings are reflected in similar work (Clark et al, 2007; Edirisingha, 2007; Miller et al, 2007; Rothwell et al, 2007; Dale et al, 2007; Frydenberg, 2006; Chan et al, 2006; Edirisingha et al, 2006). Interestingly, only 27% of the students who listened to the podcasts said they helped them prepare for lessons, which suggests that the pre-lesson episodes were less useful.

Extending previous work, the survey also revealed that students tended (68%) to use the podcast to check back on things and prepare for the assessment, as opposed to listening to each episode on the week it was released. This finding is consistent with the students' other listening habits revealed in the survey; they did not tend (22%) to subscribe to the podcast and the majority of students (90%) said the podcasts did not adversely affect lecture attendance. This finding is also consistent with the students' general attitudes towards learning. When asked "When studying for my degree, I focus mainly on things that will help me pass the assessments that count towards my final mark", 84% of students agreed with this statement, 14% were undecided and less than 1% disagreed.

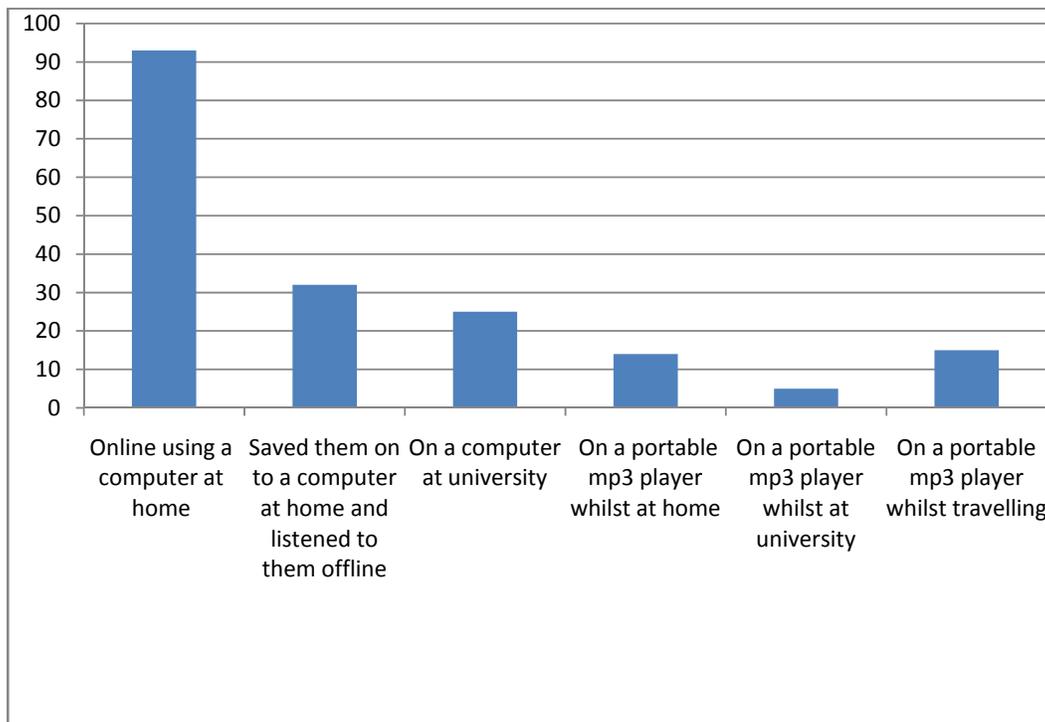


Figure 1 : The locations where students listened to the podcast

Finally, it was found that students tended to listen to the podcast on their PC, as opposed to on a portable mp3 player (Figure 1). The main reasons students gave were, firstly, that it is easier to listen to the podcast online, and secondly, they prefer to study in a fixed location, such as at their desk at home.

## **Conclusion**

Taken together, the results suggest that it may be more practical and effective to adopt a ‘targeted’ approach when designing supplementary podcasts. When using a targeted approach, a podcast would consist of a collection of episodes that each addresses a clearly defined and important need. Thus, the emphasis is not on using the podcast as a communication channel whereby episodes are released regularly. Instead, episodes are only added when they solve a specific problem or directly enhance one aspect of the course.

For example, a lecturer could create a short podcast episode to emphasise the fundamental objectives of an assessment or to give students feedback. Students are likely to benefit from the way in which a recorded verbal explanation enables the lecturer to use the tone of their voice to stress the relative importance of certain points (France and Wheeler, 2007). Additionally, podcast episodes could be included that overcome the restrictions of existing teaching methods. For example, when a concept is difficult to explain using words alone, such as if students are required to visualise a complex and dynamic process, then ‘enhanced’ (audio synchronised with graphics) or video podcast episodes could be very valuable. A further example is when there is a need to make a task more authentic or realistic, such as if students are set a task of making a product for an imaginary customer. The lecturer could record someone pretending to be the customer explaining their requirements of the product.

Although using a more targeted approach to create supplementary podcasts is moving away from the ‘true’ concept of podcasting, this is not seen as a problem. Therefore, the unique properties of a podcast (ie, a regularly updated series of episodes that can be subscribed to and listened to on a portable mp3 player) that were initially put forward as reasons why podcasting may be an effective way of helping students to learn (Campbell, 2005) actually appear to be relatively unimportant when using a podcast to enhance face-to-face campus-based courses. Instead, a podcast’s value appears to lie in their use of short multimedia clips, which are targeted at achieving specific goals and closely integrated with other course material.

## **References**

Campbell, G. (2005). There’s something in the air: podcasting in education. *Educause Review* 40, 33–46.

Chan, A., Lee, M. & McLoughlin, C. (2006). Everyone’s learning with podcasting: A Charles Strut University experience. In Proceedings of the 23rd annual ascilite conference: Who’s learning? Whose technology? (pp 111 – 120).

Clark, S., Taylor, L. & Westcott, M. (2007). Using short podcasts to reinforce lectures. In Proceedings of the Assessment in Science Teaching and Learning Symposium (pp 22-26). ISBN: 978-1-74210-005-0.

Dale, C. & Hassanien, A. (2008). Podcasting in Tourism Education. Journal of Teaching in Travel and Tourism - WTTT 7, Issue 6. (In press).

Deal, A. (2007). Podcasting: A Teaching with Technology white paper. Educause connect. URL [http://connect.educause.edu/files/CMU\\_Podcasting\\_Jun07.pdf](http://connect.educause.edu/files/CMU_Podcasting_Jun07.pdf)

Edirisingha, P. (2007). The Double Life of An iPod. Impala Berlin Online Educa Presentation. URL <http://www2.le.ac.uk/projects/impala/presentations/Berlin/palspresentation/view>

Edirisingha, P. Salmon, G. & Fothergill, J. (2006). Profcasting: a pilot study and a model for integrating podcasts into online learning. URL <http://www2.le.ac.uk/projects/impala/presentations/Berlin/Pilot%20study/view>

France, D. & Wheeler, A. (2007) Reflections on using podcasting for student feedback. Higher Education Academy - Planet 18, 9-11. URL <http://www.gees.ac.uk/pubs/planet/p18/df2.pdf>

Frydenberg, M. (2006). Principles and Pedagogy: The Two P's of Podcasting in the Information Technology Classroom. In Proceedings of Education Foundation and the Education Special Interest Group – ISECON.

Miller, C. & Newnham, L. (2007). Student perceptions of podcasting to enhance learning and teaching in an information systems course. In Proceedings of the Association for Learning and Teaching ALT-C Conference.

Patterson, L. (2006). The Technology Underlying Podcasts. IEEE Computer 39 (10), 103-105.

Rothwell, L., Ming, N. & Salmon, G. (2007). Enhancing Students' Collaborative Learning Through Podcasts. In Proceedings of the 2nd Blended Learning Conference.

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## University students' preferences in a technology-enhanced learning environment

New communication technologies have had a great impact on foreign language teaching and learning. University teachers in Argentinean Universities are implementing new and flexible ways of teaching English. Few investigations report on the effect of Spanish speaker students' learning preferences and styles on their performance when learning in a technology-enhanced environment.

Learning style is the way an individual learns and how this learning is influenced by cognitive, sensory and social preferences. Several specialists have proposed "cognitive learning styles", "sensory learning styles" and "personality learning styles" as categories to name different learning preferences (Kinsella, 1995; Oxford, 1995). This paper reports a study on students' learning preferences in a technology-enhanced learning environment. The study focused on students' learning preferences and their responses to electronic interaction and the impact of the experience on the development of new professional skills.

Many researchers have studied the relationship between learning styles and hypermedia environments and investigated how individual differences impact learner behaviours and outcomes in an online learning environment (Lee, 2004). Electronic reading provides visual, hands-on and auditory readers with the possibility of scrolling up and down multiple columns and linking graphics, animations, music files and movies quickly and easily. Besides, shifting from one page to another, or visiting different websites sometimes embedded in headers or footers, may facilitate reading for information as well as surfing all throughout the web (Hanson-Smith, 2003) to hands-on, intuitive open and global readers.

### Participants and Context

This study involved a population of 50, 21 year-old Spanish-speaking university students at the National University of Rio Cuarto in Argentina. Most of them belonged to middle socio-economic class, had a low-intermediate level of English and no previous experience in learning in an electronic environment. They were regular students of English as a modern language, who were studying their major fields in the undergraduate levels at the university. Their participation was voluntary and they represented a convenient sample.

The study consisted in the application of a treatment to an intentionally selected sample of subjects with similar learning style: *visual-extroverted-intuitive and global*, (according to Oxford's Style Analysis Survey) who worked in an integrated technology learning environment. The aim was to study the reading performance of this group of learners sharing styles and preferences. They attended classes twice a week on a two-hour-class basis in the multimedia laboratory and worked from home at any other time. This learning environment was designed following a humanistic perspective (Rogers, 1969), constructivist principles and a multidirectional model of communication. The environment consisted in a computer media laboratory and a platform from which centralized communication was supported by interactive computer-mediated resources. This communication system favoured the flow of information, active participation and feedback among teachers and students and among

students and peers. It offered students the possibility of accessing texts for reading at their own pace and according to their own interests. The electronic resources available were interactive CDs, electronic texts, online encyclopaedias and dictionaries and a grammatical compendium. The variety of graphics, sounds and videos provided them with all kinds of visual and auditory images. It was thought that the integration of multimedia together with Internet searches could foster diverse learning experiences as both these tools could stimulate the students' five senses. A portfolio assessment process was applied to track students' development; though the treatment effect was assessed by means of pre and post-tests. Attendance and the number of students at the beginning and end of the course were registered.

## **Discussion**

We used several instruments to collect data during all the instruction process. All students answered a questionnaire in which they had to indicate on a 5 point Lickert Scale whether they strongly agreed, agreed, were indifferent, disagreed or strongly disagreed with the statements presented. Besides, two unstructured interviews were administered to the students, both of them aimed at collecting data on their perceptions on electronic interaction, and effect on the development of new skills in the technology-enhanced environment.

According to their answers to the questionnaire, electronic interaction with teachers and classmates had facilitated their integration to the group and had encouraged them to continue with the course. About 75 % of the students strongly agreed on the importance of the interaction using the new communication technologies for the accomplishment of the course. Not more than 12 % of the students strongly disagreed with this fact. Besides, they said that having the resources available online increased their possibilities of learning at home or at their workplace. Most of the students strongly perceived that this was a fair way of delivering instruction.

## **Concluding remarks**

In this research we identified university students' learning preferences and studied their reading performance in a technology-enhanced environment. According to the results obtained students' performance slightly improved in this multiple-style-technology integrated-environment. However, other variables such as attendance, course achievement and motivation were remarkably consistent with our expectations, thus corroborating other researchers' conclusions that "motivation to learn interacts with learning styles" (Lin & Davidson-Shivers, 1996).

Findings suggest that students felt motivated to learn, showed self-confidence, a facility for interacting with persons and technology and a remarkable capacity for professional and individual improvement in these learning technology-enhanced environments. Future research should include qualitative explorations between similar or different preferences and styles in learning environments enhanced by the new communication technologies.

## References

Kaplan, N. (1995). Politexts, hypertexts and other cultural formations in the late age of print. *Computer-Mediated Communication Magazine*, 2 (3), 3-35.

Kinsella, K. (1995). Understanding and Empowering Diverse Learners in the ESL classroom. In J. Reid (Ed.) *Learning Styles in the ESL/EFL Classroom*. 170-194. Boston: Heinle & Heinle.

Landow, G. P. (1992). *Hypertext: The Convergence of Contemporary Critical Theory and Technology*. Baltimore: The Johns Hopkins University Press.

Lee, Y. (2004) "How To Consider Individual Differences In Online Learning Environments" Proceedings of The American Association of Computers in Teacher Education. SITE, Georgia, Atlanta, US

Lin, C. H. & Davidson-Shivers, G. V. (1996) Effects of Linking structure and cognitive style on students' performance and attitude in a computer based hypertext environment. *Journal of Educational Computing Research*, 15(4), 317-329.

Oxford, R. (1995). Gender Differences in Language Learning Styles: What do they mean? In J. Reid (Ed.) *Learning Styles in the ESL/EFL Classroom*. (pp.34-46). Boston: Heinle & Heinle.

Rogers, C.R. (1969) *Freedom to Learn*. Columbus, OH: Merrill.

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# The Use of Simulators in Technical Education: a case study

**Abstract:** For the complete understanding of concepts of Operating Systems courses, students need practical experience with related algorithms. In order to avoid the high learning effort of writing concurrent programs for experimentation, the development of ready to use programs simulating the algorithms of the kernel is an effective alternative. In this paper, a learning tool has been successfully developed to demonstrate CPU scheduling algorithms and principles through graphical representation of the processes and the CPU workflow. By this approach students can conceptualize the life-cycle of processes and at the same time make modifications of OS algorithms, factors and variables with limited complexity.

**Key-words:** Operating Systems, Educational Software, Simulation, Algorithms.

## Introduction

Textbooks usually provide the theoretical information of the Operating Systems (OS) course, but the lack of practical experience is considered as a drawback for complete understanding of OS concepts. Teaching OS includes covering of complex data structures and algorithms and this is already of much effort especially for high school students.

Secondly, operating system code runs in supervisor mode, in contrast with other applications, students usually are familiar with, that runs in user-level [Nieh & Vaill, 2006]. To write or modify OS code that runs in supervisor mode is much and complex effort especially for students who attend OS classes but they are not programming oriented. Systems running on supervisor mode are commercial and not designed for teaching. Moreover, students may be distracted because they take courses structured around a specific system to eliminate the need of specific hardware [Kikolov, 2003].

A reasonable solution to avoid developing kernel-level programming projects is experimentation with simulators. OS simulators for testing CPU scheduling algorithms, if implemented correctly, can provide definite benefits [Chernich & Jones, 1994] [Chernich et al., 1996]. A lot of simulators have been developed for teaching purposes bringing together a variety of characteristics [Robbins, 2001, 2002, 2005].

To address the above issues, a solution for teaching and experimenting around OS algorithms using a stand alone learning environment has been implemented. The virtual OS runs under a host OS (windows 9x, XP) and provides to the user an easy-to-use interface to control the overall functionality. This application is centralized in the simulation of CPU scheduling and is designed for high school students with moderate or none programming skills or previous OS knowledge.

## The Simulator

### *Introduction*

The simulator takes on a group of processes automatically created by students with random properties (priority, birth time, etc) and executes them in an orderly fashion based on a

particular algorithm. Most OS textbooks describe a standard set of scheduling algorithms. The initially supported scheduling algorithms in this application are:

- ↪ First Come First Serve (FCFS), in which the processes are executed in the order they entered the queue.
- ↪ Shortest Job First (SJF), in which the shortest process of the remaining processes in the queue is executed first.
- ↪ Priority algorithm executes first processes based on their given priority.
- ↪ A combination of Priority and Shortest Job First.

Scheduling algorithms can be pre-emptive as well as non pre-emptive depending on the time the virtual CPU starts executing processes. In a pre-emptive algorithm the simulator starts loading processes in the queue and the virtual CPU is activated by the user at a later time.

The simulator is written in Delphi, a visual development environment (RAD). The application uses calls to the host OS through application programmer interface (API) for graphic representation, I/O functionality and timing/synchronization where needed. Delphi package is based on Pascal language which is used for introduction to programming courses worldwide and its' simple syntax makes it suitable for in-class use for beginners. The CPU simulator is Open Source software, freely distributed and supports English and Greek languages. It can be used as a basis for developing and testing new algorithms in programming courses.

### ***Design and Structure***

Initially, a number of data structures like lists and queues had to be defined in order to provide the simulator with all the basic characteristics of a scheduler. A data structure analogous to 'process' need to be implemented and this is Tprocess structure as seen below:

```
Type
PProcess=^TProcess;
TProcess = record
Name:Integer;
Length: Integer;
Priority:Integer;
BornTime:Longint;
TurnAroundTime:Longint;
KillTime:Longint;
end;
```

To speed up the simulator performance 'PProcess' pointers were declared instead of simple TProcess. The container of processes to be created and the processes that are already executed by the virtual CPU are defined using a list data structure. Childs (instances) of the main list structure are the 'NewBornProcesses' and 'ExecutedProcesses'. The list structure was chosen because as a data structure is simple enough (in a matter of student's concept map) and easy to manipulate. On the other hand, the data structure to hold the ready-for-execution processes cannot be a simple list. It must be approached as a priority queue to satisfy the ordering

criteria. The 'RunnableProcess' queue is a queue that has an insertion rule to place each process in the right position. It is slow enough during insertion, but very fast on response. The type declaration of queue used in the simulator is listed below:

```

type
ProcessQueue = class
  {A priority queue that is slow at insertion, fast at retrieval}
private
  InsertionRule: Integer;
  pqList: TList;
protected
  function pqGetCount : integer;
public
  constructor Create(InRule : Integer);
    {-Create the priority queue}
  destructor Destroy; override;
    {-Dispose of the priority queue - items remaining are NOT
    freed}
  function GetItem(Item : Integer): PProcess;
  procedure Add(aProcess : PProcess);
    {-Add an item to the priority queue}
  function GetFirst : PProcess;
    {-Remove and return the item with the minimum value}
  procedure RemoveAll;
    {-Remove All Pointers}
  procedure RemoveItem(Ind:Integer);
    {Removes Pointer}
  property Count : integer read pqGetCount;
    {-Count items in the queue}
end;

```

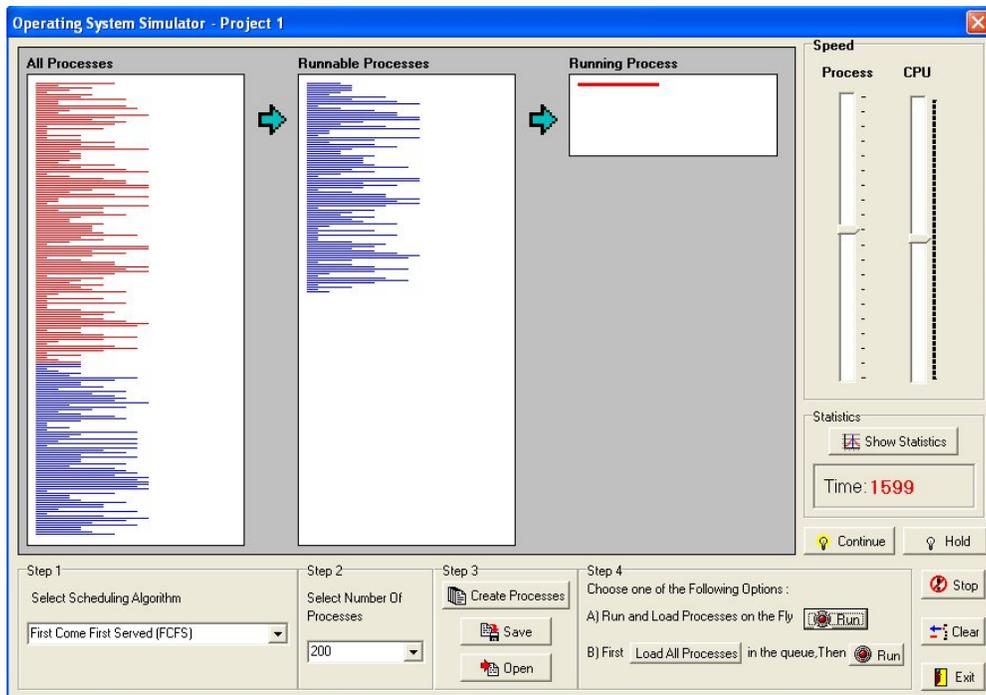
The simulation of OS has been designed using threads that run simultaneously. The functions that compose the system are organized into three major groups. Each group is developed as a thread:

- a) The 'Timer' to count time during the simulation (in milliseconds). It will be an independent timing thread respectable by all parts of the program. Since the performance-comparison of different algorithms is the object of learning scheduling algorithms in high school and not the actual speed of a real system, latent time quantum was used for all processes equal to one millisecond.
- b) The Importer to load processes from the input list (NewBornProcesses) to the Runnable Processes Queue. This thread simulates the rise of new processes (or users) that want to be served by the virtual CPU.
- c) The Executor thread to simulate the execution of processes. This corresponds to the virtual CPU of the simulator.

### *The interface*

The interface of the program consists of the simulator form (figure 1), where the required input procedure is divided into 4 separate steps. Calibration and adjustments of algorithm functionality is made possible through a number of user controls like main menu, edit boxes, buttons, track-bars and combo-box controls. An additional 'Properties form' is used to set ranges of priority values.

The scheduling algorithm begins after the user press the 'Run' button. That causes the creation of the three threads: Timer, Importer and Executor. Before Importer and Executor enter their critical region, they block the common shared space (RunnableProcesses Queue). The communication between them follows the classic approach of the Producer-Consumer problem. The completion time of the last instruction to execute is the total execution time for the trace.

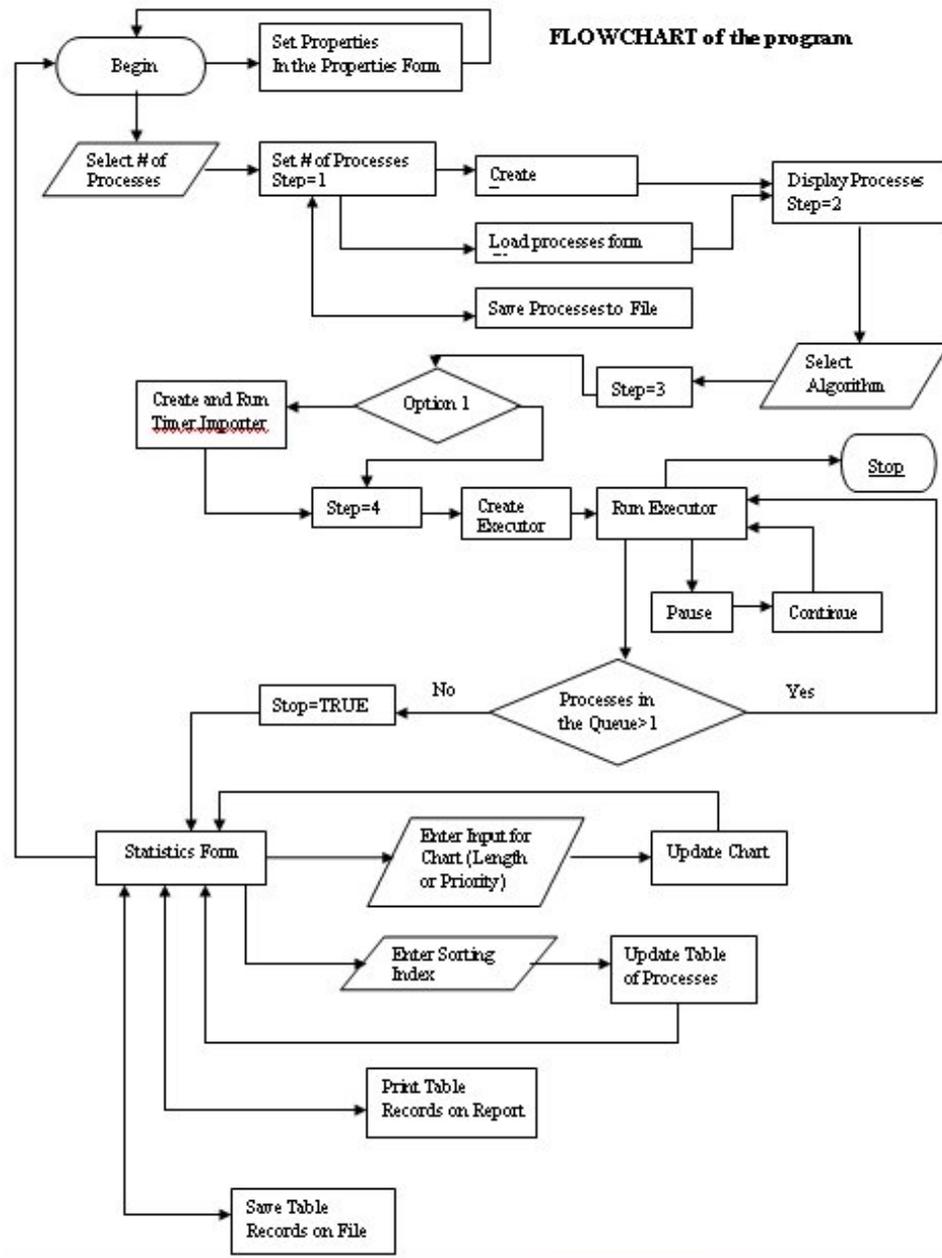


**Figure 1.** A snapshot of the OS simulator

The lower part is divided into four boxes that equals to the four steps that the user must follow to complete an experiment. Required input includes the desired number of processes to be created in a single session, the applied algorithm, the speed of Importer Thread (speed of processes' generations), the speed of virtual CPU and the option to pre-load processes in the queue before execution.

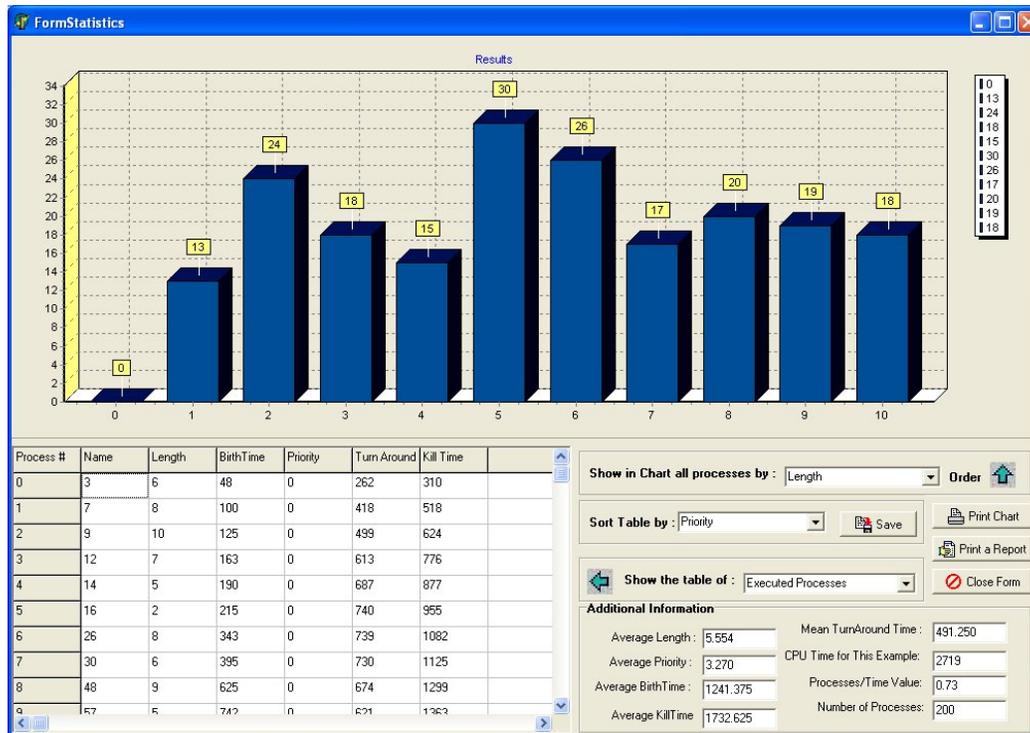
The upper part of the screen is used by the application to animate the flow of the processes between queues and the virtual CPU. This is the graphical representation of processes life - cycle (create, run, suspend, kill). Each process is represented by a horizontal line with length analogous to the duration of the process (length property). During animation, the originally

blue lines that represent the new-born processes are gradually repainted with red color to imitate the flow of processes to the queue. Figure 2 shows the hierarchy and relation between the application functions.



**Figure 2.** The flowchart of the program

After any given task, learners can compare the results of each algorithm and study the different ways processes were handled by the CPU simulator. Data of a specific set of processes can be loaded and saved in ASCII files for later use and for comparison purposes.



**Figure 3.** The statistics form

The statistics form (figure 3) offers a sufficient way to graphically display the results of the simulation. Supervised variables and related times are displayed to perform requests of performance comparisons. The supported variables are length of process, priority, birth-time, turnaround time and kill-time organized in table columns. The result table can be indexed by any of the available variables and its contents can also be summarized and printed in A4 size reports for homework. Additional information includes average length of processes, average priority, average of birth time, average kill time, mean turnaround time, total CPU (execution) time, ration of Processes/Time Value and total number of served processes.

## Conclusion

The hands-on experience based on a CPU simulator can enhance learning outcomes. The case study presented in here can be used as an experimentation tool for in-classroom demonstrations of CPU scheduling algorithms or for homework exercise. It can be helpful for students who attend introductory OS classes to apply the theoretical concepts of CPU scheduling in practice and understand general principles. The simulator generally has a positive effect on learners' active participation on experimenting projects because it allows them to make modifications and comparisons between ranges of different algorithms and apply simple statistical analysis on the data outcome. Due to the introductory level of the

courses that it is designed for, real kernel-level programming is not necessary. The simulator application illustrates underlying concepts and enables not only simple variable adjustment, but also new algorithm implementations in Object Pascal language as an open source application. The current simulation has been used from 2004 as an in-class demonstration tool for undergraduate students of technical education and of late high school students.

## References

Chernich, R., Jones, D. (1994) The Design and Construction of a Simulated Operating System. Proceedings of Asia Pacific Information Technology in Teaching and Education '94, Brisbane, pp. 1003-1038.

Chernich, R., Jamieson, B., Jones, D. (1996) RCOS: Yet another teaching operating system, Proceedings of the First Australasian Conference on Computer Science Education, pp. 216-222.

Nieh, J. & Bail, C. (2006) Experiences Teaching Operating Systems Using Virtual Platforms and Linux, ACM SIGOPS Operating Systems Review, 40, 2, pp. 100-104.

Nikolov, L. (2003) Teaching Operating System at the Technical University-Sofia, Proceedings of the 4th international conference on Computer systems and technologies: e-Learning, pp.673-679.

Robbins, S., (2001) Starving Philosophers: Experimentation with Monitor Synchronization, Proceedings of the 32st SIGCSE Technical Symposium on Computer Science Education, Charlotte, North Carolina, USA, pp. 317-321.

Robbins, S., (2002) Exploration of Process Interaction in Operating Systems: A Pipe-Fork Simulator, Proceedings of the 33rd SIGCSE Technical Symposium on Computer Science Education, Cincinnati, Kentucky, USA, pp. 351-355.

Robbins, S., (2005) An Address Translation Simulator, Proceedings of the 36th SIGCSE Technical Symposium on Computer Science Education, St. Louis, Missouri, USA, pp. 515-519.

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## **Seventh Heidelberg Innovation Forum: Call for Proposals** **Deadline: until 15 September 2008**

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- Each proposal selected will receive 10 minutes time to present the basic idea in the plenum.
- There will be the opportunity to establish detailed contacts during the following exhibition.
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