Use of ICT to design a teaching tool in heat conduction field

N.K khelalfa, University of Blida, Algeria - mail: nkhelalfa@yahoo.fr
Samira belhardj, Univesity of Mostaganem, Algeria
A.Mahrouk, University of Blida, Algeria
S.Dendah, University of Blida, Algeria
T. Benabdellah, ENSET of Oran, Algeria – mail: toufikbenab@yahoo.fr
S.E. Boudraa, ENSET of Oran, Algeria- mail:sboudraa@yahoo.fr

Abstract

This work aims to achieve a teaching tool using ICT to help engineering students in their learning of heat transfer by conduction mode

A numerical simulation based on the finite volume method was necessary, followed by the achievement of an interface which aims to achieve a "session of practical work" in heat transfer.

This will allow students to be able to compare their experimental results with those obtained by simulation and/or theoretical level due to the lack of test bed and practical work equipment, which is a crucial problem in African universities.

Keywords: ICT, e-Learning, Heat transfer by conduction, Simulation.

1. Introduction.

Nowadays, the demands of education are increasing and there is an ever increasing use of web and multimedia technologies. The contribution of multimedia (e-Learning) and the use of ICT (Information Technology and Communication) have radically changed the education and how knowledge is transmitted these years. The multimedia teaching goal is the improvement and support for daily practices. This is a new way that allows distance learning by using the tools of information and communication (via Internet).

For these reasons, we believe in designing an educational tool, namely a ' virtual practical work' of heat transfer that would accompany engineering students in their learning throughout the field of thermal conductivity.

2. Multimedia education and ICT:

Education is defined as a process of communication to foster learning. The access to knowledge becomes interactive. The massive introduction of information technology and communication (ICT) in education has changed the way of teaching. [1] [2].

Being marginalized in terms of technology, the potential of ICT in Africa used to help develop the student is paramount in access to knowledge, but it is hampered by inequalities in the distribution of ICT and the differential effects produced by their dissemination.

Student is then facing technological, economical, cultural and social challenges which will limit and prevent access, use and benefits of ICT. It is thus necessary:

• To promote access to ICT for development [3]
• Foster, finance and support research oriented towards innovative technologies (e-Learning, e-….)
• Supporting use of ICT in education and teaching field (e-Learning), employment, health, and business (e-business) …

The multimedia education aims to improve the practices of the teacher on a daily basis and provide quality support and monitoring of engineering students in training

Important research techniques were developed around ICT and new teaching methods have been created. [2]

With the globalization of LMD system, the system of formal education should change gradually because it would have to be accompanied by multimedia education due to the abundance and dynamics of knowledge

The technique of multimedia will allow teacher of crowded classes were individual relationship is very difficult to achieve, to guide students outside lecturing rooms; for that very efficient methods have been developed. [4]

Our job aims to achieve an interactive tool that will accompany work practices (WP) of heat transfer for engineering students (Cases of thermal conduction).

3. Schematic design of mathematical mode of heat transfer

The thermal conduction is the phenomenon by which energy is transferred from areas with high temperature to areas at lower temperatures. [6]

The law of Fourier (for an isotropic volume, through an insulated surface) shows that the heat flow, by conduction, in a direction is given by:

$$Q_x = -\lambda \frac{dT}{dx} A \qquad [W]$$

λ : Thermal Conductivity ($Wm^{-1}K^{-1}$)

For the case of stationary mono dimensional conduction, the equation which governs the heat conduction is given by the differential equation as follows:

$$\frac{d}{dx}\left(\lambda \frac{dT}{dx}\right) + S = 0$$

With S: the term source.

4. Simulation of stationary and not stationary thermal conduction

Currently, the numerical simulation is an inseparable tool in the field of higher education [6] [8]

Its contribution has become increasingly important as the numerical methods have been developed and computing calculation has become more efficient.

In our study, the numerical simulation of the phenomenon of thermal conductivity has been developed using the method of finite volumes (MVF) [5], [9] and [10] and this for different cases of thermal conduction, namely:

- Stationary mono dimensional thermal Conduction.
- Case of a fin.
- Non stationary mono dimensional thermal Conduction.
- Stationary bi dimensional conduction with or without heat source

For each case, the governing heat transfer equation is resolved by using finite volumes method with a uniform grid. A special processing is applied for internal points and for the boundaries points.

5. Application of the calculations:

Several algorithms of calculation were developed to simulate various cases of conduction. For each case, data entries are necessary.

5.1 One dimensional stationary case:

The necessary characteristics of the plate to calculate are:

L: length of the plate

λ: thermal Conductivity of the plate material.

The boundary conditions are:

T_1: Inlet temperature of the plate.

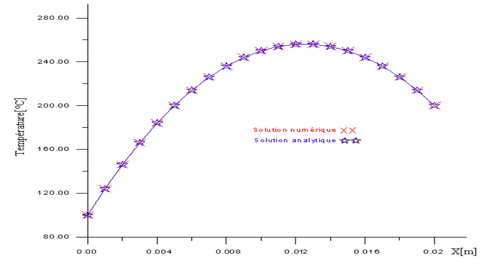
T_2 : Outlet Temperature.

And S: the term source.

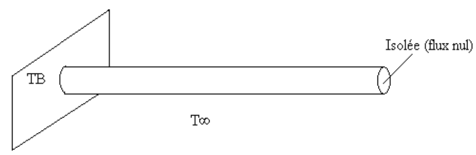
The governing equation of the physical phenomena is as follow:

$$\int_w^e \frac{d}{dx}\left(\lambda \frac{dT}{dx}\right) dx + \int_w^e S\, dx = 0$$

The results given by the simulation program are represented in the following graph:



5.2 Case of a fin:



The required calculations characteristics are as follow:

L: length of the fin

λ: thermal Conductivity of the fin material.

A: the section of the fin.

h: Convective term of the fluid.

The boundaries conditions are:

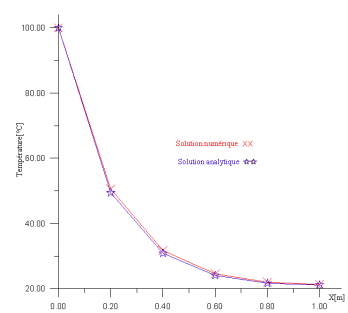
Temperature at the basis of the fin: T_B

Temperature of the fluid to the endless T_∞

The equation to be resolved for this case is as follow:

$$\int_{VC} \frac{d}{dx}\left(\frac{dT}{dx}\right) dV - \int_{VC} n^2 (T - T_\infty) dV = 0$$

The calculation algorithm established gives the results represented by the following graph:



5.3 Non stationary mono dimensional thermal Conduction.

The necessary characteristics of the plate to calculate are:

L: length of the plate

λ: thermal Conductivity of the plate material.

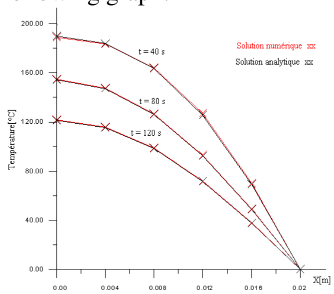
ρc_p density and specific heat.

The initial conditions (t=0) are:

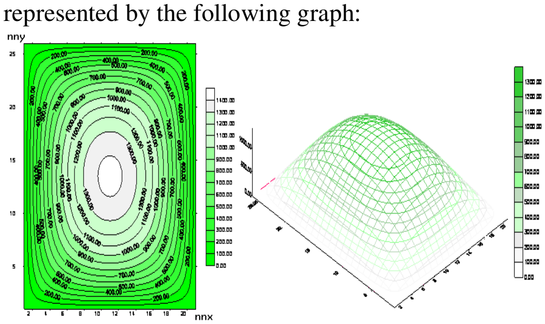
T_A= Inlet temperature of the plate.
T_B= Outlet Temperature.
The calculation is done for different values of the time t. The governing equation of the heat transfer phenomenon is:

$$\rho c_p \frac{\partial T}{\partial t} = \frac{\partial}{\partial x}\left(\lambda \frac{\partial T}{\partial x}\right).$$

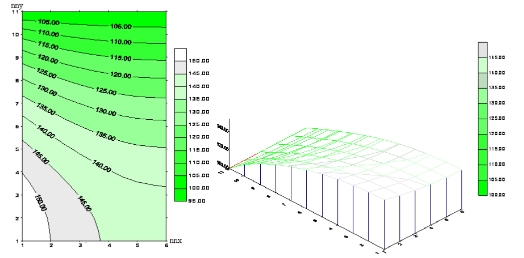
The results of the calculations are represented in the following graph:



5.4 Case of stationary bi dimensional conduction along a thin plate without a heat source:
The characteristics of the plate are as follow:
L: length of the plate
L: width of the plate
λ : thermal conductivity of the plate.
ρc_p density and specific heat
The boundary conditions are:
T_i= temperature at the i eme front.
The established algorithm gives the results represented by the following graph:



5.5 Case of stationary bi dimensional conduction along a thin plate with insulated sides:
The characteristics of the plate are as follow:
L: length of the plate
l: width of the plate
λ : thermal conductivity of the plate.
The boundary conditions are the temperatures in the edges of the plate.
The established algorithm gives the results represented by the following graph:



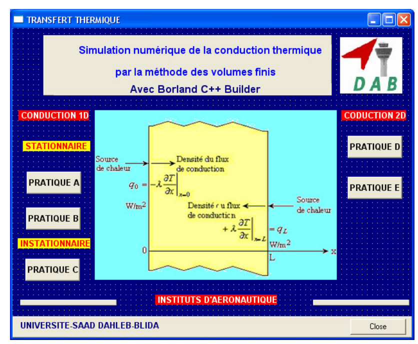
6. Design and user guide interface

The language C++ has been used in the design of the interface of the virtual work practice (WP) of thermal transfer by conduction. An algorithm was necessary for connecting and manages various windows designed. The use of this interface is very simple. The guide to use the following:

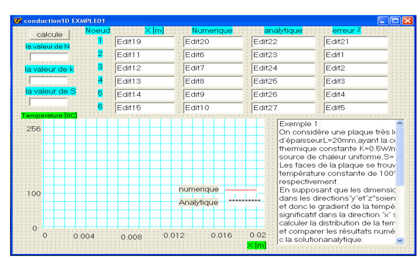
7. User guide

To use the interface it is enough to follow the steps underlined below

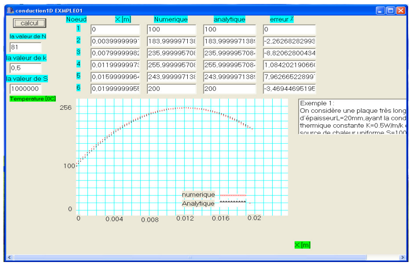
1/ Open the main menu



2/ Choose the required item in the menu
3/ after opening the icon, the next page will be displayed



4/ Choose the different calculation parameters and click on the ‘run’ button of calculation.
5/ finally, the results will be display on the next page.



An explanatory window will provide full information on the method used for the numerical simulation

8. Conclusion

In this work, a pedagogic multimedia tool has been developed, namely a' virtual' Work Practice (WP) in heat transfer by thermal conduction for one dimensional, two-dimensional, stationary and not stationary cases.

The work was based in the first time on the multimedia (e-learning) and education, followed by a study of the various existing numerical methods in engineering. A numerical simulation of the phenomenon of thermal conduction for different cases has been achieved. An interface came to close this study.

The results of simulations were quite consistent with the analytical results, confirming the validity of models and programs. The interface is well designed because of its ease of use.

In perspective, it would be interesting to achieve other virtual WP using ICT for different disciplines to support the training of students. As it would be interesting to encourage activities that help the participation of the African in the process of production and consumption of ICT and integrate the training relating to information in the curricula at all levels of formal and informal programs of training and education.

9. References:

[1] Brusilovskey, P. ″Knowledge tree: A distributed architecture for adaptive e-learning″, *Journal of education,* P8

[2] Kiyoshi, A. and Chiba, M. ″Developing an e-learning system which enhances students ″

[3] *TTISSA News letter UNESCO*, Volume 1, April2008

[4] Lanzilohi**,** R.”Systematic Evaluation of e-learning systemes”, *changing, Nordichi*, 14-18 October 2006, Oslo, Norway Roles, p195

[5] LOAN POPA**,** C.″ *Modélisation numérique du transfert thermique par la méthode des volumes finis″*, UNIVERSITARIA CRAIOVA, 2002.

[6] KREITH**,** F. ″ *Transmission de la chaleur et thermodynamique″* Edition Masson et SIE. Editeur, Paris, France 1967.

[7] Ames, W.F. “ *Numerical methods for partial differential equations*” par Barnes and noble, New York 1969.

[8] Patankar, S.V ″ *Numerical heat transfer and Fluid flow″*, Series in computational methods in mechanics and thermal sciences.

[9] Malalasekera**,** W. and Versteeg**,** “*computational fluids dynamic, the finite volume methods*” Pearson, prentice hall 1995.

[10] Bejan, A. ”*Heat transfer***”**, John. Wiley Inc 1993.