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A STUDY ON THE USAGE OF MOBILE DEVICES IN COLLABORATIVE ENVIRONMENTS VS DESKTOPS

An approach based on flow experience

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Abstract: The teaching method using the computer is an added value, it is certainly very appealing to students and more motivating, stimulating them to interact with different situations and depictions of real life, forcing the student to think creatively and independently new subjects and materials. New technologies have created new spaces of knowledge. Now, besides the school, also the company and place of residence became places of education and learning. The number of people in their homes using the Internet to increase their knowledge is increasing. The combination of a personal atmosphere, together with the ability to manage their time and what to learn, makes the use of courses of e-learning increase. In order to evaluate the use of mobile devices and desktops and the potential of mobile devices in collaborative environments vs desktops, it was performed a experiment involving students of higher education. This study has the main objective to validate if the students that use laptops or desktops are in the flow experience and witch of them are more in the flow experience. This study is based on the flow experience introduced by Csikszentmihalyi (1975). The main purpose of this study is to establish whether the user is feeling the flow experience when using Google Groups when using laptops or desktops. In the context of this study, information has been gathered through a survey, applying the five dimensions of the flow state. The sample used consisted on one hundred and twelve students. At the end of the study, after analyzing the gathered information, it was possible to conclude that students have experienced the flow and that it had a positive effect on their learning experiences both by students using laptops or desktops, but having the students that used the laptops more engaged in the flow experience than the students that used desktops.

1 INTRODUCTION

The learning process is very much due to technological advances, in particular, the learning through Information and Communication Technology (ICT) was the obvious step in the evolution of distance education. E-learning also provides the opportunity to create learning environments focused on students as a global trend to transfer to the client, the activity focus. These learning scenarios are characterized by being interactive, efficient, and easily accessible and distributed.

Technological applications and the way how they are used has evolved in such a way that the manipulation of learning objects is no longer limited to a personal computer, but extended to the use of mobile devices (PDA, mobile phone, Smartphone,

Laptops, and Tablet PC) to provide a greater range of application and obtain the benefits that mobile computing offers to the education sector. This results in the establishment of a new area of activity related with the use of technology in learning, named m-learning.

This educational model based on the use of mobile devices, has been developed over the past few years, resulting in several research projects and some commercial products. Current and past promises of more learning outcomes are needed to be evaluated.

2. TECHNOLOGY ENVIRONMENTS

Imagine that we are living in a time where cars could not go faster than 25 km / h; where letters were only written on paper; and where computers were only used for writing text. How could one live in this global economy and in this century? If you can not work with obsolete tools and services when it comes to survival, how can it continue to support an educational system that ignores the new research on learning and continues to "educate" using outdated tools? (Caine and Caine, 2007).

For a long time, it was felt that teaching was primarily the transmission of knowledge content and the training of the memory, and instil in students the values of society. It was felt that learning was to acquire knowledge through a process of attention, memorization and reproduction of it, which is an individual task, homogeneous, that can be standardized (Duarte e Silva, 1995).

This type of learning, based on the "content dumping" on the student, was taken into account, supporting the idea of learning as knowledge construction.

"The integration of the computer in education is now a reality impossible to ignore and that we must understand." (Duarte and Silva, 1995).

Thus, the use of computers in teaching fits the constructive approach of learning. Although the computer is not a technology designed for the education system, its characteristics of interaction and the system of choice for dealing with information, makes it a very useful and promising tool (Duarte e Silva, 1995).

The teaching method using the computer is an added value; it is certainly very appealing to students and more motivating, stimulating them to interact with different situations and depictions of real life, forcing the student to think creatively and independently new subjects and materials.

Information technologies are rapidly changing the way we live. Computers, calculators and other technologies for processing information help our brains to create knowledge from information. Until recently they were being used in the majority of cases, for repetitive tasks (accounts; write and print) and to perform these tasks in a more rapid and with a minimum of possible errors. Since the evolution of the computers, they are already capable of being used for tasks far more complex than in the past. These tasks have a direct implication on how to create a learning environment (Cleveland, 1996):

- Access to unlimited information: computers allow users to access a vast amount of information;
- Interactive teaching: computers may be designated for interactive learning environments that allow students to learn at their own pace;
- Multimedia: since the advent of the CD-ROM, this enables us to integrate teaching with voice, video, text, graphics and music;
- Simulation: The computers allow students to simulate different kind of experiences. These allow the exploitation of various kinds of experiences without students being limited to physical environments;
- Virtual Reality: Allows users to create experiences in an environment in three dimensions;
- Distance learning: The technology allows students to learn at any point in time in any place, without having to be in a particular geographical place;
- New connections: Computer networks allow students to connect with each other in order to share a common knowledge among them.

When using the technology for education we should use this in a fair and moderate way. We must not use it too much, because it may lead to cases where the users are so addicted to the technology that they can not release it. Also if users are far removed from it, they never benefit from its advantages (Buchan, 2008).

The main advantages that contribute to technology as an asset to the school environment are (Boytchev, 2005):

- The technology is attractive: You can not think of using a particular technology if it is not attractive. The attractiveness of

technology is achieved by the mode of operation, and its appearance;

- The technology is available: A particular technology has no value to society if it is not used. The technology should not be locked behind a door where nobody has access.
- Technology is addictive: This is an ambiguous feature of technology. This feature reflects the effort that users are learning to use the technology.

Educational technologies can be considered simply as a set of information technologies and communication. However, what we do with these technologies is important, it is the way we are encouraged to use this set of technologies (Buchan, 2008).

Technologies for education are a key part of a learning environment (Buchan, 2008).

3 MOBILE DEVICES

Quin cited by (Corbeil and Valdes-Corbei, 2007) states that m-learning is the interaction of mobile computing (small applications, portable, and wireless communication devices) with e-learning (learning facilitated and supported through the information and communication technology).

We can see the widespread use of mobile devices in our modern world: mobile phones, PDA's, MP3 players, portable gaming devices, Tablet PCs and notebooks, which predominate in our everyday lives. From children to older people, they are increasingly linked, communicating with each other through communication technologies, something that didn't happen a few years ago.

There are a number of mobile devices that can be considered for an m-learning environment (Corbeil and Valdes-Corbei, 2007):

3.1 IPod

The media player from Apple allows users to download music, books, audio, podcasts, photos and video from the Internet. It also includes an address book and a calendar that syncs with Microsoft Outlook or Outlook Express. It can also serve as a storage device.

With the iPod, students can download podcasts of relevant educational materials, along with audio and video lectures. Although most models have a small screen, future versions will probably have bigger screens, so that users can read e-books on them. The iPod video (iPod Touch), for example, takes a step in this direction. And recently Apple has launched the IPad that has a bigger screen, offering the user a much more convenient way for reading electronic materials.

With the iPod, students can exchange files, review materials for a particular discipline, prepare them self's for exams, show their work to others and share the results of a project, with their colleagues.

Pros: With 87% of the market share, the iPod has proven its popularity among students. Apple's iPod University, allows teachers to upload their lessons for students to download these materials, so they can study them.

Cons: First, consider the cost. An iPod cannot be accessible to all students, and also because this device requires an application owned by Apple, the iTunes. We should also consider the screen, these are generally too small to be used by sophisticated applications or to read large amounts of text (although this will probably be changed in future versions, we can see this change already in the IPad) and also because these devices do not record sound.

3.2 MP3 Players

This digital music player reads music and audio files. Some of these models have an integrated voice recorder.

Students can use these MP3 players to download and listen to podcasts and audio lessons. Students can also review the materials for a particular course, study for exams, stay informed about the course contents, listen to audio books, and with some devices, record lectures.

Pros. MP3 players are compact and light. They have an excellent audio quality and they are upgradeable and expandable.

Cons. An MP3 player may be replaced with other devices that also play audio files.

3.3 PDA

The PDA combines the computing power and the Internet access in a single system, with a calendar, notepad, address book, and also productivity tools. It is a device integrated with Bluetooth, Wi-Fi and a mini USB interface.

A PDA plays audio, video, *Flash* animations, allows editing of text documents and allows users to access e-mail and also Web contents; supports instant messaging and text messages, and can be used to store information.

These PDA's provide support for collaborative learning environments. Students can use them to present projects, write documents in Word, and take notes in a classroom.

Pros: The PDA's have a big screen (for a portable device) that makes reading easier. They also combine the various types of computing and communications tools in a single device. Data entry is possible through the on-screen keyboard, a pen, or through external peripherals.

Cons: The PDA's are big when compared to other mobile devices. They are not efficient for the introduction of long e-mails or text, without the use of an extra input peripherals device.

3.4 Drive USB drive

The USB drive is a storage device that connects easily to multiple computers and other types of devices.

The USB drive is ideal for storing work files, audio and video. Students can share files for collaborative work. They can also copy files from this drive to school computers and vice versa, and send their work to the teachers.

Pros: The drive is small and portable and the USB interface is compatible with all newer computers. It works well for transporting files from home to school and vice versa. There are applications with the autonomy to run in a USB Drive.

Cons: A USB drive is a device with just one purpose only. Other devices can also serve for storing information.

3.5 E-Book Readers

E-book readers are used to download text-based materials. They can store hundreds of e-books, newspapers and magazines. The zoom and the search functionalities are one of the fundamental characteristics of these types of devices.

Pros: The e-book reader has a large screen for reading, and also has a light to facilitate the reading in dark places. The digital markers allow users to mark their texts, and the search functionality enables users to easily find a particular text. A e-book reader can also store the entire contents of books from various courses.

Cons: An e-book reader is a device with only one purpose, with limited computing capabilities. These may require proprietary file formats and there are a limited number of e-books available today.

3.6 Smart Phone

A smart phone combines the capabilities of a phone with a PDA, mass storage, MP3 player and Internet access in a single compact system.

Students can download audio, video lectures and podcasts to their Smart Phones. They can play audio, video, flash animations, view and edit text documents, access e-mail and Web contents, send instant messages and text messages and use the phone to storage files.

Pros: Smart phones can also be used in collaboration environments. Users can also access global information. These devices can support collaborative learning.

Cons: The small screen makes web browsing and reading difficult. The small keyboards or the virtual keyboards make writing text inefficient for emails and long texts. Finally, some smart phones cost as much as a normal PC with only a fraction of their capacity.

3.7 Ultra-Mobile PC (UMPC)

The UMPC's have the entire main features of a tablet PC, but on a much smaller size device. They offer support for audio, video, games, Internet and other types of communications and networking applications. They have Bluetooth, Wi-Fi and Ethernet controllers.

Students can download audio, video lectures and podcasts for their UMPC's, surf the Web, send emails, send instant messages and text messages and also log into sites of distance learning courses.
The UMPC's allows users to participate in collaborative learning environments.

Pros: These ultra-small, ultra-portable PC's have a 7'' touch screen, which is great for web browsing and viewing multimedia contents. The small size makes these devices great for travelling.

Cons: These units are expensive, costing more than a high-powered PC. Due to its small size, most UMPCs do not have a full-size keyboard.

3.8 Laptops / Tablet PC

The most complete system of all the mobile devices. Laptops / Tablet PCs come with Bluetooth, Wi-Fi and Ethernet. These devices offer additional features such as handwriting and voice recognition.

Students can download audio, video lessons, podcasts, browse the Web, send emails, send instant messages and text messages and log into the course website at home or while they are on the road. These devices are great for collaborative learning.

Pros: The Notebook / Tablet PCs are very good for students who need to take their work with them. They provide greater power and capacity of all mobile devices.

Cons: The Notebook / Tablet PCs are still relatively expensive, and its size makes it more difficult to transport when compared with other mobile devices.

4. THE FLOW EXPERIENCE

An aspect related with the interaction of the users with collaborative environments has to see with the flow experience introduced by Csikszentmihalyi (1975). The experience of the flow means the sensation that people feel when they are completely involved in what they are doing, that is, people like the experience and want repeat it (Csikszentmihalyi, 1982). This means that for students to be involved with collaborative environments, it is necessary that they presence the flow state.

The theory of the flow allows us to measure the interaction of users with the computer systems, verifying if these are more or less playfulness (Trevino and Webster, 1992).

The flow experience is used in this article to characterize the interaction between the human and the new technologies (Trevino and Webster, 1992). When one is in the presence of the flow experience, this will bring to the users, a sense of pleasure of what he is doing. This satisfaction will encourage the user to repeat the task again (Webster et al., 1993).

Csikszentmihalyi says that a person who is in the presence of the flow state has the following characteristics (Csikszentmihalyi, 1975, Csikszentmihalyi, 1990):

- Clear goals and immediate feedback;
- Equilibrium between the level of challenge and personal skill;
- Merging of action and awareness;
- Focused concentration;
- Sense of potential control;
- Loss of self-consciousness;
- Time distortion;
- Autotelic or self-rewarding experience.

For a person to be in the presence of the flow experience it is necessary a balance between the level of challenge and personal skill (Csikszentmihalyi, 1982) (Figure 1).

Figure 1 – Flow Experience (Csikszentmihalyi, 1982).

The sensation of an excellent experience in the accomplishment of any day by day task is our reason of living. If we do not feel this excellent experience with our everyday tasks, we will question our self, if it is worth living (Csikszentmihalyi, 1982).

Previous researches have used the flow experience to measure playfulness, involvement, satisfaction and other states with the involvement in computational environments (Chen et al., 2000, Ghani and Deshpande, 1994, Novak and Hoffman, 1997, Novak et al., 2000, Trevino and Webster, 1992)

Trevino and Webster (1992) define four dimensions for the flow experience:

- Control;
- Attention Focus;
- Curiosity;
- Intrinsic Interest.

There is one more dimension, sense of time, that is also important to measure the flow state (McKenna and Lee, 2005) .

Control

Individuals should experience, feelings in control, within computer interactions (Csikszentmihalyi, 1975).

Attention Focus

Attention focus is another important element of flow. When individuals are in the flow state, their minds are narrowed to what they are doing, filtering out irrelevant thoughts and perceptions (Webster et al., 1993).

Curiosity

Curiosity is aroused when in the flow state. The curiosity sensation can be aroused through varied, new and admirable stimulations. For example, the new technologies will be able to cause this sensation of curiosity through colours and sounds (Webster et al., 1993).

Intrinsic Interest

When people feel they are in the flow state, these are involved for the amusement and pleasure (Webster et al., 1993).

Sense of time

When people feel they are in the flow state, there is a perceptual transformation of time, characterized by the sensation of time slowing down or speeding up (McKenna and Lee, 2005).

People who interact with computers, with an entertainment spirit, transmit a much more positive experience, of those, who are in the computer for obligation (Webster et al., 1993).

5. THE STUDY

To evaluate the flow experience and to verify its occurrence in collaborative tools, an experience was carried through involving students from a university school. The main tool used was Google Groups, for this experience. This chapter presents the carried through experience, the data obtained, as well as the statistical procedures applied.

Previously to this study, a test with five students was done, to analyze the effectiveness of the survey. From this previous study, we concluded that some questions were ambiguous for the population in the study.

After the accomplishment of the project given by the teacher, in witch they used Google Groups, the students answered the questions of the survey.

The survey was passed through the Internet with the help of "LimeSurvey". The data collection was performed in the first week of November of 2009.

The Instruments used were Google Groups, Google Docs and Facebook and a survey consisting on some questions, in order to verify, in the end of the study, if the students were in the presence of the flow state. This survey will use the four dimensions: control, attention focus, curiosity and the intrinsic interest (Webster et al., 1993), as well as the dimension sense of time (McKenna and Lee, 2005). Beside these questions, this survey also contains other generic questions. All the related questions from this survey were built on a Likert scale of five points, since one (I totally disagree) up to five (I totally agree). Two questions for each dimension were elaborated.

5.1 Sample

This study intends to determine if the students inquired are in the flow state. The data has been collected through one hundred and twelve surveys of students. The surveys have been submitted to a rigorous test, having not excluded any individual; therefore, the sample consisted on one hundred and twelve valid surveys. The criteria of exclusion of inquiries were: students who had not discriminated their sex or age in the survey; students with incoherent answers throughout the survey (e.g answers that always presented values in the extremities of the scales, or incompatible); students who left 80% of the survey in blank. Once, one hundred and twelve valid inquiries were obtained, the sample is considered sufficiently satisfactory.

The statistical treatment of the data and the respective procedure(Pereira, 2002, Pestana and Gagueiro, 2005), that will be announced next, was carried through the software "S.P.S.S. - Statistical Package will be Social Science" (version 12.0 for Windows, http://www.spss.com/):

- Descriptive Statistics of the variables in the study;
- Evaluation of the index of internal consistency (Cronbach's alpha) for the dimensions of the flow experience;
- Correlation between the variables of the flow;
- Factor analysis in order to reduce the number of variables.

5.2 Analysis

This study was composed of 78.57% males and 84,82% had ages between sixteen and twenty four years. Most of the students have already used discussion forums in a fairly way.

The majority of the respondents used the laptop (72.32%) to access the tools for the project development, followed by the Desktop (27,68%).

We verified that Cronbach's alpha is always superior to 0.7, being able to conclude that the data is related to one same dimension, that is, the questions of the survey for the use of Google Groups, allowed us to determine if the individual finds himself in the presence of the flow experience, for students using a laptop or a Desktop.

To determine how the variables are correlated with each of the different devices used (laptop and Desktop), a correlation matrix was created for both types of the devices, where the correlation coefficient, R, is presented, that is a measure of the linear association between two variables. We can conclude from the correlation analysis that the correlation between the variables, for laptops, has a greater number of variables positively correlated than the desktop.

After the studies mentioned previously, we used the factor analysis in order to reduce the number of variables, both for laptops and desktops.
The extraction of the factors is given by considering the percentage of variance explained by the factors (Table 1 and Table2).

Table 1 – Number of factors to be retained (Mobile Devices)

	Mobile Devices		
	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	2,371	47,422	47,422
2	,881	17,625	65,047
3	,707	14,136	79,184
4	,631	12,613	91,797
5	,410	8,203	100,000

Table 2 – Number of factors to be retained (Desktop)

	Desktop		
	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	2,374	47,475	47,475
2	1,053	21,053	68,528
3	,704	14,077	82,604
4	,565	11,301	93,905
5	,305	6,095	100,000

From the previous table, we can observe, for each of the factors (or components) that it can be deducted from the five original variables, which is its own value (eigenvalue) and the percentage of the total variation occurring in five variables which he explained.

To set the number of components to be retained, we choose, by default, those that have eigenvalues greater than one. If the total variance explained by the factors retained is less than 60%, then, at least, one more factor should always be selected. Thus, for this case study, two factors were retained in each type of device. For the mobile device, it appears that the first factor explains 47.422% of the total variation and the second 17.625%, both explaining 65.047% of the total variation that exists in the five original variables. For the Desktop, the first factor explains 47.475% and the second 21.053%, explaining both, 68.528% of the total variation.

The matrix of components after rotation (Varimax method) aims to exaggerate the value of the coefficients that relates each variable to the factors

retained, so that each variable can be associated with only one factor. The higher the value of the coefficient that relates one variable to a component, the greater is the relationship between them. We present below the matrix of components after rotation (Table 3) and the bold factor associated with each variable.

Table 3 – The matrix of components after rotation

	Mobile Device Component		Desktop Component	
	1	2	1	2
Concentration	,411	**,614**	**,751**	,001
Control	**,653**	,317	,011	**,955**
Curiosity	**,874**	,057	**,714**	,461
Intrinsic Interest	**,705**	,383	**,841**	,155
Sense of time	,033	**,877**	**,694**	,121

Having concluded the following for the case of the laptops:
Factor group 1: (Intrinsic Interest, Control and Curiosity)
Factor group 2: (Attention Focus and Sense of time)
And for the case of the desktops:
Factor group 1: (Attention Focus, Sense of time, Intrinsic Interest and Curiosity)
Factor group 2: (Control)

6. CONCLUSIONS

In order to evaluate the use of mobile devices and desktops and the potential of mobile devices in collaborative environments versus desktops, it was performed an experiment involving students of higher education. This study has the main objective to validate if the students that use laptops or desktops are in the flow experience and witch of them are more in the flow experience.

Most people all around the world use mobile devices. Due to the advance of the new technologies, and its size, users can carry them anywhere; can connect with a wide range of information to anywhere whenever they go.

Despite the widespread use of mobile devices today, there is a lack of reference to identify the advantages and disadvantages of the m-learning in collaborative environments, this is, we can not see the m-learning as an extension of e-learning but a rupture in the process of teaching and learning.

The analysis of data allows us to conclude that the majority of the students were males, had ages between sixteen and twenty four years and that most of the students have already used discussion forums.

When going further to the analysis of the data, we verified that the variables described all the same characteristic (threw the determination of the Cronbhach's alpha), that is, the variables describe the flow experience.

We can conclude from the correlation analysis that the correlation between the variables, for laptops, has a greater number of variables positively correlated than the desktop.

From the factor analysis it was possible to isolate two factors that explain the majority of the total variation. Such factors had been Factor group 1: (Intrinsic Interest, Control and Curiosity), Factor group 2: (Attention Focus and Sense of time) for the laptops and Factor group 1: (Attention Focus, Sense of time, Intrinsic Interest and Curiosity) Factor group 2: (Control) for the desktops.

In order to determine the presence of the flow experience for each type of device, it was verified that, on average, the students were above value three (Likert scale of five points), that is, the majority of the students, in each of the different devices used (laptop and desktop), are in the presence of the flow experience, for the five variables mentioned for this study (attention focus, curiosity, control, intrinsic interest and sense of time). We can also see, that the average of the five variables associated with the flow experience, for students who used the laptops, were greater than those using the desktop to access the tools of the project development.

From this study we can conclude that the flow experience exists for people that use Google Groups, both for people that used the laptop or even the desktop, but having a more positively effect for users of the laptop.

REFERENCES

BOYTCHEV, P. (2005) Technology enhanced natural learning. *Technology Enhanced Learning Workshop.* Sofia, Bulgaria.

BUCHAN, J. (2008) Tools for survival in a changing educational technology environment. *ASCILITE 2008***,** 100-109.

CAINE, G. & CAINE, R. (2007) Natural Learning: The Basis for Raising and Sustaining High Standards of Real World Performance.

Position Paper: Natural Learning Research Insitute.

CHEN, H., WIGAND, R. T. & NILAN, M. (2000) Exploring Web users' optimal flow experiences. *Information Technology & People,* 12.

CLEVELAND, J. (1996) The Changing Nature of Learning. *On Purpose Associates.*

CORBEIL, J. R. & VALDES-CORBEI, M. E. M. (2007) Are You Ready for Mobile Learning? , Educase.

CSIKSZENTMIHALYI, M. (1975) *Beyond Boredom and anxiety,* San Francisco, CA.

CSIKSZENTMIHALYI, M. (1982) Towards a Psychology of Optimal Experience. *Annual Review of Personality and Social Psychology.*

CSIKSZENTMIHALYI, M. (1990) *The psychology of optimal experience,* Harper Collins.

GHANI, J. & DESHPANDE, S. (1994) Task Characteristics and the Experience of Optimal Flow in Human-Computer Interaction. *The Journal of Psychology,* 128**,** 381-391.

MCKENNA, K. & LEE, S. (2005) A Love Affair with MUDs: Flow and Social Interaction in Multi-UserDungeons.

NOVAK, T. P. & HOFFMAN, D. L. (1997) Measuring the Flow Experience Among Web Users. Vanderbilt University.

NOVAK, T. P., HOFFMAN, D. L. & YUNG, Y. (2000) Measuring the Customer Experience in Online Environments: A Structural Modeling Approach. *Marketing Science,* 19**,** 22-42.

PEREIRA, P. A. (2002) *Complementos de Estatística*.

PESTANA, M. & GAGUEIRO, J. (2005) *Análise de dados para Ciências Sociais - A complementaridade do SPSS*.

TREVINO, L. K. & WEBSTER, J. (1992) Flow in computer-mediated communication. *Communication Research,* 19**,** 539-573.

WEBSTER, J., TREVINO, L. K. & RYAN, L. (1993) The dimensionality and correlates of flow in human-computer interaction. *computer game research,* 9**,** 411-426.