

Impact of Pervasive Computing in Education

Jasmine Norman

Vellore Institute of Technology, Vellore – 14, India

Jasmine@vit.ac.in

Abstract

Pervasive computing has greater influence in different domains on both local and global scenarios. It is important for researchers to identify the challenges, rewards, goals, and methods of developing these technologies in different domains to fully aware of its potential. Pervasive computing would take away the boundaries in computing and ultimately, benefit the whole society. Just as a smart car or a smart home or a smart classroom, it should not be hard to anticipate a smart student or a smart teacher. In this paper, several issues pertaining to education and pervasive computing are discussed. The different applications and the challenges in implementing them are analyzed. The roles of a teacher and a student in the ubiquitous era with respect to the cognitive domain are listed and an educational framework is proposed.

Keywords: *Pervasive Computing, Education, Smart Student, Smart Teacher*

I. Introduction

Pervasive computing is the realization of Mark Weiser's [1] dream of technology weaving into individual lives. Pervasive computing technologies [2, 3] enable new ways of acting, interacting and stimulating fundamental reassessments of the meaning of human action and interaction. The computing landscape is evolving into an environment in which computers are autonomous devices that provide largely invisible support for tasks performed by users. Pervasive computing is going to be part of our everyday life and will assist us in all our activities regardless of our location. This vision of Pervasive computing is that, ultimately, our whole society will benefit from such systems, and not just a few people doing very constrained tasks within physical "islands" of computing support. A pervasive system cannot reach its full potential – and cannot really be described as pervasive – when it is limited to, say, a "smart house" or a "smart car". So it is essential to develop better understandings and design methodologies for large-scale pervasive systems in different domains and the societal challenges that they will entail. So far pervasive computing has dominated the health care sector. There are very few applications related to education domain. In this paper the facts and challenges of the influence of pervasive computing in education is discussed.

2. Related Work

Pervasive computing in education can be termed as borderless education. Pervasive computing: vision and challenges is given by authors in [4, 5]. Pervasive computing is going to influence the society as never before. The societal impact of the technology is studied by the authors in [6-8]. The Elite Care Information Technology Group has deployed a system [9] with many elements of pervasive computing, including portable and wearable devices and wireless networking, to create intelligent and responsive work and living spaces for the

elderly in a residential setting. There had been a great deal of research and systems related to health monitoring systems. Pervasive computing applications are available in plenty as the authors suggest in [10-15]. In [16], the authors suggested a context awareness health monitoring system. Wearable computing has found a place in health care as proposed in [17].

There is not much work available in education domain as in health care sector. The use of mobile phones enables learning at any place, at any time. In [18], the authors have highlighted the learning with smart class room technology. The design of pervasive computing with respect to education is studied by the authors in [19]. A pervasive computing platform for individualized higher education is given in [20].

In [21], interactive multimedia education, quality control and personalization of multimedia services, peer-to-peer multimedia streaming, mobile TV, and VoIP systems are analyzed. In [22], the authors give an overview of new advances in wearable computing. The paper highlights wearable context and activity recognition, research using cell phones, challenges of human-computer interaction, novel sensing modalities, electronic textiles, and wearable applications.

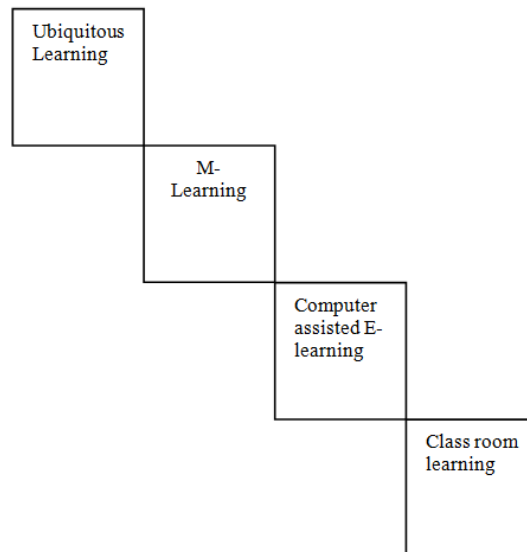


Figure 1. Evolution of pervasive computing

Wireless sensor networks and adhoc networks can be used to collect real information from the internet gateway. For example, if the students want specific information they can immediately query the gateway and collect the information. The teaching network may consist of various universities, colleges and libraries across the globe. Apart from the global library, wearable computing would further enhance the learning process. Figure 1 shows the evolution of pervasive computing. It shows the various technologies' influence on education in different periods. The technology has improved learning process from class room learning to E-learning to M-learning. The present paradigm is pervasive computing and in this paper the impact of pervasive computing in education is discussed.

3. Cognitive Domain

The cognitive domain involves knowledge and the development of intellectual skills. It is all about recollecting and recognizing of facts, procedures, patterns and concepts. This domain helps in the development of skills and intellectual abilities. There are six major

categories, which are listed in order below, starting from the simplest behavior to the most complex. They are in the order of increasing difficulty. The influence of pervasive computing in each category is discussed below.

3.1. Knowledge

Recall data or information is characterized as knowledge. Reciting a poem, recollecting names are examples of knowledge. Basically it is about defining, describing, identifying, matching and recognizing skills. This phase will be completely taken over by pervasive devices. As against the laptop era where e-learning complimented the process, pervasive learning is going to substitute the learning process. It is not far fetched to think of extension to the brain as wearable chips. The volume of data that the human being can remember is very much limited. It fades away with time and diseases. Instead the knowledge gained from extended memory will never fade.

Example: Embedded chips / Wearable chips

3.2. Comprehension

This phase is about understanding, interpolating and interpretation of instructions and problems. It is like explaining the steps for performing a complex task in one's own words. It is about comprehending, distinguishing, explaining and interpreting. The pervasive devices would assist in comprehension thus making the process very quick and efficient. This is possible with the vast inter related knowledge architecture of the pervasive computing.

Example: Search engines

3.3. Application

Using a concept given a new situation is application of knowledge. It helps to apply the classroom learning into work place situations. It is like using a programming language as a tool to develop an automated system. It is about computing, constructing, predicting and relating things. As the era of pervasive computing opens up real data analysis, even the learning process would be application oriented. Typically learners would use real data for applications. Also the devices would be useful tools for developing exciting applications.

Example: Weather prediction

3.4. Analysis

Analysis is separating concepts into component parts so that its organizational structure may be understood. For example, troubleshooting gathers information from a department and selects the required tasks for training. It is about contrasting, distinguishing, illustrating and separating. Pervasive devices would be useful tools for analysis as they would have enormous volume of real data.

3.5. Synthesis

Synthesis is defined as building a structure or pattern from diverse elements. It is like designing a robot to perform a specific task. It is about combining, composing, revising and designing. In pervasive world real data would be available making it easier to synthesize rather doing prototypes on sample data.

3.6. Evaluation

This phase is to make judgments about the value of ideas or materials. Optimizing data for best solutions is the main aspect of this phase. It is about appraising, concluding, defending and evaluating. The pervasive devices would assist in making quick judgments based on different inter domain parameters.. In short, almost the whole of cognitive domain will be taken over by the pervasive devices.

4. Challenges

The challenges of pervasive computing with respect to teaching domain are specified below.

1. Making components

Apart from Laptops, ipads, wifi connectivity many new small devices need to be made to make this a reality. For example, sensors that keep track of a student activities is needed to monitor the presence of a student. Also making embedded chips and wearable chips that would extend the brain would be another challenge.

2. Wearable computing

It is possible to make knowledge boxes and put it in store. The effect of embedded chips as an extension to brain is a challenging assignment.

3. Affordability

As of now only the current big players in education can afford this setup. Whether this would influence remote places is a big question that needs to be addressed.

4. Privacy

The concern about privacy in ubiquitous computing is huge and so it is also applicable to education domain also. The student being monitored constantly may pose a potential risk.

5. Security

There is a possibility of forgery at a large in pervasive computing as everything is virtual. Improper access control is another issue that needs to be tackled.

6. Losing thinking power

With the advancement of technology, there is going to be a decline of natural brain processing power as the extensions would do the work quicker and efficiently.

7. Evaluation system – This is particularly difficult as it is difficult to comprehend which is the original brain's work.

5. Benefits

The Benefits are highlighted below.

- There is plenty of knowledge available instantly.
- Knowledge is 24/7 service and any time any where.
- Based on context, knowledge can be retrieved.
- Both teachers and students can specialize any domain without any contact hours.

- Interdisciplinary skills will be at high as it would be easy to get related information at a touch of a finger.
- There would be no boundaries and domains.
- Flexibility in learning
- Choosing custom made courses

6. Smart Education

Smart education includes smart teacher, smart student, smart classroom and smart institution.

6.1. Teacher Vs Smart Teacher

In the traditional teaching paradigm, knowledge is available inside the classroom. There would not be any repetition of lectures. But in pervasive paradigm, knowledge is permanently available. It is available all the time. Whenever a student wants, he/she can go through the lecture again.

	Knowledge	Analysis	Application	Evaluation
Teacher	Books, Electronic Books Search Engines Temporary – Wades off	Not much of interrelated / multidisciplinary analysis done	Mostly sample data is given	Examination method – Not suitable as it is theory oriented
Smart Teacher	Electronic form Permanent	Web of interrelated materials available , making it possible for better analysis	Applications on Real time data possible	Automated

6.2. Student Vs Smart Student

For a student gaining knowledge would be the first goal. But in smart environment, knowledge would be just a click away. So more emphasis would be on application and synthesis phase. It would be more interesting to identify the different disciplines weaving together with the repository of knowledge.

6.3. Evaluator Vs Smart Evaluator

This is the toughest area in smart education domain No longer the educator can ask questions like ‘explain’, ‘describe’ or ‘what is’. Smart evaluation has to be totally application oriented. One can expect euphoria of new applications hitting the market as the smart education would facilitate new innovative and interdisciplinary applications.

6.4. Smart Administrator

There would be wide choices for the students starting at an early age. Any student can opt for any course. There won't be fixed class rooms. Based on the completion of prerequisite courses, the students would have the liberty to choose any course/title.

7. Educational Framework

The students register for a school would get access to all the relevant materials available in the class room as wearable chips. The complete education automation is given in the following steps.

7.1 Education automation

Automation means ability to manage self. For example, home automation which is a reality now, is all about managing the home. Thus it is possible to automate education domain too. The Figure 2 depicts the architecture of the ubiquitous learning. The student will have the connection to the institution / parent/ public only through the central monitoring system. There is no direct connection between any pair. Further, the links are different. The access control for each category could be specified by the individual. *i.e.*, the student has control over what others can access about him/her. This greatly improves the privacy issues.

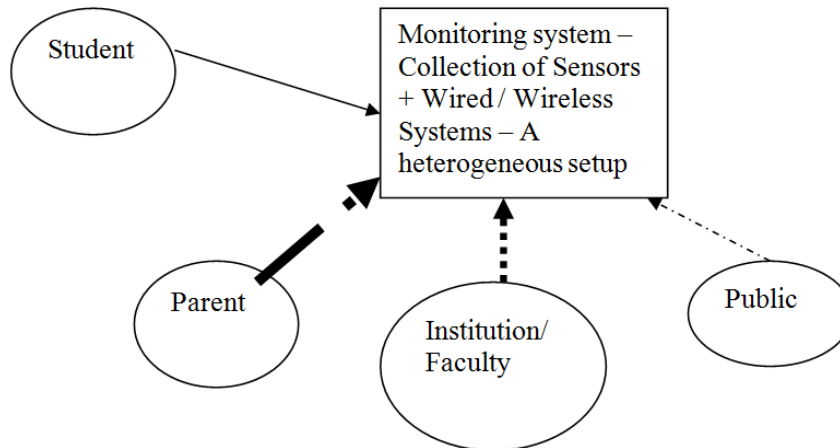


Figure 2. Education Pervasive Framework

1. Students enroll by themselves after passing a test challenged by the computer based on his credentials.
2. The system would give him choices to study based on his performance after checking the prerequisites.
3. The student would select a course and enroll for a class
4. The students activities will be monitored by the sensors and automatically updated in the central database
5. At any time, the parents and the faculty can see the status of the student
6. Physical presence in the class room is optional.

7. The sensors would monitor his working hours and the subjects that he had learnt
8. After possessing the required knowledge, the student would be notified about the examination.
9. The student would be posed a few applications that he needs to solve in real time.
10. The student would be evaluated
11. After successful completion, the process would stop.

7.2 Advantages

- Time – This has to be measured as time taken by the teacher to update self with time taken for E-learning with real time applications.
- Efficiency – No more simulated environment / theoretical studies
- Cost – The cost incurred will be one time set up cost and maintenance cost.
- Flexibility – The students can register for any course any time according to his/her preference. The traditional approach has fixed slots.
- Convenience – The students need not be physically present in a classroom. Instead there would be virtual class rooms.

8. Application of Pervasive Computing in Education Domain

1. Anywhere anytime Knowledge

There will not be a tiny bit of knowledge that is unavailable to the community. Thus it is possible for interdisciplinary analysis.

2. Real time data for research

Thanks to wireless sensor networks, real data would be available in the internet gateway.

3. Internet of Things

Wearable computing would make internet of things a reality. Knowledge can be sold as embedded chips. These chips can communicate with the brain, outside the body and even with the internet.

9. Psychological Barriers

The class room teaching is going to be slowly invaded by the digital devices. It would be meaningless to give knowledge to some one who already possesses it. The biggest challenge is in understanding part. To understand, there are different options available. Already teaching is partially taken over by the laptops. The old fashioned chalk and talk method may not be appealing any more. The students can get satellite data in real time. They can see and understand the working of an instrument/device in real time instead of the map of the instrument. But as a society that is so used to class room teaching and learning process, it is going to be a slow revolution. There may be a big digital divide among communities. The students too may not like to be monitored as that might risk their privacy. As wearable computing is the new jargon, one can anticipate knowledge boxes in shops. Any one who wants to have knowledge of a subject/topic can buy that box and wear it. The knowledge would be transmitted to the brain voluntarily. If that knowledge needs to be permanent, it can

be embedded in the body transmitting signals to the brain. In short, one can extend the functionality of the brain. According to Mark Weiser, "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it". This would become a reality in the ubiquitous era. But this will come with a price. The students will miss out on peer communications. They will have cyber peers and slowly the emotional problems would settle in. This will increase loneliness, selfishness and students will become an island of their own. But one can never stop the technology pace and the society should take necessary precautions and learn to use the technology effectively. Whether the class room teaching is going to be complimented by the pervasive devices or substituted by the pervasive devices is going to be a major factor in the next decade.

Under ubiquitous learning, there are no age limits and no boundaries. A 50 year old can take the same subject as a 10 year old. Typically the students take an examination (Written, oral, demonstration) at the end of the study period in addition to continuous assessment exams. The student's knowledge can not be evaluated as there would be knowledge boxes on his body transmitting data. So it is imperative to check the application and problem solving skills of the student on real data.

10. Conclusion

To realise pervasive computing in education, a thorough analysis have to be initiated at the earliest possible time. First of all, national strategies need to be drafted for the technological innovation process. Without a clear strategy to promote the benefits of pervasive computing, the innovation process would be purely technology-driven and might cause severe conflicts and high external costs in the future.

Pervasive computing becomes interesting for academicians when opportunities outweigh the risks. The change is inevitable. Thus it is important for the government, educational institutions and all the stakeholders to work together to solve this problem amicably. The society would not be able to accept the changes in technology quickly. That is why it is important to educate and take drastic measures before this invades us.

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