KIKI – A Key to the Integration of Knowledge and Innovation

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Abstract. The proliferation of ICT within the educational domain is serving to overcome several barriers associated with traditional pedagogies. However, the challenge of balancing educational objectives against technical limitations and harsh financial realities is becoming more relevant than ever. Specifically, one is often faced with insufficient funds for hardware resources, lack of streamlined distribution mechanisms for software, and irreconcilable disparities in the packages offered.

In this paper, we present KIKI as a tentative solution to the aforementioned obstacles. KIKI is a prototypical system devised following extensive research on learning paradigms, including collaboration and the use of games within the educational context. It is meant to serve as a platform for deploying educational software through an extensible architecture which provides inherent support for MultiPoint functionality, inter-computer communication, user identification, and progress tracking. Seamlessly integrated, it would bind all stakeholders (developers, administration, teachers, and students) in their respective roles, amplifying the dissemination of knowledge and providing enhanced educational opportunities for all, irrespective of age and financial conditions. The system would also enable an innovative edge, giving unbounded opportunities for the development of applications to best meet the local demands.

Keywords: Constructivist Pedagogy, KIKI, MultiPoint, Platform, eLearning

1 Introduction

> “ Education provides people with the tools and knowledge they need to understand and participate in today’s world. It helps to sustain the human values that contribute to individual and collective well-being. It is the basis for lifelong learning. It inspires confidence and provides the skills needed to participate in public debate. It makes people more self-reliant and aware of opportunities and rights. ”
>
> – UNESCO [1]

Education is one of the fundamental human rights, and its beneficial role in society is undeniable. Providing education for all is one of UNESCO’s goals, aimed to be accomplished by 2015. Unfortunately, providing education for all is not an easy goal to achieve due to various difficulties in today’s world. As indicated by UNESCO Bangkok [8], one of the most difficult challenges is that of balancing educational objectives with technical limitations and harsh financial realities. U. S. Pawar et al. [3] report a typically high student-to-computer ratio in most developing countries, stating that it is “not unusual” to have up to ten children on a single computer. One must also consider the challenge of keeping the student engaged – the process of learning requires that the student, no matter what age-group he/she belongs to, is actively involved in the learning activities he/she is participating in. Losing the student’s interest in the educational activities one is offering renders the learning process ineffective.

Through ICT, one can transmit knowledge by presenting educational content to the student in the form of multimedia. Audio-visual lessons and games help in motivating the student’s interest; games in particular keep the student absorbed because of their competitive nature, especially when human opponents are involved.

> “ Picture this: In a classroom of 40 children with only four PCs among them, 10 students crowd around each machine. Within each group a dominant student – often the brightest, richest, or oldest child – takes center position and controls the mouse. While other students point, gesture and vie for control of the mouse, they ultimately have no direct control of the PC and often lose interest and shift their attention elsewhere. The child with the mouse is learning on his own, and the others are not learning at all. ” – Microsoft [2]

The distribution problem arises when it comes to installing, maintaining, and updating the software in all the educational institutions. Even if it were possible to supply a computer per student, how would the commissioning entity be able to distribute up-to-date educational software for each student in a cost-effective way?

Providing education for all is a great challenge, and success will give millions more skills to rise out of poverty. We aim to develop a complete system which is extensible and, at the same time, easy to use and implement.

1.1 Collaboration

There are many advantages in letting students work together which are directly related to the self-improvement of the student, both as an individual and also concerning how he/she works with his/her peers.

By using a technology which allows multiple input devices on one computer, it is possible to have several students participating actively on a single computer at the same time – this addresses the high student-to-computer ratio and encourages collaboration by allowing the students to learn together without having one particular student at a physical advantage over the others. Studies by K. Inkpen et al. [4] have indicated that the performance of students collaborating on a single computer using multiple mice would exceed that achieved by the same students working alone.

1.2 Educational Games and Multimedia

Researchers and teachers are realizing the potential of using games for educational purposes. Research into the use of mainstream games in education is relatively novel, but growing rapidly. A broad literature review of the topic is given by J. Kirriemuir and A. McFarlane [5]. Gender-specific studies, on the other hand, have been carried out by J. Lawry et al. [6] and K. Inkpen et al. [7] for boys and girls respectively.

The challenge for developers and designers, possibly with the help of teachers and researchers, is to create educational games which have the same level of engagement as games used for purely entertainment purposes – educational games which challenge the player and make him/her want to play (and consequently, learn) more.

By using new technologies, designers and developers can produce interactive educational games easily, and hence help in making the learning process more fun and engaging.

2 KIKI – System Overview

A solution to achieve UNESCO's EFA (Education For All) goals is a fully-integrated MultiPoint system which is easy to use, extensible, and most importantly, promotes a constructivist pedagogy and an intuitive way for teachers to make their lessons more interactive, interesting, and collaborative. Through our proposed system, students may be assessed whilst engaging in educational software activities, enhancing their motivation. State-commissioned or commercial developers may upload new applications which would be seamlessly incorporated into the system and immediately available within all classrooms. We aspire for our system to serve as a *Key to the Integration of Knowledge and Innovation* (thus the name *KIKI*).

The system provides four types of clients, respectively designed for the application developers, the school administration, the teachers, and the students.

The administration client provides a user-friendly interface for the members of the school's administration to insert or update details pertaining to the school's students, teachers, and classes. The teacher and the student clients are more oriented to the actual classroom scenario. Login is done through the use of virtual cards, and applications can be downloaded and run during the lesson with utmost ease. In this way, the teacher does not need to prepare any exercises, nor be an expert in computing. The student client is MultiPoint-enabled and, thus, introduces the idea of competition and collaboration among students residing on the same or different computers whilst, at the same time, allowing all the students to participate and control their own mouse. Moreover, the clients are localizable such that they can be modified to support any language.

The system is flexible and extensible enough to support any type of application or tool that is useful for both the teacher and the students, giving developers a range of options to choose from, such as MultiPoint-enabled or single-point applications, .NET 3.0 or .NET 2.0 applications, and providing a teacher and/or a student mode. Tools such as slideshow designers would be particularly useful to teachers.

2.1 Conceptual System Layers

The high-level design of the system was inspired indirectly from the Open Systems Interconnection Basic Reference Model (more popularly known as the OSI Model). The system is divided into layers (abstraction levels), with each layer building upon the lower layers to provide a set of functionality for use by the higher layers.

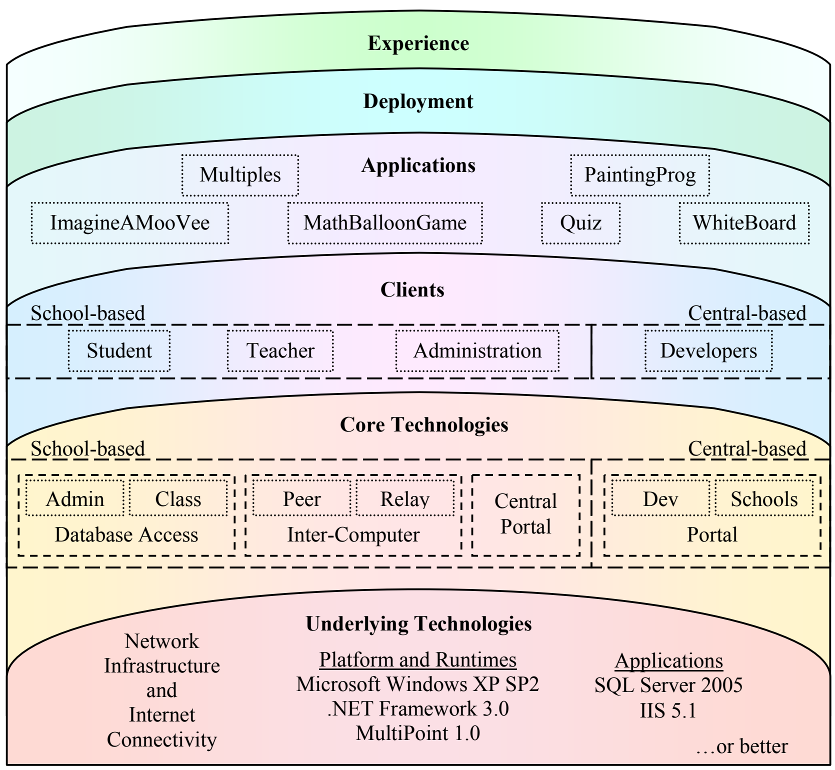

Fig. 1. The six conceptual system layers

The *Underlying Technologies* layer covers all the requirements necessary for the system to run. The central authority and the schools' administrations should ensure that the computers on which the servers and clients will be installed meet the specified system requirements, and that the deployment procedure is completed.

The *Core Technologies* layer provides the enabling framework which empowers all stakeholders to participate accordingly in the system. It exposes back-end functionality (such as database access and inter-computer communication) through a series of WCF services to which the clients subscribe.

The *Clients* layer serves as the front-end for the system, and provides for user interaction such as log-in, information retrieval and presentation, and submission of data or results. It also defines an API which would allow independently-developed applications to integrate with the class clients, taking advantage of system-provided features such as student authentication, progress tracking, and inter-computer communication.

Development of the *Applications* layer is principally intended to be commissioned by the central authority. Applications may be uploaded to the central repository through the developers client, and will be deployed on the class clients automatically through the system architecture. The scope of applications may range over educational games, animated tutorials, homework exercises, and tools such as dictionaries and visualization aids. Each application may also be made customizable using swappable XML content files.

The *Deployment* layer involves the fruition of the system by the individual schools and teachers. It covers the following aspects:

- *propagation*: sending the selected application to connected student clients
- *customization*: choosing the content file to be used in a particular application
- *utilization*: making use of the provided tools, e.g. for constructing visual tutorials

Finally, the *Experience* layer concerns the students' enhanced educational venture. Students may engage in educational games selected by the teacher, watch videos prepared by a slideshow designer, or make use of any of the available applications subject to teacher control.

3 System Architecture

The central server is maintained by the central authority, and hosts the central database and the application repository. The central server also provides two portals; one for developers, and the other for schools.

The developers portal allows application developers to log onto the central server, upload new applications to the repository, download and enhance existing applications, or provide new content files for customizable applications. Since the developers portal is a WCF service, it is possible for developers to access the system remotely, thereby giving them the opportunity to work from the comfort of their own homes, or even from abroad.

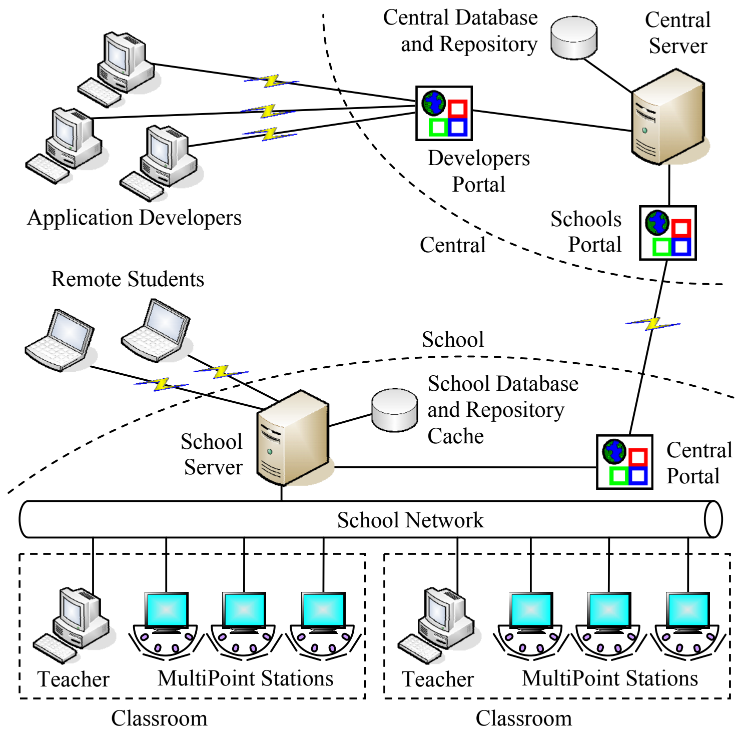

Fig. 2. The system architecture

Each school would, in turn, maintain a school server which hosts the school database and the repository cache. The school database holds details pertaining to all its students, teachers, and classes. The school server also hosts a number of school-based services used by the administration and class clients, including the central portal which is used to access the central server (over the internet or through a wide-area network set up by the central authority) for the retrieval of applications from the central repository.

The school server would be connected to the school local-area network, enabling its services to be used by the class clients deployed on the class computers. Such services include:

- retrieving student, teacher, and class information from the school database
- recording student progress to the school database
- setting up a peer-to-peer inter-computer communication mesh amongst a given classroom's computers
- downloading applications from the central repository through the central portal

It is worth pointing out that the entire system is integrated in such a way that all the above interactions take place seamlessly and with minimal human intervention. Suppose, for example, that an application developer has completed a new application, and uploaded it to the central repository using the developers client. Almost immediately, the new application is available for deployment in all classrooms connected to the system, without needing any installation whatsoever on the class clients or even the school servers.

4 Evaluation and Conclusion

In order to evaluate the capabilities of our prototypical system, we ran a demonstrative deployment with the help of a class of thirty students, aged between nine and ten, from a primary state school. The setup consisted of eight computers for the students, each having three to four mice, and a computer for the teacher. Each student individually controlled a mouse to which a cursor with a specific unique color was associated. The computers, on the other hand, were assigned a unique name corresponding to the soft-toy placed on the top of the monitor.

Fig. 3. Students attentively follow an educational slideshow presentation about nutrition

In preparation for this trial, we uploaded a number of sample applications which we had developed onto the central repository. The teacher was allowed to select any of the applications from the available list; once downloaded from the repository, all the thirty students in the class could participate in the activity. The sample applications, together with the rationale behind their conception, are described hereunder:

ImagineAMooVee is a tool developed for teachers to be able to build educational slideshows easily. The main idea behind this application is that visualization is the key for making learning easier. Rich Mayer, a cognitive psychologist, has developed a cognitive theory of multimedia learning, and has proposed seven research-based principles for how to design learning environments [9]. Our idea follows his first principle, *The Multimedia Principle*, which states that "Students learn better from words and pictures than from words alone."

WhiteBoard and *PaintingProg* follow the same principle. *WhiteBoard*, as the name suggests, acts as a virtual whiteboard which the teacher can use to visually illustrate concepts to the students while explaining. *PaintingProg* works on the same idea as *WhiteBoard*, but instead of having the teacher as the centre of attention in the class, we have the students trying to explain words to each other through illustrations by means of an engaging Pictionary-like game which encourages collaboration and competitiveness amongst the students.

Fig. 4. The *MathBalloonGame* deployed within the student client

MathBalloonGame, *Multiples*, and *Quiz* are games which students can choose to play by using either a cooperative or a competitive approach. For educational games to be effective, they need a high level of engagement, as explained by J. Kirriemuir and A. McFarlane [5]; therefore, these three games were designed to be MultiPoint-enabled and given a colorful theme. MultiPoint also brings about the collaborative aspect which makes the educational experience more compelling, as shown by K. Inkpen et al. [4].

4.1 Closing Observations

The competitive aspect brought about by this fresh pedagogy was very successful at keeping the students engaged in the activity. They were absorbed throughout the lesson, with a constant display of enthusiasm towards the new system.

Students were not confused about the idea of multiple mice and cursors. They were not distracted or talkative. Instead, they collaborated and cooperated together so that every student was able to participate in the competitive games and enjoy this new idea of a classroom. Becoming a collaborator and no longer a dictator, the teacher was able to easily control the entire class and spend more time monitoring and analyzing the performance of the students with the help of the real-time progress-monitoring system, which works transparently behind the applications. The sample applications illustrated the possibility of having a wide variety of activities that can be followed in a class.

Notwithstanding the favorable response exhibited towards the system during the trial, one should bear in mind that this was meant primarily as a demonstration, and should by no means be considered an authoritative or conclusive evaluation of the system's effectiveness in the long run. A more thorough study would need to be extended over the course of an entire academic term or year, incorporate applications offering a broader and deeper coverage of the curriculum, and objectively measure the performance of the participating students against a control group of similar ability (not exposed to the system) by means of common assessments.

Finally, the trial served to demonstrate that KIKI is capable of successfully overcoming the obstacles mentioned earlier. For merely €4 per mouse, we managed to actively involve a class of thirty students on just eight computers. By uploading the developed applications to a server connected on the school network, we eliminated the need of having to install them manually on each computer. We also ensured that the applications took advantage of our system-provided capabilities, such as MultiPoint functionality, inter-computer communication, user identification, and progress tracking, thereby providing a smoother and richer experience for both students and teacher alike.

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