

The Greek School Network: A Paradigm of Successful Educational Services Based on the Dynamics of Open-Source Technology

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Abstract—The Greek School Network (GSN) is a closed nationwide educational network that offers advanced telematic and networking services to all primary/secondary education schools and administration offices in Greece. The primary objective of GSN is the provisioning of a network infrastructure for the interconnection of school PC laboratories so that modern educational methods and pedagogical models can be applied to the school community. GSN has scaled in size, has reached maturity, and is currently delivering a wide range of network and telematic services to its users. The emerging power of open-source software provides a sound technological basis for building cutting-edge services, capable of meeting internal administrative and monitoring needs, and modern pedagogical requirements for tools and services. The current paper presents an overview of GSN and an evaluation of its services based on the opinions of its users, and on service utilization and traffic measurement statistics. The paper reaches the conclusion that open-source solutions provide a sound technological platform that can cover, to a great extent, the needs for advanced educational services of the school community.

Index Terms—Education, network infrastructure, open-source software, school network.

I. INTRODUCTION

THE Greek School Network (GSN) [1] was founded in 1998 and constitutes the educational intranet of the Ministry of Education and Religious Affairs (<http://www.ypepth.gr>). GSN interlinks all Greek schools and educational administration offices and provides advanced telematic services to the student, teacher, and school administrator communities [2]. GSN was funded by the second and third Community Support Framework of the European Union. GSN has been designed and is being maintained by a group of research centers and universities, under the directions of the Ministry of Education. GSN offers a large number of diverse services [3] to more than 15 000 schools and administrative units, serving more than 60 000 teacher accounts (out of a total number of 160 000 teachers), and placing GSN second in infrastructure size nationwide. GSN plays a substantial role in fulfilling the social-political goals for the diffusion of Internet access and the promotion

of modern educational models in the Greek society. GSN also contributes decisively to the convergence of the national information technology (IT) usage metrics with the European Union average and has received international best practice awards for IT utilization based on its acceptance by educational units. GSN must play a multidimensional role; it must continue to provide traditional Internet service within its domain and also introduce pioneering and innovative services covering new educational models and strategies. In the immediate future, GSN will be challenged to move further with the provisioning of new cutting-edge services for education. To meet the goals set, GSN is expected to continue relying on open-source software, since the benefits derived from its use are in very good agreement with GSN's business and educational goals.

Most GSN services are based on open-source platforms. Open source liberate the learning process from the narrow dependencies of tools and platforms. Open-source technologies give stakeholders the ability to shape the service offered to them, based on their needs and on their growing knowledge about the service itself. Learning is not confined within the naïve usage of tools, nor is it confused with the tool that implements the service. If knowledge is indeed produced, it can be modeled and implemented by GSN engineers, teachers, pupils, and can be made available to the educational community, or anyone interested. Knowledge production takes place both in the classroom and the GSN service development team. With the adoption of open-source technologies, the GSN development team is itself able to obtain a better understanding of educational services and pedagogical strategies, something that is also indicated by the number of contributions to open-source educational projects made by GSN engineers (Section II-B). While basing service implementation on open-source technologies, GSN is also trying to analyze the impact the services offered bring on the national educational system. The strategy behind services design is that it must be both open from a technological point of view and complementary from an educational point of view [4]. Even though services are logically autonomous and independent of each other, they form a coherent set of educational tools for enhancing education and accommodating modern digital education methodologies. GSN's role is not to define the teaching method, but to provide the technical means that can cover all educational specifications. Teachers must be free to choose their preferred teaching method and style among the enabling services provided.

The rest of the current paper discusses the ways open-source technologies are enabling modern pedagogical strategies within

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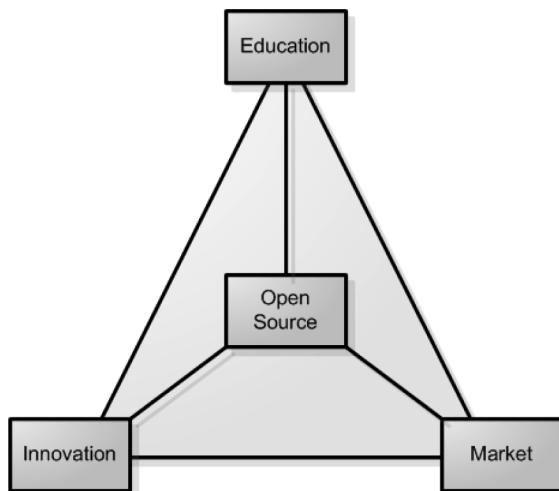


Fig. 1. Open source enables pedagogical, innovational, and market strategies for GSN.

the educational system. Section II presents an overview of the GSN core and advanced services. Section III discusses the value of GSN e-learning services and presents results obtained through usage measurements and questionnaires answered by end-users. The last section presents conclusions and describes directions for future work.

II. GSN IN EDUCATION

A. Education, Innovation, Market, and Open Source

The open-source and education community philosophies seem to subtly converge, enhancing the role of open-source software in modern education practice. The mentality of the open-source community is closely related to desired characteristics that formal education today still lacks and strives to promote, such as an open and inclusive ethos. Involving students in large-scale, international open-source projects have the potential of transforming the relationships among students, educational institutions, and society at large. The adoption of open-source software also sets the educational sector free of corporate influence that is not always in the best interest of the former. With open source, the selection of tools and technologies is made by specialized professionals who work in education and are knowledgeable of the IT field.

GSN rests on the separating border between the academic and the commercial worlds. Thus, its business objective is not solely profit maximization or cost reduction. From an operational point of view, GSN acts in the way a commercial service provider would act, continuously trying to offer new educational services as IT evolves, and studying new business relationships between GSN and other Internet stakeholders. However, GSN is also subject to academic influence since the national educational network is maintained by capital and human resources closely related to the academic community. Innovation is vital for GSN as a means of staying on the technology frontline in the fields of IT, engineering, and educational information systems. Open source is an ideal solution for organizations seeking to combine innovation, competitive solutions, and educational value (Fig. 1). Open source produces reliable enterprise technologies, while maintaining at the same time academic/scholar

origin. As the open-source community grows rapidly, the quality of the solutions provided mature with time.

B. Infrastructure and Services

The GSN network infrastructure is hierarchically structured into three manageable layers—the core, the distribution, and the access networks. GSN users interact with software implementing services on a daily basis through the access network, used to directly connect schools to prefecture's gateways through a variety of access technologies [digital subscriber line (DSL), integrated services digital network (ISDN), dial-up, wireless]. The core network interconnects with the Greek Research and Technology Network (GRNET) [5], the national branch of GEANT¹ via eight cross points. The distribution network provides for the interconnection of the schools and educational administrative units to the core network. The distribution network consists of 51 nodes, installed at the capital of each prefecture. Most GSN services are deployed on distribution network nodes. A variety of techniques and configurations have been used and the results of combinational engineering work are reflected in numerous contributions to the open-source community. Open-source code has been used, modified, and/or contributed to various projects, such as the Apache, Hypertext preprocessor language (PHP), JetSpeed Portal, WindowsGet, Moodle Course Management Platform, Horde Web Mail, PHP Bulletin Board (PHPBB), Berkeley Internet Name Domain (BIND), Free Remote Authentication Dial In Service (FreeRADIUS), RADIUS, QMAIL, Open Secure Sockets Layer (OpenSSL), Mysql, Squid, FreeBSD, Jabber Studio, proFtpD, Mailman, Multi Router Traffic Grapher (MRTG), Cricket, and other projects (Table I). Innovative custom software has also been developed under open-source licensing, such as the OpenRSM software tool, a lightweight integrated system for remote systems management (RSM), one of the very few tools within the respective open-source enterprise management systems (EMS) market. The services offered by GSN can be divided into the following categories.

- Basic services: network connection provisioning, user authentication and authorization, portal, students portal, automatic registration.
- Communication services: e-mail, e-mail antivirus and antispam, electronic lists, discussion groups, instant messaging, teleconference, news.
- Web hosting: teacher and school page hosting, authoring tools for Web pages, dynamic pages hosting, database service.
- Advanced services: video on demand (VoD), live casting, synchronous and asynchronous e-learning.
- Complementary services: electronic cards service, e-magazines, calendar, address book, work list, personal notes, virtual drives.
- Central infrastructure services: domain name service (DNS), lightweight directory access protocol (LDAP), distributed help desk, online statistics, school geographic information systems (GIS) service.
- Management services: users management service, network monitoring, network security, remote router administration.

¹GEANT is the European multigigabit communications network for research and education.

TABLE I
OPEN-SOURCE TOOLS AND CORRESPONDING SERVICES

Service	Implementation	Service	Implementation
DNS	Bind	Server Operating Systems	FreeBSD, Linux, Solaris
Authentication and Authorization	FreeRadius, Dialup Admin	Discussions	PHPBB
E-Mail	QMail, Courier IMAP, OpenSSL	Instant Messaging	JabberStudio, PSI
Web Servers	Apache, PHP	FTP Servers	ProFTP
Application Servers	JBOSS, Tomcat	Mail Lists	Ezmlm, Mailman
Database Backends	MySQL, PostgreSQL	Network Monitoring	Mrtg, Cricket
Portal	Jetspeed	Remote Management	OpenRSM, UltraVNC
Web Mail	Horde	Organizer service	Imp, turba, Kronolith
Teleconference	Moodle	SLA Monitoring	Nagios
Proxy and Web Filtering	Squid, SquidGuard	Remote Systems Management	OpenRSM, Winventory, NINO, UltraVNC

C. Core Services Overview

This section presents a short overview of some of the services deployed by GSN, such as asynchronous e-learning, Proxy, and Web hosting. Asynchronous e-learning is based on the Moodle open-source software (<http://www.moodle.org>) for interactive Web-based e-learning based on PHP technology. Moodle is used for creating Web-based courses and educational content. Teachers can create new courses or add content to existing courses, and students can view the material, answer questions, and participate in activities. Moodle provides an efficient method for course organization and categorization. Each course maintains basic, thematic, or calendar organization. Teachers may also organize courses in sections that can be related to projects, discussions, questions, educational material, and more. In the projects section, teachers can assign projects to students; project deadlines, grading, and revisions are also supported. Discussion forums for groups of teachers or students are supported in a separate section. Teachers are also provided with a database service for storing questions (and answers) that can be used in quiz and examination preparation. Other choices that are available include time limitations for quiz/examination completion, scheduling, automatic grading and many more. The educational material section can include multimedia or Web content that is accessible to all participants. Asynchronous e-learning is enhanced by complementary functionality including calendar, student profiles, course creation/configuration wizard, dialog questions, extended quiz questions, user activity monitoring, document management, and personal messages. The educational profile section records information on user activities and performance. The profile has

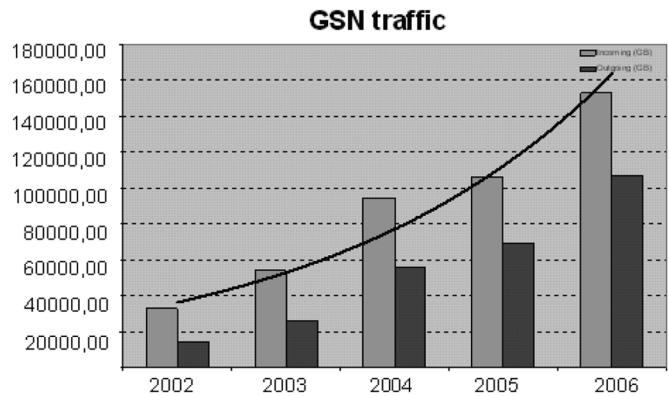


Fig. 2. Aggregate incoming/outgoing GSN traffic. (The figure includes data for the year 2006 from January 1 to December 14.)

been integrated within the e-learning platform, enabling advanced information presentation to teachers. Dialog questions are used for real time information exchange between teachers and students; questions can be imported in the knowledge base of the platform. The extended quiz module introduces question-rating so that lists of questions of varying difficulty can be created. Most of the above extensions have been made available to the open-source community and have since been incorporated in versions 1.3 and on the Moodle platform [6].

Another important service is the proxy service. Implemented in a cluster of machines running in Squid and SquidGuard open-source software, the service proxies connections and applies advanced Web filtering policies using keyword blocking, black and white listing, content labeling, and rating. The keyword blocking methods used are based on page, metadata, and request parsing for offensive content. The definition of content with the use of content labeling [7] and Rating systems is performed by attaching a set of tags to each Web page, specifying the type of information contained in it. Organizations that provide such ratings for websites include the Internet Content Rating Association (ICRA), SafeSurf (<http://www.safesurf.com>), and the Entertainment Software Rating Board (ESRB). SquidGuard is used to provide efficient and quick access control management. Additionally, GSN also maintains a database for the implementation of its own black and white listing to provide customized access control to content inconsistent with the GSN terms of use. The GSN proxy has been implemented so as to be transparent to the user, and is, therefore, the ideal point for Web policy application since all Web traffic passes through it. The traffic volume through the proxy typically reaches 85 GB/day, and the rate of requests generated reaches 8.5 million/min. Web filtering rejects 1.67% of the requests. Commercial solutions for content filtering would be costly to use, while the adoption of open-source solutions has been fully justified by the operational results obtained, including high availability, performance, and cost.

The Web hosting service provides space for schools, teachers, and administration units to host their own Web pages and Web applications within the GSN Web servers. Each school or administration unit connected to GSN has its own DNS under the sch.gr domain, implemented as a virtual Web hosting server. If a unit has more than one accounts, each of them has an independent website that is accessible under the address [unit DNS]/[account name]. The service allows the users to publish static HTML pages or dynamic pages using the PHP language.

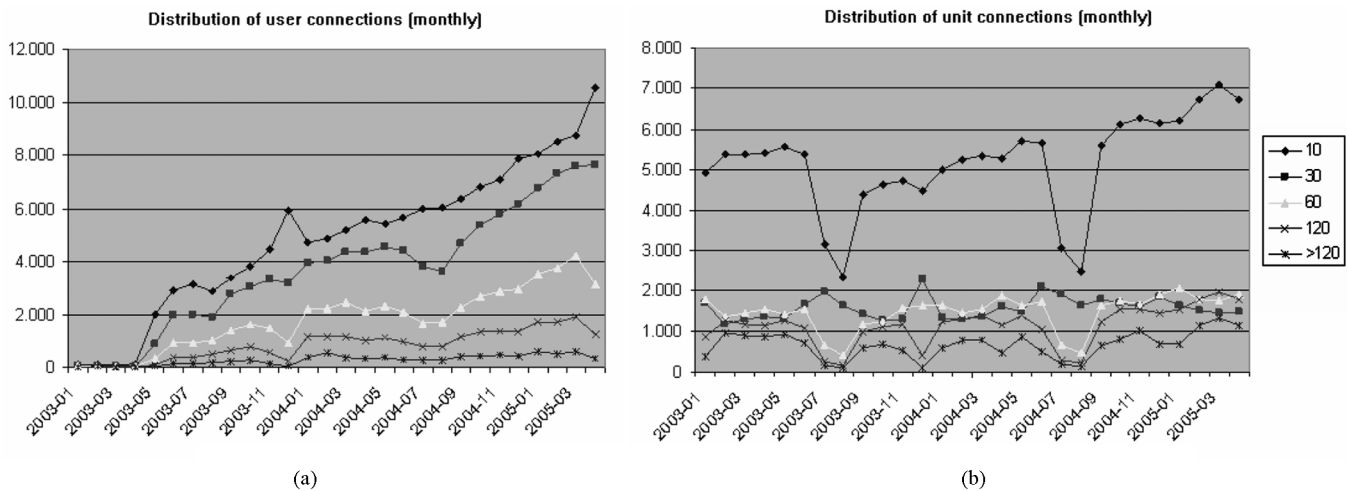


Fig. 3. Number of users accessing digital services 10, 30, 60, 120, and more than 120 times per month. (a) User connections. (b) Unit connections.

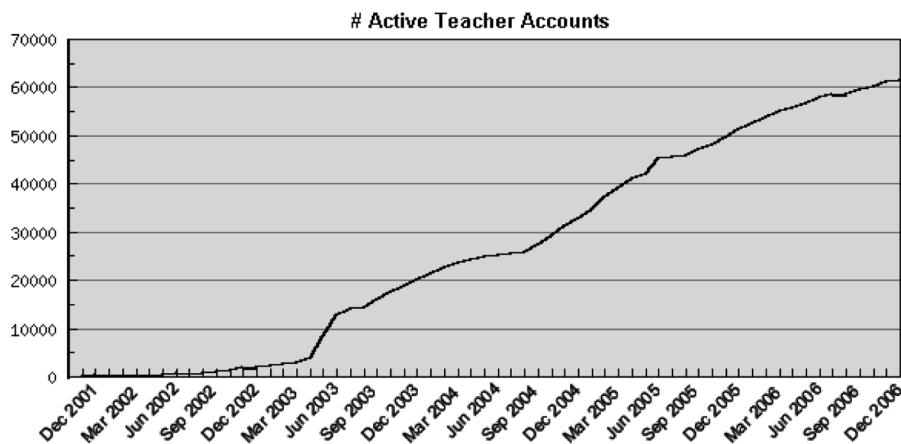


Fig. 4. Teacher accounts.

Backend database service is also provided, based on the MySQL platform. User-level database administration is exposed through a Web interface provided by the GSN portal. Each school or administration unit is allowed 100 MB of Web space, and each individual teacher is allowed 50 MB of Web space. GSN offers four different tools for building Web pages (html, php), Web text authoring tools, and Web page authoring wizards, all developed by the GSN development team. Additionally, GSN users are given file transfer protocol (FTP) access to their Web space, so that they can upload content. Schools and teachers' sites are displayed in the Web portal in a dedicated area, and are grouped according to their thematic areas. A rating mechanism is also available, and the sites with the highest rates are shown on the first pages of the Web portal. Additional services implemented through the Web portal include the storage and management of user's favorites, and an advanced search mechanism for teacher and school websites [8]. The search can be executed through a graphical interface (a map of Greece), allowing queries by author, name, and geographical area.

D. More E-Learning Enabling Services

In addition to the above mainstream services, GSN provides several advanced services expected to have an important impact on the way the national educational process is conducted

today. The "educational pages" service offers the ability to select educational pages published through the portal interface, and inspect and grade Web links published. Selected external links, teachers' Web pages, or thematic catalogues can be reviewed in the same manner. The GSN portal also offers a set of personalized services, including detailed account management, Web page authoring, and favorites. Other services that can be accessed through the portal include Web mail, calendar, notes and jobs management, discussion groups, and collaborative environments for asynchronous e-learning. A considerable amount of news, unit information, and press material is also available through the portal. Other services capable of accommodating special educational needs are forums and administered lists, Web hosting, thematic catalogues, and Web magazines. GSN also offers a full featured instant messaging service based on the jabber protocol. Note that according to third party (<http://www.alex.com>) domain access measurements at the time this paper was written, the GSN portal ranked first in the educational section and 29th within the national domain.

In addition to services implemented through open-source tools, GSN provides services with high educational value based on commercial products. Teleconferencing and synchronous e-learning can be used to orchestrate bidirectional or multidirectional multimedia communication in real time. Users may

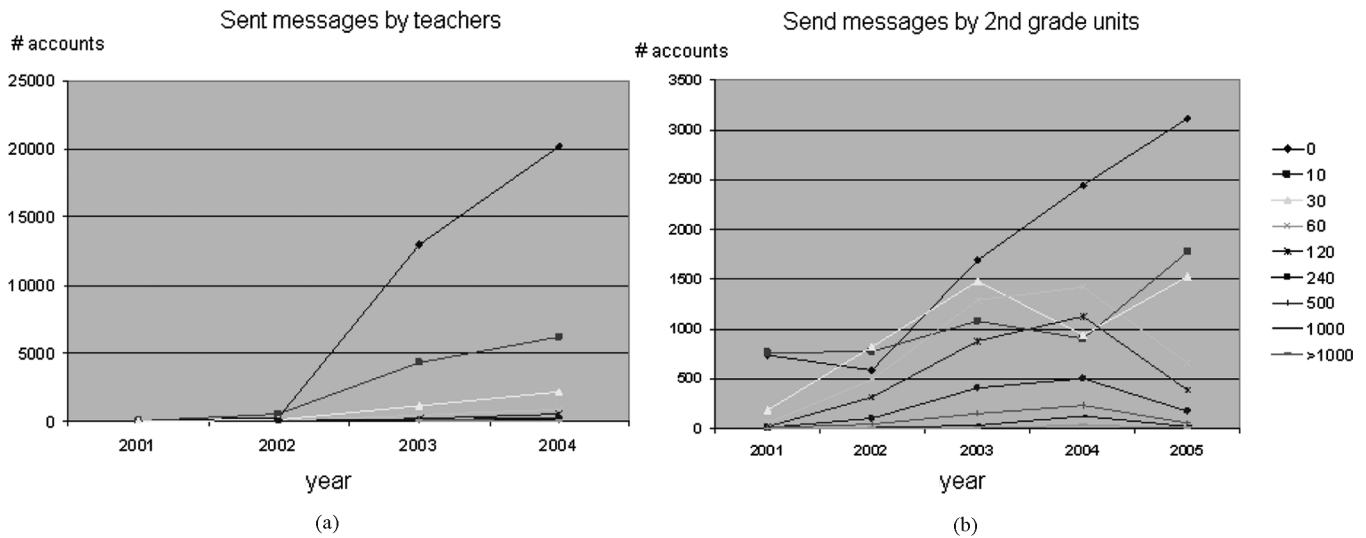


Fig. 5. Average number of messages sent per account. The figure presents the number of accounts sending 0, 10, 30, 60, 120, 240, 500, 1000, and more than 1000 e-mail messages per month. (a) Teacher accounts. (b) School unit accounts (includes first quarter of 2005).

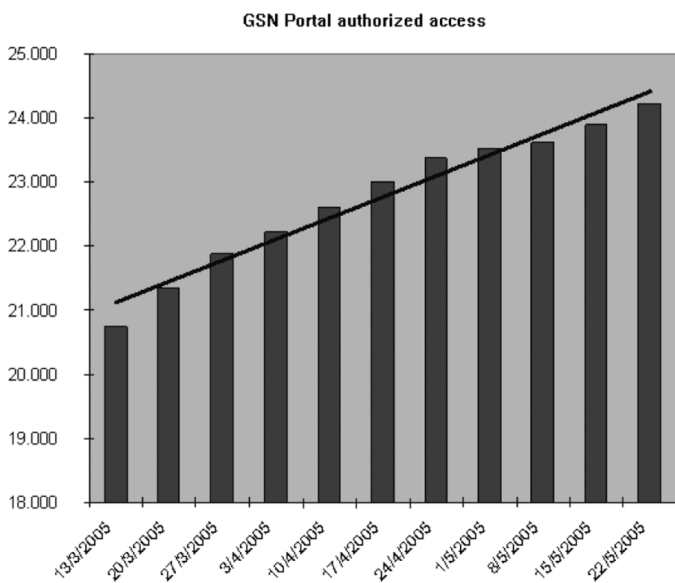


Fig. 6. Authorized login to the portal.

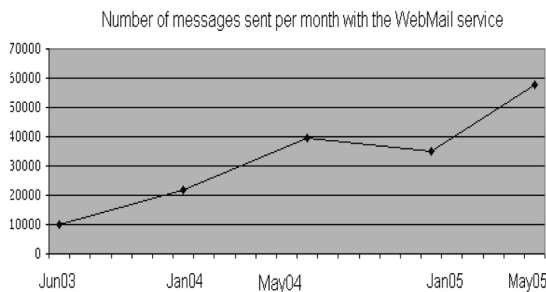


Fig. 7. Web mail usage.

TABLE II
DATA SAMPLE: AGE AND GENDER CHARACTERISTICS

Age	Gender		
	Male	Female	Total
<30	88	136	227 (8.7%)
31-40	500	335	830 (31.8%)
41-50	667	101	1025 (39.3%)
51-60	389	0	505 (19.3%)
>60	22	0	22 (0.1%)

TABLE III
DATA SAMPLE: EDUCATIONAL USAGE VERSUS AGE

Age	Educational Usage		
	No	Yes	Total %
<30	7	212	8.6%
31-40	34	775	31.8%
41-50	68	929	39.2%
51-60	64	435	19.6%
>60	4	15	0.1%

exchange video, audio, and text. Presentation and application sharing is also supported and has been implemented using open-source and custom-built tools. Last but not least, the

VoD service enables teachers to upload and categorize content visually so that it is easily accessed by students.

Δράσεις Προώθησης Πανελληνίου Σχολικού Δικτύου - Microsoft Internet Explorer

Address: <http://www.sch.gr/questionnaire/index.php>

sch.gr ΠΑΝΕΛΛΗΝΙΟ ΣΧΟΛΙΚΟ ΔΙΚΤΥΟ
Το δίκτυο στην υπηρεσία της Εκπαίδευσης

Εφαρμογή αποδελτίωσης των ερωτηματολογίων από τις δράσεις προώθησης του Πανελληνίου Σχολικού Δικτύου

Μέρος 1ο Σχολικό Δίκτυο Μέρος 2ο Εκπαιδευτικά Λογισμικά Μέρος 3ο Εκπαιδευτική Πύλη Υ.Π.Ε.Π.Θ.

Στατιστικά στοιχεία από τις καταχωρήσεις

Παρακαλούμε για στατιστικούς λόγους συμπληρώστε τα παρακάτω στοιχεία

Ηλικία :	<input type="text"/>	Φύλο :	<input type="radio"/> Άνδρας <input type="radio"/> Γυναίκα
Ειδικότητα :	ΑΓΓΛΙΚΗΣ ΓΛΩΣΣΑΣ (Α΄ βαθμιας)	Τύπος Σχολείου :	<input type="radio"/> Δημοτικά / Νηπιαγωγεία <input type="radio"/> Γυμνάσια <input type="radio"/> Λύκεια <input type="radio"/> ΣΕΚ/ΤΕΕ Άλλο (παρακαλώ αναφέρατε) : <input type="text"/>
Νομός :	ΑΙΤΩΛ/ΝΙΑΣ	Δήμος :	<input type="text"/>

1. Έχετε πρόσβαση στο διαδίκτυο από το σπίτι σας;
 Ναι Όχι

2. Πόσο συχνά συνδέεστε στο διαδίκτυο;

Fig. 8. Questionnaire form for direct services evaluation.

III. USER EVALUATION AND LEARNING VALUE

A. Learning Scenarios

The services described in previous paragraphs have been designed to appeal to all GSN users (teachers and students), offering an environment suitable for the implementation of modern educational methodologies and the introduction of modern practices [9]. Traditional teacher-centered, linear, lecture-dominant, text-based teaching methods can be enriched using the GSN services. For instance, the tele-education service enables all kinds of active, visual, group, collaborative, cognitive learning scenarios, while providing additional benefits for people with disabilities. Classroom practice can migrate to student-centered motivational learning, liberating each student to learn by personal experience and individual perception. The GSN services enable classroom techniques based on active participation and facilitate the research and discovery of knowledge through free procedures. GSN is not to define the teaching method. GSN offers enabling services, which teachers

are expected to use to conduct the courses according to the specifications and the educational strategies proposed by the National Institute for Education (<http://www.pi-schools.gr/>).

GSN tries to estimate the value and popularity of its services using both direct and indirect systematic methods for service value estimation. Indirect methods rely on service usage metrics and statistical measurements taken on the server machines and on selected active elements of the network during the routine network monitoring and maintenance work. Statistical information, presented in Section III-B, reflects normal network and services operation and is particularly useful in estimating the user acceptance of core services. Such data are also invaluable for GSN in obtaining macroscopic and long-term growth estimates for service planning purposes. GSN also employs methods for obtaining user feedback directly to apprehend service usage and end user satisfaction. Feedback information is usually collected through structured questionnaires and is used to identify services that are not well adopted to educational practice, and try to improve the business and educational strategies used.

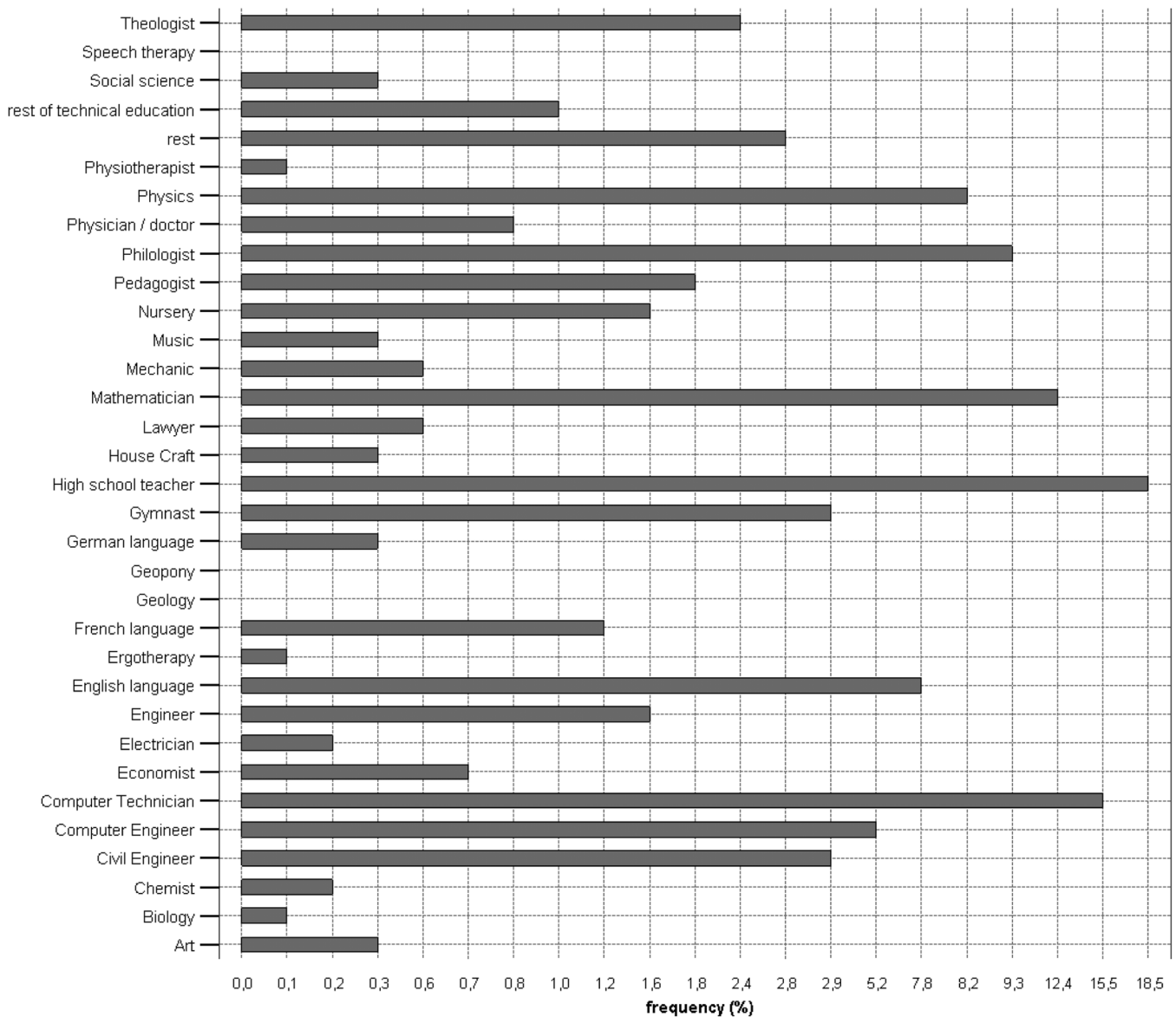


Fig. 9. The distribution of the teachers who submitted the questionnaire.

B. Services Value Growth and Acceptance

Figures and tables presented below illustrate the usage and user acceptance for most GSN services. Fig. 2 presents the overall incoming/outgoing traffic through GSN. As the figure shows, traffic through GSN has nearly doubled in the last three years for an average annual growth of about 23%. Regarding the outgoing traffic, the average annual growth has been around 130%, while the annual growth for the minimum outgoing traffic was 235%. A similar pattern is observed for the usage of all core services.

The use of the GSN infrastructure and services is growing because users accept GSN services in their daily routine, a fact depicted in Fig. 3, where the number of users connecting to the network is presented. User connections have grown rapidly, as shown in Fig. 3(a), while unit connections have not increased accordingly. This situation can be explained

by considering the different purposes and the differed types of connections are created for. Unit connections are mostly realized for official purposes and their growth follows unit growth. More than 60% of educational units read their new messages within 12 hours. The corresponding percentage for teachers is only 19% (measured on April 2005). User connections are realized spontaneously by users, and their steady growth clearly reflects real end-user acceptance. Services usage is bound to follow the tendency; mainstream services are usually the first to be adopted widely, with specialized services following shortly afterwards, as the educational environment matures and embodies new technology.

Figs. 3–7 present usage statistics for the basic services, such as dial-up, e-mail, portal access, and Web mail. The number of e-mail and dial-up teacher accounts is growing steadily as illustrated in Fig. 4. Since 2004, each teacher e-mail account has also been a dial-up account. According to Fig. 4, at that time,

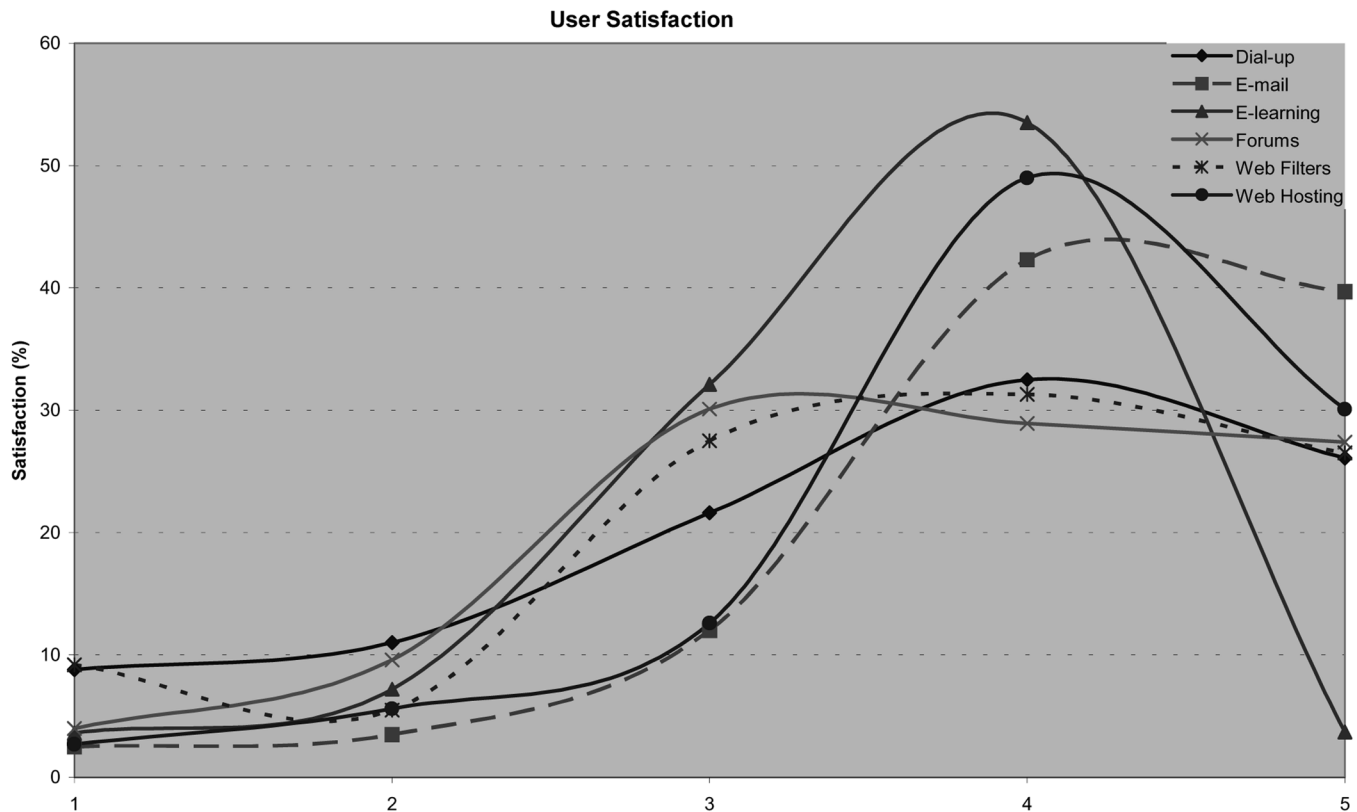


Fig. 10. User satisfaction. Users have been asked to grade the services with which they are familiar. The figure presents the distribution of the answers.

TABLE IV
GSN USAGE PURPOSE

Field	%
Information retrieval for products and services	85,5
Mail	83,1
Press	67,8
Music / games	7,8
Internet Banking	2,6
Other	7,8

more than 85% of teachers that were assigned a GSN user name for e-mail also received dial-up service in 2004. The respective number is above 95% today, corresponding to more than 57 000 accounts. Fig. 5 presents the number of accounts that use the e-mail service in a specified way, that is, to send more than a specific number of messages. Note that the data for 2005 presented in Fig. 5(b) refer to the first quarter of the year—the pattern in the graph followed a similar tendency in terms of growth rate in the rest of 2005 and 2006. The number of teacher accounts that use the e-mail service for sending large amounts of traffic is increasing, and that increase has not yet reached saturation. As far as educational units are concerned, the number of accounts that send substantial amounts of messages is rising also.

TABLE V
KNOWN/USED SERVICES

Service	Known %	Used %
Email	87,44	77,39
Dial-up	61,96	26,97
Lists	51,53	22,57
Publication	19,88	n/a
Web hosting	9,74	n/a
Web filtering	7,62	n/a
E-learning	1,56	0,22
Forums	1,45	0,37
Teleconference	0,86	0,00
Messaging	0,78	0,00
Video on demand	0,41	0,00
GIS	0,11	0,04

Web mail connections and GSN portal access usage have substantially increased over the last years. The Web mail is a service used mainly by people who are familiar with both Web and mail technologies. The rapid increase in the usage of the Web

mail service that is evident in Fig. 7 shows that teachers who are capable of using such services actually do so. Even during the summer months usage hardly declines, signifying that the service is becoming popular. Connections per month is also rising, indicating that the service is becoming known and popular. The tendency for increasing services usage is the same for all core services.

Other statistical data about GSN usage include measurements conducted by the Observatory of Information Society (OIS) (<http://www.observatory.gr>), based on the eEurope 2010 methodology [10]. A telephone research was performed that included 801 randomly selected schools during the period from June 6, 2005 to June 29, 2005. The statistical error of the analysis was 3.47%. According to that research, 95% of the schools were connected to GSN, most of them using ISDN technology (broadband connections were 6%). Ninety-two percent of them were using their e-mail account and 35% of them were publishing educational information through their school Web page.

OIS also reported that school and educational unit work station usage results designate that work stations were used for educational purposes (73%), for dedicated teacher's usage (57%), and for administrative/managerial reasons (55%). The same research found that students use work stations for establishing familiarization with computer technology (91%), for homework preparation/studying (78%), for games (52%), for collaborating with other schools (25%), for communicating with other students/teachers (22%), and for information retrieval (5%). Internet is used by teachers mainly for searching for teaching material and lesson preparation, e-mail communication, administrative and management tasks (each more than 85%). The Internet also serves for communicating with other teachers (35%), collaborating with other schools (32%), and communicating with students (14%).

C. End User Assessment

An end-user assessment of the network and the offered services has also been performed. A sample of 2910 teachers (Tables II and III) answered questions regarding their use of GSN services during the period from January 1, 2006 to May 30, 2006. The means for retrieving the information was a structured questionnaire, composed of open and closed questions (Fig. 8). The questionnaire was published through the GSN portal (<http://www.sch.gr/questionnaire>). GSN was evaluated by more than 33 categories of specialized personnel (Fig. 9). Table II presents age and gender characteristics of the sample.

According to the data obtained, 68.9% of the users indicated a desire to use only the GSN for network access. Connection frequency is "at least once a week" in 88.1% of the cases (88.9% for the 68.8% of the users who connect only through GSN). Of all users, 91.2% explicitly state that they use GSN for educational purposes (Table III).

In addition to the reasons listed in Table IV, users state that they use GSN for the reasons listed in Table V. Answers to explicit questionnaire questions asked show that 93% of the sample were aware of the existence of the GSN domain and the portal; 73% knew about the GSN help desk service; 49%

of them had actually used it. Dominant services are the e-mail and dial up service. The usage of the Web hosting service is also growing rapidly. From May 2005 to December 2006 the number of teachers' Web pages increased by 44%, from 1376 to 1981. Users were asked to evaluate services (Fig. 10) on a scale from 1 to 5 (poor to excellent). All services but GIS were graded by more than 50% of the users with a grade higher than 3. For the GIS service, the percent of users grading above 3 was 47.8%.

IV. CONCLUSION

GSN uses open-source solutions in the vast majority of the services provided. The statistical data on usage and user satisfaction presented above show that the service development and deployment model GSN is successful. The services implemented exhibit high levels of reliability, availability, and scalability. GSN maintains a thoroughly tested, reliable set of services. Users have welcomed GSN core services, and have made them popular during the last few years. GSN users are aware of the advanced, educational services offered, and they state that they use GSN for educational purposes. However, statistics show that advanced educational services' usage still remains moderate. GSN is offering a set of complementary, competitive educational services and expects to exploit the unprecedented dynamics of open-source software. Open source has been free and innovative since birth, but now that technological evolution has made typical work stations capable of hosting heavy logic, open source is also becoming highly competitive in service development. Thus, the expectation is that advanced educational services will follow core GSN services in quality and acceptance.

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