

Educational Technology



Digital Educational Infrastructure

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eLearning infrastructure - Contents



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Unless clearly stated, most material is taken from:

- Developing an Infrastructure for Online Learning Alan Davis, Paul Little & Brian Stewart, from "The Theory and Practice of Online Learning", Terry Anderson, AU press 2008.

Digital Educational/Learning Infrastructure/Tools

- Educational infrastructure: a suite of educational services, information systems, applications, and learning/teaching tools as well.
- As ICTs move on, educational technologists are trying to:
 - *create adequate platforms/systems/tools and*
 - *run educational/learning services*for satisfying the demands of online learning.
- Who is investing on such educational infrastructure/tools:
 - *Formal education realm (schools/universities)*
 - *Corporations/organizations offering non-formal (usually on-site training)*
 - *Informal training sites/social media infrastructures*



Online/Digital Education Platforms

- In online learning context, educational resources and activities, are implemented through technology-enriched environments.
- A common name for these environments is: (Digital or Online) *Educational (or Learning) Platforms*.
- Educational platforms: information systems / applications that usually provide digital services supporting educational procedures.
- Online education platforms are essential to online education activities.
- Different online education platforms serve their specific educational scenarios and may vary in characteristics and advantages.
- Most of them are delivered or organized over the Internet. Most known categories according to UNESCO^(*):
 - *Webcasting tools*
 - *LMS (Learning Management Systems)*
 - *MOOC (Massive Open Online Courses)*
 - *Communication skills*



Digital educational tools examples

- Authoring tool engines,
- Course managements tools,
- Specific educational purposes tools
- Game engines (serious game development)
- Simulation engines
- Virtual reality tools,
- Augment reality tools,
- Learning analytics tools,
- Intelligent tutoring tools,
- Assessment and evaluation software,
- Project management software
- Badges provision (gamification)
- Calendars, resource management,



Digital educational systems examples (offered in campus)

- Learning Management Systems
- SIS (secretary, lecturers, students, parents),
- Institutional portals (learners, lecturers, admin staff),
- Library services and digital repositories (educational resources, thesis, etc.),
- Booking resources and creation of course and exam timetables,
- Web 2.0 platforms (forums, blogs, social media, wiki etc.),
- Content creation tools (media management, authoring tools, gamification facilities, whiteboards, etc.)
- Web-conferencing platforms,
- Streaming media platforms,
- Remote lab infrastructures,
- Learning analytics environments,
- Administrative software (ERP, HRM, CRM, etc.)
- Authentication and Authorization Infrastructures (AAI), etc.



Digital educational platforms examples (offered in the net)

- Cloud educational services offered by internet/content providers or companies
 - *Online eLearning platforms, LMSs, video, authoring tools, web-conferencing, blogs, forums, etc.*
- Social media platforms
- Specialized tools (language learning, edu activities, etc.)
- MOOC platforms
- Online authoring tools
- eLearning platforms (for delivering courses)
- Personal Learning Environments/Networks
- Repositories (Learning Objects, OER, academic/research stuff, games)
- Assessment platforms
- Collaborative platforms



Three pillars of EduTech

- According to Dr. Terry Anderson in tertiary education, there are three main categories (pillars) of system that support eLearning:
 - *Learning management system (LMS), for providing structured formal teaching and assessment.*
 - *Social Media infrastructures for expanding the learning context to new places and new participants, and*
 - *Personal Learning Environments for creating high quality content, communicate effectively in multiple media and build personal and professional social capital.*

List of vendors of EduTech products and services

- In <https://teachonline.ca/> there is a comprehensive directory of 3,200+ vendors of online learning products and services.
- These products are grouped in 12 categories:
 - *Adaptive Learning Platforms*
 - *Additional Resources*
 - *Big Data Integration, Analysis and Reporting Tools*
 - *Consulting/Custom Development Companies*
 - *Course Authoring Tools*
 - *Generic (off the shelf) Online Learning Courseware Vendors*
 - *Learning Content Management Systems (LCMS)*
 - *Learning Management Systems (LMS)*
 - *Social Networking/Learning Tools*
 - *Student Information Systems*
 - *Unique*
 - *Virtual Classrooms*



Creating EduTech systems in institutions

- Day by day, digital learning systems are becoming more and more popular and complex in all educational environments.
- Unfortunately, in the market there aren't enterprise (total) solutions to choose from.
- Usually various separate products, components and services are offered/developed/installed without seamless integration.
- In-house customization for integration is expensive, with not always straightforward solutions and with increased risk of failure.

Developers must find ways to reduce the cost and complexity of system integration work while ensuring that their systems are built on a reliable and scalable architectures that are characterized by flexibility and interoperability.



What institutional systems?

- In institutional educational activities, usually, there are three major categories of software applications that should be connected and operate seamlessly:
 - *Applications for supporting learning, ranging from desktop authoring, quizzing and collaboration tools to larger server/web/cloud-based systems with capabilities for course, learning, content management, virtual class implementations etc.*
 - *Administrative systems for managing, users' directories, student information (grading), human and non-human resources, research project management, ERPs, accessibly etc.*
 - *Academic systems such as library information systems and digital repositories of research and educational resources.*



Building EduTech infrastructures in institutions

- In building ICT infrastructures for eLearning, various components and factors should be considered.
- Before start the development of an EduTech system, careful attention should be given on:
 - *the needs of the intended learners,*
 - *the curricula to be offered, and*
 - *the context for the institution.*
- There is no a straightforward checklist or a well-structured recipe to follow in developing such specific systems.
- Only wide- accepted methodologies suggested by “software engineering” area, are used.
- The selection/development, deployment, and ongoing performance of an eLearning platform it is challenging, and sometimes unsuccessful.



Factors to be considered for EduTech in institutions

- There are a lot of factors that should be considered on implementing digital infrastructures for education in institutions, including:
 - *planning,*
 - *structural and organizational issues,*
 - *system's components with integration issues (interfaces), and*
 - *various other issues (human resources, decision-making, training, etc.).*
- Scalability is another issue, as any developed infrastructure must be able to evolve in order to face changes on needs, technologies, and curricula.
- Further, many internal and external environmental factors should be considered, such as:
 - *competing priorities,*
 - *budget constraints,*
 - *faculty and student readiness,*
 - *professional bodies' requirements, and so on.*



Ideal versus real eLearning system

- The ideal online learning system is developed from scratch, with no restrictions on costs and staffing, and without bounds from previous practices.
- A real system, is characterized by any or all the following deviations from the ideal one:
 - *limited resources,*
 - *legacy systems that have loyal advocates,*
 - *key staff who must be retrained,*
 - *unworkable policies and practices that require reinvention,*
 - *inadequate governance processes,*
 - *back-end administrative systems (interfaceable or not), plus*
 - *an evolving understanding of new pedagogical underpinnings of EduTech.*
- A real system must also be able to change constantly, because curricula, learning technologies and teaching approaches evolve constantly.

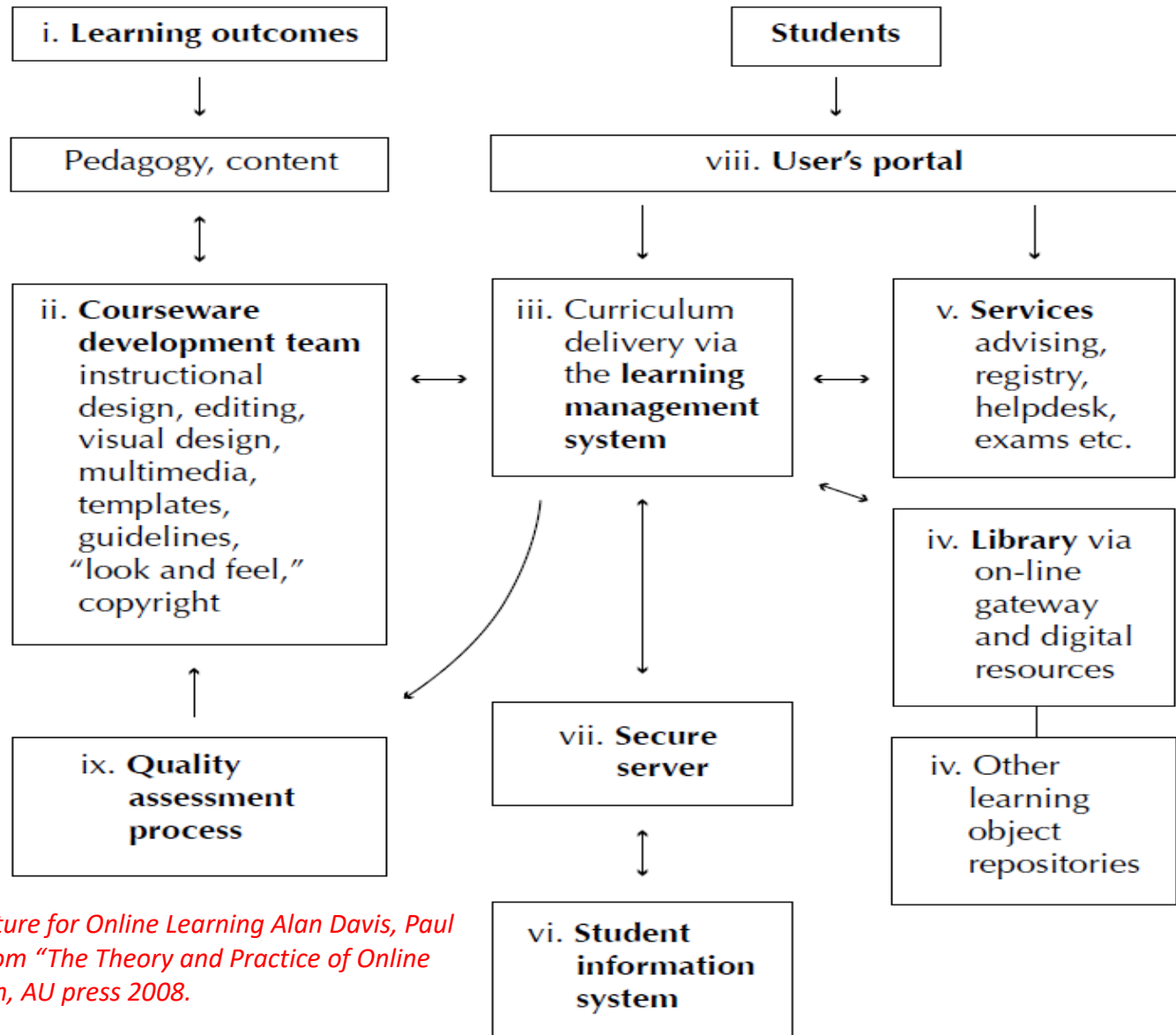


EduTech system context in institutions

- For an endeavor for employing an EduTech environment, each stakeholder: department, faculty, institution or company, must have its own mission, mandate, goals, and values that need to be considered during planning and designing faces.
- All EduTech systems should be designed having in mind:
 - *the needs of the intended students, and*
 - *the intended learning outcomes of the course or program.*
- Also, fundamental educational design perspectives are the size, scope, functionality, integration and scalability needed for an eLearning system.
- Even in universities, where the EduTech market is well understood and learning outcomes clearly defined or prescribed, the implementation of eLearning often involves a good deal of trial and error.



eLearning system rough framework

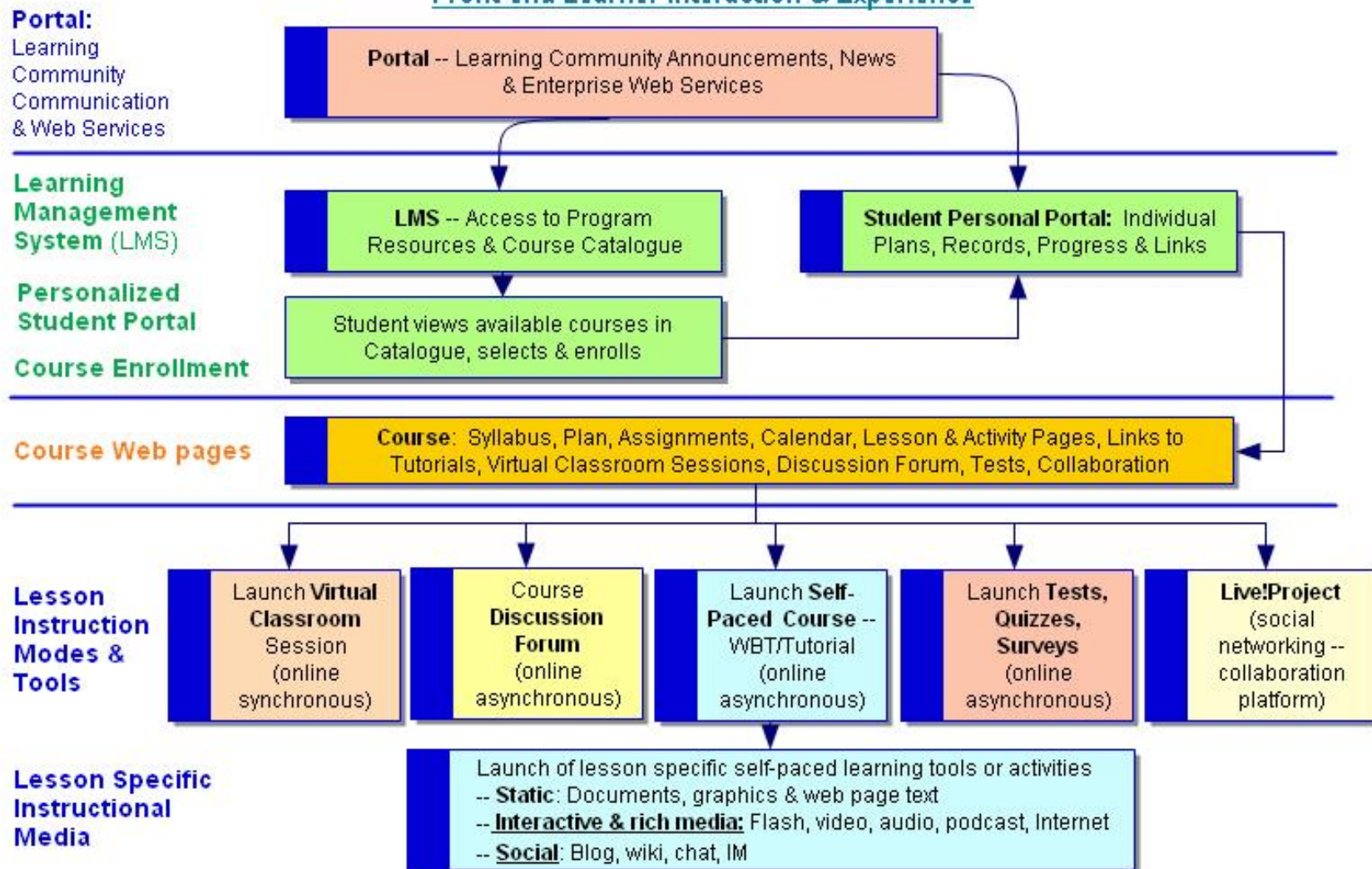


Developing an Infrastructure for Online Learning Alan Davis, Paul Little & Brian Stewart, from "The Theory and Practice of Online Learning", Terry Anderson, AU press 2008.

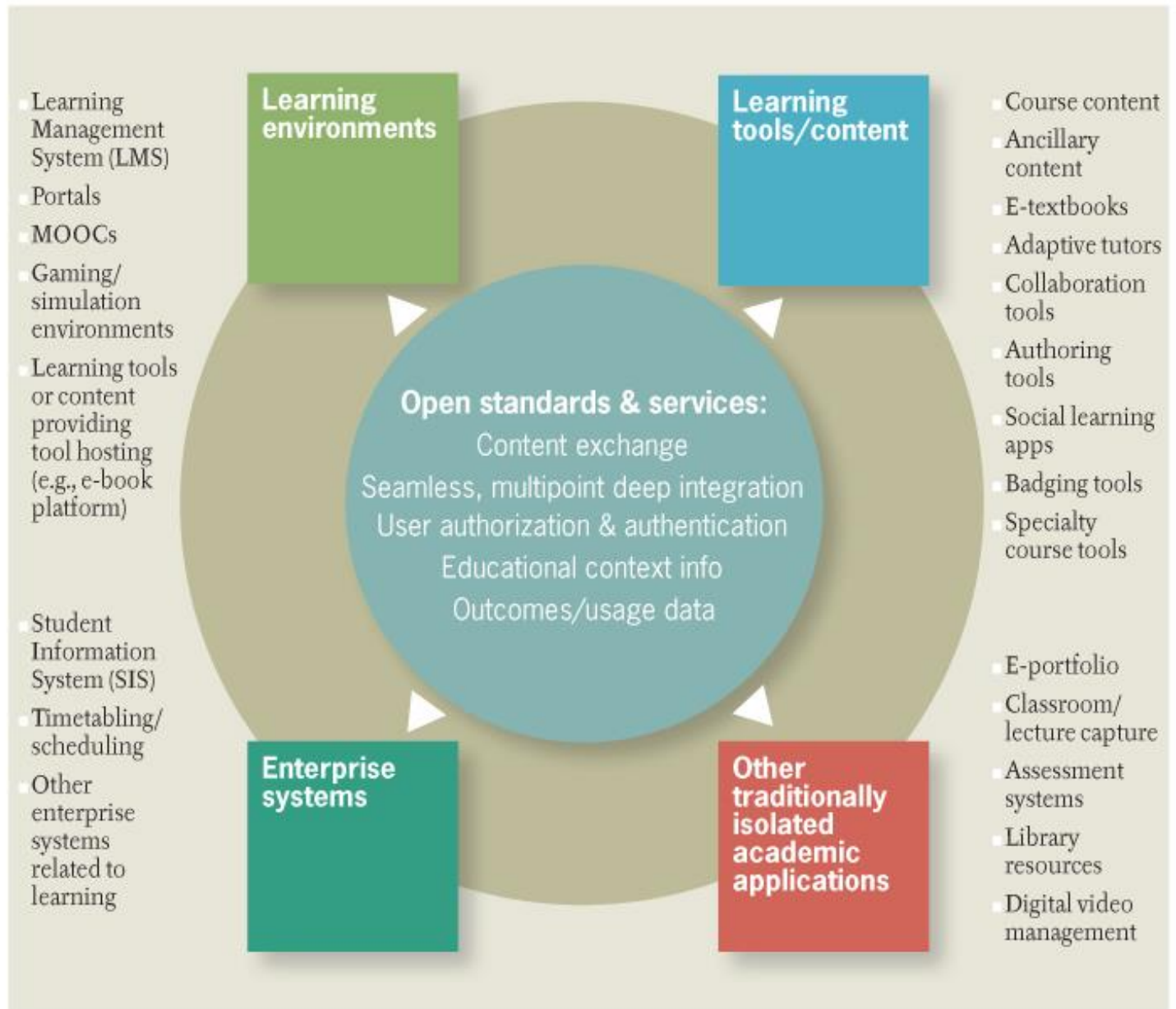
At least 4 layers of learner interaction

Virtual Learning Environments: Online software

Front-end Learner Interaction & Experience



A new architecture for learning^(*)



^(*)<http://er.educause.edu/articles/2013/10/a-new-architecture-for-learning>

Academic and administrative computing teams

- Usually, these teams are separated and functioning through different managerial units.
 - *Academic staff and systems need a lot of support and maintenance from the central administrative computing unit.*
 - *Administrative computing teams prefer a more centralized system, in order to improve integration, avoid duplication, ensure security, and minimize the divergent approaches and the subsequent complexity of support.*
 - *Academic computing staff prefer a more decentralized approach, with more freedom to innovate, and to choose platforms and applications that suit their specific needs and preferences.*
- The complexity of learning systems requires a jointly developed vision for the technological architecture that provides flexibility and sustainability for both groups.
 - *Separating the activities will ultimately compromise the ability of the organization to provide students with a responsive, flexible, and dynamic learning system.*
- Another issue is who really “owns” the discipline...



EduTech components for learning

- Development of courseware. *Determine objectives, target learner group, eLearning approach, content and pedagogy. Identify the synthesis of the development and delivery teams.*
- Learning Management System (LMS). *Key decision. Commercial (proprietary), in-house development or open source? Also, insufficient technical helpdesk and training could have negative impacts. The costs of changing systems is very high, despite the efforts to develop standards for interoperability and reusability.*
- Content Management System. *A CMS will provide the functionality for the creation, collaboration, production, and publishing of learning materials. Ideally, the e-course delivery will be seamlessly provided through the LMS.*
- Library and Digital Resources. *Linking the e-course to the necessary online resources is crucial element. Institutional libraries are used to acquire and share resources (in house or external repositories). Issues on knowledge management and intellectual property.*

EduTech components for learning (continued)

- Learner Services. *Very vital issue. Concerns technical help, educational advising, various forms of counselling, services for learners with special needs, etc.*
- Student Information System. *Ideally an LMS is linked to SIS so that the right learner is automatically placed in the right course at the right time with all the right student information easily available to the right instructor. Very rare in real situations.*
- The User's Portal. *The portal should allow the stakeholders, to access seamlessly the LMS, SIS, library services and any other related services. Personalization-community issues.*
- Quality Assessment. *An eLearning system should include a plan for the independent evaluation of all aspects of the system (specially to state the achievement of the stated learning outcomes and system's return on investment).*
- Authentication and authorization (AAI). *Provide secure login through identity management infrastructures (Single Sign On, LADP and CAS).*



Issues on hardware and policies

- Hardware infrastructure (servers, storage capacity, high-bandwidth connectivity, UPSs, switches, etc.) should be under ever-increasing demands and be estimated up and balanced correctly.
- Connectivity will need to be estimated routinely adjusted as the number of users grows and the system evolves to more demanding applications (videoconferencing, VoD, streaming).
- Expectations for up-time (usually 24 hours, seven days a week) and streaming (voice/video) demands will be increasingly used routinely in future.
- Polices related to access to servers, security, and the use of the online learning system need to be in place, to balance the need for stability and security with the need to innovate.
- Similar issues exist in outsourcing solutions.



Issues on supporting and hosting

- Technical support services should be organized for maintaining the eLearning system and its subsystems in terms of effective running, proper customization, backups and routine software updating.
- Helpdesk services (for training & user support) needs to be in place, possibly linked to a training, orientation, and documentation function, which can provide support to students and staff on the online learning system.
- Decisions for:
 - *Hosting:*
 - *internal (flexibility, security, responsiveness) or*
 - *external / outsourcing (quicker, no need for ICT support)*
 - *Open-source options.*

Factors on implementation

- Change management is important for all stakeholders who will be accessing the system.
- Timelines estimation (requirements, specifications, build infrastructure, configuring, customization, testing, firing).
- What technologies are required?
- Decision for hosting (external-internal). How?
- Customization. Maybe expensive and it could delay the implementation process significantly.
- Integration (LMS, registration systems, SIS, library or data management systems, and/or HR systems).
- Planning supporting (updates, troubleshooting, helpdesk).
- Training for instructors and students.
- Data transition from the old to the new system.



SaaS or SaaS (School as a Service)

- For educational institutions, building online programs can be an expensive and daunting task.
- Many institutions lack start-up costs, knowledge and resources to execute effectively.
- Last decade, a growing number of companies designed to help traditional educational institutes manage the challenges of developing and maintaining online programs has emerged.
- These companies have expertise in program design, IT support, implementation of educational services and marketing.
- They can effectively build and manage online programs for their partners from the ground up.
- Partner institutions remain focused on the pedagogical side of online learning.

Human resource issues

- The deployment of an eLearning system does not only focus on processes, but also on how human resources function.
- Changes on the working conditions mostly in terms of the place and time (beyond the normal working day).
- Constantly shifting nature of the work that staff undertake.
- Re-arrangements on the traditional approaches for hiring, employment contract terms, promotions, position classification, access to training and professional development.
- Also, the eLearning system itself should inspire new types of flexible training for staff, with inter-institutional and intra-institutional support groups and learning communities.
- Care must be taken for balancing between those who know and understand a lot, technical staff who directly support the online system, the central administration and the users (lectures and students). Very important: evaluation process.



Other related issues

- Organizational Change. *The organization's capacity and capability of effectively managing change is of vital importance.*
- Leadership. *Effective change starts with leadership. Having the right attitude towards change, its importance and value, is essential.*
- Awareness about emerging technologies. *Some staff, as part of their work, must look around for emerging trends and ideas and provide a place for others to feed information they come across.*
- Governance. *A governance body is needed that deals with current issues related to online systems and revisits the vision for the online learning system regularly.*
- Communication. *All stakeholders must be aware of what is going on and communication at all levels of the organization is necessary.*
- Pilot Projects and Evaluation. *Use of pilot projects for new developments. Effective evaluation of their impact before proceeding to wider adoption*
- Change Management. *New ideas and approaches must be fostered, by financial and in-kind resources.*

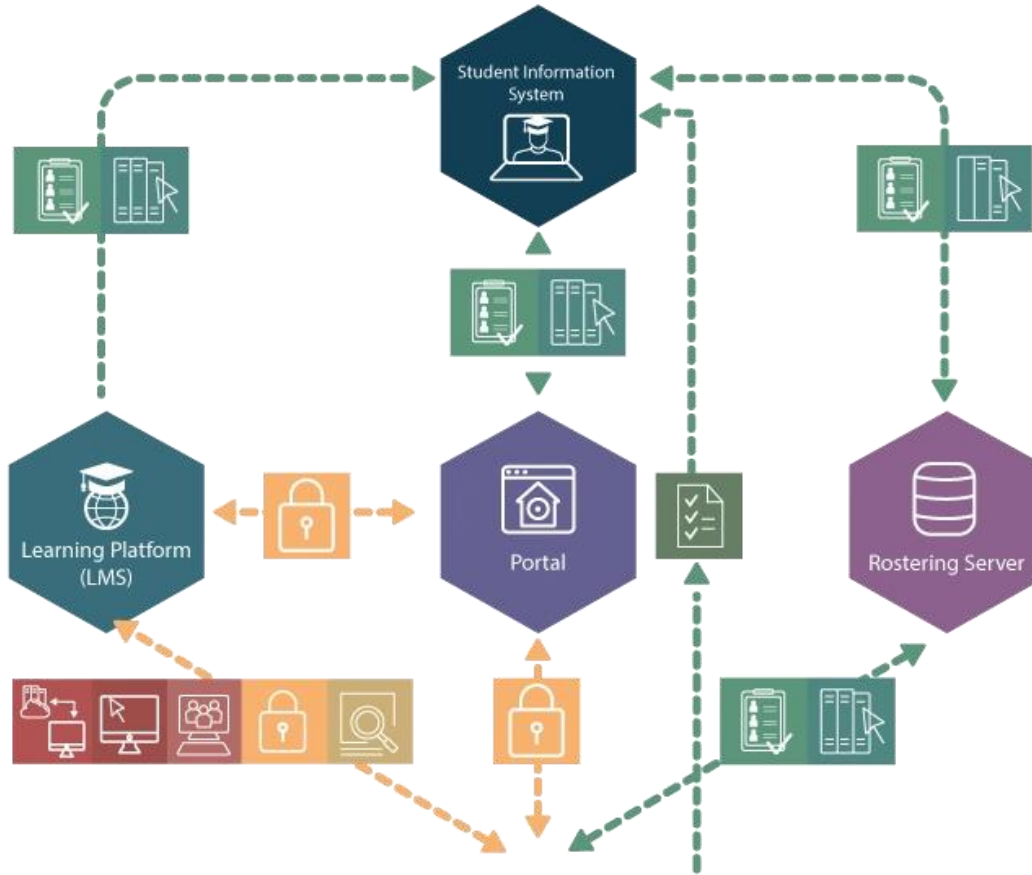


Standards for e-learning system' s architectures

- Various standards have been designed to propose eLearning systems architectures and promote interoperability among learning content and e-learning systems. They are gaining acceptance worldwide.
- The purpose of these standards is to discover high-level frameworks for understanding certain kinds of systems, their subsystems, and their interactions with related systems.
- Such standards are:
 - *IMS Learning Information Services (LIS),*
 - *IMS Learning Tools Interoperability (LTI),*
 - *OKI Open Service Interface Definitions (OSIDs), Open Architecture and Schools in Society (OASIS), IMS Enterprise Services, IEEE LTSA.*



1EdTech ecosystem (based on LTI[®] and OneRoster[®])



OneRoster and LTI Advantage support the launch and secure flow of data to any learning platform, tool, or app used in your district IMS standards are flexible to meet your evolving needs.

OneRoster

Add efficiency by automating tasks from your SIS to platforms, tools, and apps



Rostering

Automate rostering from the SIS for platforms, tools, and apps through syncing



Resources

Automate assigning resources to users based on roles



Gradebook

Sync grades from the LMS gradebook with the SIS gradebook



Assessment Results Profile for Gradebook Service

Sync assessment scores, necessarily tied to a course, with the SIS gradebook

OneRoster

Bringing secure launches rich digital resources and real-time data together in your LMS or better student outcomes



Names & Role Provisioning Services

Add users to tools and apps in an LMS course in real-time



Deep Linking

Add content from third-party tools to a course in the LMS in real time



Assignment & Gradebook Services

View scores from tools and apps in real-time in the LMS gradebook



LTI 1.3

Ensure secure launches with the new IMS Security Framework



LTI 1.3

LTI Resource Search defines how to search digital repositories for a set of resources

Personal data protection rationale in eLearning

- With the advance of the globalization of online education, the personal data security (learners and educators) on online education platforms has increasingly become a major concern and one of the most challenging issues.
- Personal data privacy and protection is part of human rights as declared in the Resolution 68/167 adopted by the United Nations (UN) General Assembly:
 - *unlawful or arbitrary surveillance and/or interception of communications, as well as unlawful or arbitrary collection of personal data, as highly intrusive acts, violate the rights to privacy and to freedom of expression.*
- In this context, personal data of school students, most of whom are children, demand particular attention and more accurate measures.
- More and more countries and regions are adopting comprehensive regulations on personal data privacy and protection with regard to students and teachers.



Personal data terminology (EduTech context)

- **Personal data:** the information that relates to an identified or identifiable individual.
- **Student's Personal data:** the information that relates to a specific student, including students' Personally Identifiable Information (PII), contact information such as school, grade, class, and home address, learning behavior information such as academic performance, test scores, student files, and platform access information, etc.
- **Guardian's Personal data:** the information that relates to the guardian of a student, including his or her Personally Identifiable Information (PII), relevant information about related students, and platform access information, etc.
- **Teacher's Personal data:** the information that relates to the teachers of the platform, including his or her PII, contact information (position, school, grade, class, and home address), teaching information (courses taught, courseware, knowledge points, and platform access information), etc.



Security Properties and Measures (ISO/IEC standards)

- **Confidentiality:** Property that information is not made available or disclosed to unauthorized individuals, entities, or processes. [ISO/IEC 27000:2018]
- **Integrity:** Property whereby data have not been altered in an unauthorized manner since they were created, transmitted or stored. [ISO/IEC 29167-19:2019]
- **Availability:** Property of being accessible and usable upon demand by an authorized entity. [ISO/IEC 27000:2018]
- **Authenticity:** Property that an entity is what it claims to be, which can be achieved by means of password, digital signature, biometrics and multi-factor authentication, etc. [ISO/IEC 27000:2018]
- **Non-repudiation:** Ability to prove the occurrence of a claimed event or action and its originating entities. [ISO/IEC 27000:2018]
- **Access control:** Means to ensure that access to assets is authorized and restricted based on business and security requirements. [ISO/IEC 27000:2018]



Security Risks of Personal Data (EduTech context)

- The operation of an educational system may cause security issues concerning personal data.
- Personal data related to online education platforms mainly faces security risks of the following three aspects:
 - *Technical Risk. Insufficiency, incompetence and misuse of employed security technologies.*
 - *Management Risk. The lack of security awareness can cause collection of users' personal data without consent, failure to protect lifecycle data and absence of proper disaster recovery measures.*
 - *User Operational Risk. Users might use weak passwords or fail to properly protect passwords and other authentication methods.*
- These may cause security issues such as thefts and integrity violations of personal data, unauthorized data destruction, and impersonation fraud, which further brings reputational damage, mental injury and financial loss to platform users.



Recommended Technical Solutions (1)

- **Data Collection.** It should comply with the security principles and provide classification and category of the data according to data attributes. The platform should have the consent or authorization of a guardian when collecting and using information of students.
- **Data Transmission.** The platform should establish an appropriate protection mechanism in the process of data transmission and use network security protocols and recommended cryptographic algorithms.
- **Data Usage.** Platforms should provide unified rights management to ensure that users apply and access relevant data on demand. It should also provide comprehensive security monitoring and access auditing measures for the use and access of relevant data, as well as PII protection mechanisms.
- **Data Storage.** It should comply with the security principles and have the capabilities of high availability, data backup and disaster recovery mechanisms.
- **Data Destruction.** Data removal and physical destruction should be carried out in accordance with relevant standards to avoid the risk of data leakage.



Recommended Technical Solutions (2)

- **Communication Network.** Deployment of proper control measures for protecting or protect the network transmission security (link redundancy, network intrusion detection, anti-virus, network security audit, authentication, encryption, intrusion detection)
- **Computing Environment.** Platforms should ensure the security of the platform computing environment (middleware, Operating System, Application, Database etc.)
- **Access Control.** Compliance to standards for account management, authentication, rights management, behavior audit, etc.
- **Cryptographic Algorithms and Protocols.** Platforms should adopt the cryptographic algorithms and protocols recommended by the cryptographic standards
- **Key Management.** Platforms should strictly manage the keys to ensure the security throughout the keys' lifecycle (ISO/IEC 11770).