Improving learning through smart learning analytics

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Designing Adaptive and Personalized Learning Environments

By Kinshuk

Routledge – 2016 – 200 pages

Series: Interdisciplinary Approaches to Educational Technology

Designing Adaptive and Personalized Learning Environments provides a theoretically-based yet practical guide to systematic design processes for learning environments that provide automatic customization of learning and instruction.

The book consists of four main sections: In "Introduction and Overview," the concepts of adaptivity and personalization are introduced and explored in detail. In "Theoretical Perspectives with Example Applications," various theoretical concepts underlying adaptive and personalized learning are discussed, including cognitive profiling, content-based adaptivity, exploration-based adaptivity, and mobile and ubiquitous settings. In "Practical Perspectives with Example Applications," the implementation process for adaptive and personalized learning environments is described, followed by application in various contexts. In "Validation and Future Trends," various evaluation techniques for validating the efficiency and efficacy of adaptive and personalized learning systems are discussed. This final section concludes with a discussion of emerging trends in adaptive and personalized learning research.

Based on cutting-edge research, Designing Adaptive and Personalized Learning Environments is appropriate as a primary textbook for both undergraduate and graduate courses focused on the design of learning systems, and as a secondary textbook for a variety of courses in programs such as educational technology, instructional design, learning sciences, digital literacy, computer based systems, and STEM content fields.

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Current trends in learning

• Inclusive education
• Focus on individual strengths and needs
• Various learning scenarios – in class and outdoor environments
• Relevance of the learning scenarios with learners’ living and work environments
• Authentic learning with physical as well as digital resources
• Result: better learning experience
Vision

~ Learning omnipresent and highly contextual ~

seamless integration of learning into every aspect of life

which implies

immersive, always-on learning

that happens so naturally and in such small chunks

that no conscious effort is needed

to be actively learning while engaged in everyday life
Smart learning analytics

Discover, analyze and make sense of student, instruction and environmental data from multiple sources to identify learning traces in order to facilitate instructional support in authentic learning environments.
Discover

*Past record and real-time* observation of:

Learner’s capabilities, preferences and competencies
Learner’s location
Learner’s technology use
Technologies surrounding the learner
Changes in learner’s situational aspects
Analyze

Learner’s actions

Interactions with peers and instructors

Interactions with physical objects

Interactions with digital information

Learner’s trends of preferences

Changes in learner’s skill & knowledge levels
Making sense: Learning traces

A learning trace comprises of a network of observed study activities that lead to a measurable chunk of learning.

Learning traces are ‘sensed’ and supply data to learning analytics, where data is typically BIG, un/semi-structured, seemingly unrelated, not quite truthful, and fits multiple models and theories.
Why learning traces are important?

Different students can adopt different learning approaches for the same learning activity!

Ex: Why a pointed object penetrates better than a blunt object?

- A visual-oriented learner may choose to see this in action and explain the results
- A psychomotor-oriented learner may take a sharp pencil and test it against his/her palm to explain the results
- A cognition-oriented student may workout the mathematics behind pressure to explain the results
Examples of Smart Learning Analytics
- Empowers organizations in the energy industry to train and recertify their operators in standard and emergency operating procedures.
- Tracks the knowledge and behavior of operators through highly-monitored multiple-choice questionnaires.
- Provides a dashboard to view the operators’ proficiency and performance in every step of an operating procedure.
- Gives organizations the ability to manage and optimize knowledge assets and human capital.
An immersive training and testing environment using techniques and technologies such as augmented reality and game development environments.

Provides trainees with multimedia lessons which may include video and audio clips, animations, interactive maps, and customized learning activities.

Captures all users’ interactions with both the physical and virtual worlds and delivers customized feedback to trainees.

Applies to any domain requiring the application of knowledge in the real world.
Augmented Reality Testing | Training Environment
- Tracks programmers’ interactions with coding tools.
- Records coding habits such as debugging and testing strategies.
- Monitors the problem-solving process underlying the development of a program.
- Analyzes the functionality of a program.
- Recognizes techniques employed by programmers.
- Provides metrics to assess the proficiency and performance of programmers.
- Supports the customization of the techniques assessing programmers.
We now have the capacity to observe study habits of students working on similar problems from around the world, at real time.
Students do undergo complex study tasks and in most cases do not receive immediate help.
A student writes code & reviews errors

Teachers do not have the opportunity to see the types of errors students faced while writing code!! We now have the technology to address this issue.
A top student solves a similar problem

Students (or teachers) can show/analyze real-time study habits of students from around the world. Since the initiative comes from students, they get a global perspective on learning, and also engage teachers in similar perspectives.
CODEX
CODing EXperiences
- A learner-centric dashboard with visualizing and reporting capabilities.
- Enables learners to access their learning outcomes in a single place.
- Embeds tools which learners can use to reflect and provide feedback about learning activities they just completed.
- Includes predefined queries, visualizations, and reports such as the development of a student’s proficiency and performance.
- Provides tools to select the learning data from which to view personalized results.
Welcome to our Learning Analytics System

**CODEX**

Coding Experiences

CODEX is a NetBeans learning analytics plugin that will enable you to track your coding experiences as you go through your various software engineering activities. CODEX will also capture seamlessly in real-time the development of a particular program's code, the time taken to solve a particular problem, the number of times a particular program has been compiled, and the errors generated at each compilation. CODEX will guarantee through state-of-the-art technologies that the integrity of your learning experiences is preserved during SCALE analysis.

**SCALE**

Smart Competence Analytics on Learning

SCALE is a smart competence analytics technology that analyzes your learning experiences in programming. SCALE basically transforms your learning traces into measurements that will help you assess how proficient you are in the concepts introduced in your programming course. SCALE will also allow you to evaluate how confident you are at solving a particular programming exercise and how confident you are in the overall learning domain. SCALE's mission is to provide you with a scale that will help you see and optimize your learning as it occurs.

**Mi-DASH**

Mixed Initiative Dashboard

Mi-DASH is a learning analytics dashboard that will allow you to visualize and monitor your proficiency and confidence levels in programming. Mi-DASH will enable you to view your competence portfolio as well as your current level of confidence as you work through each activity in your course. You will also be able to view the progression of your proficiency in a particular competence over time and the progression of your confidence level over time for every learning activity as well as for the overall programming domain. Enjoy!

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Please contact us with any questions you may have at scale.webmaster@outlook.com
A tool to help students manage, structure, and engage in coursework in a disciplined way.

Teaches students effective learning habits by encouraging initiatives and goal-setting among learners.

Enables students to know more about themselves by identifying strengths and weaknesses in specific skills.

Identifies students’ learning needs and offers solutions by bringing together students in needs with those who previously went through the same challenges.
LEARNING INITIATIVE DESIGN

Helps the learner choose goals, decide on strategies

Makes the regulation process explicit

Provides hints and support for indecisive learners

Tutorials are included in both embedded and independent forms
Real-time monitoring of learner activities
Immediate learner feedback on goal progress
Educators may monitor learner progress with the same mechanisms
Initiative goals may be edited to allow for progressive initiatives
NEW VIRTUAL CLASSROOM DYNAMICS

Chat system allows immediate learner interactions
Educators may form learner groups with shared initiatives
Educators may assign default initiatives for all learners, to provide easy-to-identify goal examples
Students will see their learning as competency progression instead of assigned grades.
Educators may create shared initiatives for specific learners to address specific deficiencies. Shared initiatives allow educators to pair needy learners with skillful ones, or to group needy learners together into work teams. Learners may form these groups independent of educator actions, or may request the help of more skillful learners.
Self- and Co-Regulated Learning
For Students
Assesses the writing skills of its users both at the English level and at the content level.
Tracks the evolution of a composition at very fine-grained levels.
Tracks spelling and grammar errors and the corrections made by a student along the way.
Records the formation and flow of topics within paragraphs.
Provides feedback on how to improve the quality of a piece of writing and one’s efficiency.
MUSIX stands for MUSIc eXperiences.
MUSIX enables learners and teachers to reflect and regulate on music-oriented data and instruction.
“The Music Analytics pedagogy prototype that targets a single competency will allow the administrator and the music pedagogue to estimate the value of information obtained from the music analytics system. The prototype will develop a pedagogy dashboard with which music teachers can plan their instruction based on the Wirth method.”
Memoo is Mechanical Moods, a multiple-media sentiment analytics engine.
JFlapEx is for analyzing learner interactions on Formal Languages.
xDesign is for analyzing learner interactions on Experimental Designs.
SDLeX is for analyzing learner interactions on Self-Directed Learning environments.
MHADS is for analyzing learner interactions in Healthcare Analytics in the domain of Attention Deficiency Syndrome.
Synthetic Biology Analytics is an educational and training tool for synthetic biology in genome sequence assembly, bioinformatic analysis, biochemical pathways, and gene expression analysis. Uses techniques similar to the ones used in learners’ text interactions.
P-PSO is a parallel particle swarm optimization algorithm adopted in LAMBDA.
GIOIA is for analyzing semantics on algorithms to cluster and classify large volumes of datasets.
RPA is a tool to analyze research publications.
TADA is a tool for Traffic Analytics with Data Accretion, a brand new tool/technique being proposed that allows learners to contextualize sensor data from physical objects with sensor data from personal data.
Interview Mastery Analytics is a system that simulates an online interview environment, conducts a simulated interview, observes the response of the candidate, offers feedback, and allows reflection/regulation opportunities to the candidate.

ListenEx is an environment where learners can listen to utterances and respond to follow-up questions to measure their level of listening comprehension. Moreover, the system measures the time intervals between the question and the answer, as well as, the quality of responses.

MUSIX is a tool to explore and research ways to enhance the experiences of musicians by means of technology.

ReadEx is a reading analytics tool tracking the ability of the learner to read and understand the content, the speed with which reading comprehension happens, and the relation between reading comprehension and working memory.

SpeakEx is a speaking analytics tool that parses translated written material arising from speech utterances and presents a scaffolded dashboard to provide feedback, reflection, and regulation opportunities to learners. The types of feedback include grammar-based feedback, feedback on the pacing of the speech, feedback on the breaks in speech, and identification of misspoken words.
Learner awareness

Personalization of learning experience through dynamic learner modeling

• Performance
• Meta-cognitive skills
• Cognitive skills
• Learning styles
• Affective state
• Physiological symptoms
Technology awareness

Personalization of learning experience through the identification of technological functionality

- Identifying various device functionality
- Dynamically optimize the content to suit the functionality

Display capability, Audio and video capability, Multi-language capability, Memory, Bandwidth, Operation platform
Location awareness

Personalization of learning experience through the use of location modeling

- Location based optimal grouping
- Location based adaptation of learning content
Location based technologies

- Manual Sensing
  - Barcode
  - QR code
  - Post Code
  - Address

- Auto Sensing
  - Tagging RFID
  - Map (e.g., Google Map)
  - WiFi
  - GPS
  - Cell ID
  - Bluetooth
  - Active RFID

- Position Identifier

- Database
- LBS Application

- Sensor Performance
  - Manual Sensor
  - Auto Sensor

- Environment
  - Outdoor
  - Indoor
Location aware dynamic grouping

Location Grouping
Mobile Learner’s Address
Mobile Learner’s Cellular Data
Mobile Learner’s GPS Coordinates
Mobile Learner’s Other Location Info

Mobile Virtual Campus
Mobile Learner’s Learning Profile
Mobile Learner’s Learning Style
Mobile Learner’s Learning Interests
Real-life physical objects

Personalization of learning experience as per surrounding environment

- Public databases of POIs
- QR Codes
- Wi-Fi & Bluetooth Access Point identification
- Active and Passive RFIDs
Surrounding awareness

Personalization of learning experience through the use of surrounding context

• Identifying specific context-aware knowledge structure among different domains

• Identify the learning objective(s) that the learner is really interested in

• Propose learning activities to the learner

• Lead the learner around the learning environment
Skills and knowledge level detection

Competency level
Confidence level
Mapping learning outcomes to specific skills
Mapping learning outcomes to specific skills
Teacher’s dashboard

Teacher’s dashboard shows individual and group progress. Teachers receive triangulated data that explains issues faced by students.
Parents checking-in
Analytics data from a variety of sources
How to do effective learning analytics

Learning Analytics is a *soup* of:

- content
- learning theories
- styles
- pedagogies
- instructional designs
- learner capacities
- institutional reputation ...

How to prepare a *cup of soup* to the liking of each student/teacher/administrator/industry with custom flavour, taste, consistency, ...?

This is where learning analytics specifications, emerging standards, come into play.
Caliper Framework Architecture
Provides a unified learning analytics platform in which learning experiences can be sensed, analyzed, and reported.

Standardizes the generation, transmission, and interpretation of learning events.

A suite of tools empowering students to manage not only what they learn but also why they learn and how they learn.

Links isolated datasets together to form a clearer and broader picture of the learner and his/her context.

Reports data from a wide range of learning domains including programming, math, writing, etc.
• Analyzes students’ learning artifacts (such as a composition, a piece of software, mathematical calculations, etc.) and lists the skills displayed by the student and how proficient the student is in each skill.
• Assesses students’ behavior in problem-solving processes and reports student's performance and confidence.
• Identifies and classifies students as good, average, and at risk.
• Enables students to compare themselves against classroom’s average and anonymized top students.
• Customizable for any learning domain and any course.
References

- Learning Measurement for Analytics (http://www.imsglobal.org/IMSLearningAnalyticsWP.pdf)
- What is the Tin Can API? (http://tincanapi.com/overview/)
- What is a Learning Record Store (LRS)? (http://tincanapi.com/learning-record-store/)
- Layers of the Tin Can Onion (http://tincanapi.com/the-layers-of-tin-can/)
- Learning Tools Interoperability™ (http://www.imsglobal.org/toolsinteroperability2.cfm)
- IMS Question & Test Interoperability Overview (http://www.imsglobal.org/question/qtiv2p1/imsqti_overviewv2p1.html)
- IMS Global Learning Information Services Specification Primer (http://www.imsglobal.org/lis/lisv2p0p1/LISSpecPrimerv2p0p1.html)
Thank you!

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