

ADAPTIVE LEARNING INFLUENCE IN EDUCATION

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Abstract:*In the field of education, and special, in the field of educational technology the term “adaptive learning” is now consecrated like one of its many aliases: adaptive instruction, adaptive hypermedia, computer-based learning, intelligent tutoring systems, computer-based pedagogical agents...At the most basic level, adaptive learning is the notion that computers and their software can improve educational outcomes. So, can we say that has the potential to revolutionize education?*

Key words: *education, educational outcomes, educational technology, adaptive learning.*

Being an important social component of the life, *education* is now a phenomenon which arouses a lot of debate all around of the world. As we know, from etymological point of view the word “*education*” is derived from the Latin *ēducātiō* (“A breeding, a bringing up, a rearing”) from *ēdūcō* (“I educate, I train”) which is related to the homonym *ēdūcō* (“I lead forth, I take out; I raise up, I erect”) from *ē-* (“from, out of”) and *dūcō* (“I lead, I conduct”).⁶⁴

Education in its general sense is a form of learning in which knowledge, skills and attitudes / habits / mentalities of a group of people are transferred from one generation to the next through teaching, training, research, or simply through “learning on your own” or “by yourself” named auto-didacticism.⁶⁵ Generally, it occurs through any experience (which comprises knowledge of or skill of something or some event gained through involvement in or exposure to that thing or event) that has a formative effect on the way one thinks, feels, or acts.

Educational process, as we know, can take three essential forms: *formal, non-formal and informal*. We will refer only at formal education, here. *Formal*

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⁶⁴ <http://en.wikipedia.org/wiki/Education>

⁶⁵ Dewey, J., (1916/1944). *Democracy and Education*. The Free Press. pp. 1–4. [ISBN 0-684-83631-9](https://doi.org/10.1080/00220273.1916.10558461).

education is performed by specialized institutions following National Curricula, Syllabi and accredited methods of evaluation, having the purpose to fulfil educational ideal through the general and specific objectives of the educational system, and, in the mean time, for each cycle of study, programme of study, discipline/subject or a discipline module. Study programme, discipline/subject or a module, in its design, involves formulating the *learning outcomes* which can be measured.

Learning outcomes are the specific intentions of a programme, discipline/subject or module, written in specific terms. They describe *what a student should know, understand, or be able to do at the end of that programme, discipline/subject or module*. Learning outcomes are written bearing in mind the educational standards for that level or award.

Given the incredible development of computer technology and software is no wonder that concepts of education in general and learning in particular are changed, are modelled and structured, evolving like the other sciences. Is no doubt that the terminology for learning process which involves IT is *educational technology!*

Educational technology relies on a broad definition of the word „technology”. Technology can refer to material objects of use to humanity, such as machines or hardware, but it can also encompass broader themes, including systems, methods of organization, and techniques. Some modern tools include but are not limited to overhead projectors, laptop computers, and calculators. Newer tools such as „smartphones”, „iPad”, and games (both online and offline) are beginning to draw serious attention for their learning potential.

Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources.⁶⁶ The term educational technology is often associated with, and encompasses, *instructional technology*.

While *instructional technology* is „*the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning*” according to Garrison and Anderson⁶⁷, *educational technology includes other systems used in the process of developing human*

⁶⁶ Richey, R.C. (2008), *Reflections on the 2008 AECT Definitions of the Field*. TechTrends. 52(1) 24-25

⁶⁷ Garrison, R., D., Anderson, T., (2003), *E-learning in the 21st Century: A framework for research and practice*. Routledge. ISBN 0-415-26346-8.

capability. Educational technology includes, but is not limited to, software, hardware, as well as Internet applications, such as wiki's and blogs, and activities. But there is still debate on what these terms mean.⁶⁸

“Children and young people are growing up in a vastly changing context. No aspect of their lives is untouched by the digital era which is transforming how they live, relate and learn”⁶⁹. Some examples of these changes in the classroom include:

- Problem Based Learning (PBL) - is a student-centered complex method in which students learn about a subject through the experience of problem solving;
- Project-based Learning (PbL) - is an instructional method that provides students with complex tasks based on challenging questions or problems that involve the students' problem solving, decision making, investigative skills, and reflection that includes teacher facilitation, but not direction;
- I(E)nquiry-based Learning (IbL) – describe approaches to learning that are based in the idea that when people are presented with a scenario or problem and assisted by a facilitator, they will identify and research issues and questions to develop their knowledge or solutions.
- *Adaptive learning* (AL) – is an educational method which uses computers as interactive teaching devices. Computers adapt the presentation of educational material according to students' learning needs, as indicated by their responses to questions and tasks. The motivation is to allow electronic education to incorporate the value of the interactivity afforded to a student by an actual human teacher or tutor. B.F. Skinner created the original adaptive learning teaching machine back in the 50's while working at Harvard.

Together they are active learning (an umbrella term that refers to several models of instruction that focus the responsibility of learning, on learners) educational technologies used to facilitate learning. All four are student centered, ideally involving real-world scenarios in which students are actively engaged in critical thinking activities.

⁶⁸Lowenthal, P. R., Wilson, B. G. (2010). Labels *do matter!* A critique of AECT's *redefinition of the field*. TechTrends, 54(1), 38-46.

⁶⁹Craft, A. (2012), *Childhood in a Digital Age: Creative Challenges for Educational Futures*. London Review of Education, 10 (2), 173-190

Adaptive learning – that means adaptive instruction, adaptive hypermedia, computer-based learning, intelligent tutoring systems, computer-based pedagogical agents etc – is not only “a fashion” into the educational field but is a real way which improves learning process, based, obviously to IT and its instruments.

At the most basic level, *adaptive learning is the notion that shows how computers and their software can improve educational outcomes*. From this point of view, adaptive learning makes content dynamic and interactive, placing the student at the centre of his or her individual learning experience. Having a large scale of instruments, adaptive learning put the students into different and diverse learning situations.

Adaptive learning, which influences positively the education, could be provided in asynchronous and/or synchronous mode.

In asynchronous mode, thinking only at a *learning platform as an adaptive learning instrument*, we can observe how the student interacts with the system and learns, leveraging the enormous quantities of data generated by a student’s online interactions with ordinary (textbook, handouts, guides etc.) and extraordinary (games and social-media) content, with teachers and peers, and with the system itself. It assesses not only what a student knows, but also determines what activities and interactions, developed by which providers, delivered in what sequence and medium, most greatly increase the possibility of that student’s academic success and confirming fulfilment of the learning outcomes. Fear of online and computer-based educational approaches often stems from a misguided belief that these approaches will reduce teacher-student face time. In fact, the opposite is true. The platform frees up classroom time, allowing teachers more time to engage students directly. Individualized student data allows for more meaningful teacher-student interactions.

The adaptive learning platform provides a current snapshot of the student, coupled with the diagnostic information and recommendations so critical to improvement, while there is still time to help. Forget end-of-lesson/chapter/term/year assessments that reveal deficiencies without providing information or opportunities to remediate. This information is presented while lessons are still underway – giving students and teachers the data they need to act and improve, immediately.

*Adaptive Learning provides content and services to meet individual or group learning needs with improved learning achievement and efficiency*⁷⁰. Adaptive

⁷⁰ <http://www.trainingplace.com/source/research/adaptivelearning.htm>

learning uses prior successes and measures learner progress to identify and provide future targeted learning strategies. *Adaptive learning supports adaptive interaction, feedback and delivery of information and content.* The key to successful adaptive learning is finding the multiple sources of personalization intelligence (e.g., learning orientation⁷¹, academic background, etc.) that tells the system how to adapt appropriately. *Accounting for individual learning needs and differences correctly has especially increased in importance as learners' transition to online learning and seek more personalized solutions to match their learning needs.* Personalized learning is a contrasting approach to adaptive learning.

Adaptive learning systems have traditionally been divided into separate components or „models”. While different model groups have been presented, most systems include some or all of the following models (occasionally with different names)⁷²:

- *Expert model* – The expert model stores information about the material which is being taught. This can be as simple as the solutions for the question set but it can also include lessons and tutorials and, in more sophisticated systems, even expert methodologies to illustrate approaches to the questions. Adaptive learning systems which do not include an expert model will typically incorporate these functions in the instructional model
- *Student model* - The model which tracks and learns about the student
- *Instructional model* - The model which actually conveys the information

⁷¹The Learning Orientation (LO) Research discusses the theoretical foundations for understanding sources for individual learning differences. It specifically explores *the important impact of emotions, intentions, and social factors on learning.* Discovery in the neurosciences in the last ten years have revealed the extraordinary complexities of brain activity and multiple levels of processes interacting dynamically. These theories highlight more than the cognitive element, they explore *the dominant power of emotions and intentions on learning.* This research provides a blueprint for personalizing learning and a foundation for sequencing learning objects and relationships. It offers rules and guidelines to govern how to take all the objects and organize them for particular instructional and performance objective - put it all together. This research captures psychological and biologic influences to contribute greater pedagogical value between learning object and relevant learning relationships. The current behavioral emphasis is not enough.

(<http://www.trainingplace.com/source/research/researchdescription.htm>)

⁷² Bloom, C. P., Loftin R. B., (1998) *Facilitating the Development and Use of Interactive Learning Environments*, Lawrence Erlbaum Associates

- *Instructional environment* - The user interface for interacting with the system

In synchronous mode it named *adaptive e-learning* or *real adaptive intelligent learning system*.

Although the World Wide Web now is accessible almost everywhere, on-line instruction is not catching on as rapidly. In large part this is because courses must be assembled manually and cannot be adapted easily to individual student needs. Currently, less than 10 percent of U.S. Colleges and Universities and less than 7 percent of European Universities offer on-line courses.

To tap into a potentially vast market for distance learning, *Real Adaptive Education will develop the technologies needed to enable non-programmers to design courses rapidly and provide materials and interactive instruction that are customized for each student.*

It's plans to *integrate latent semantic analysis (LSA)*, an automated method of deriving meaning from text, *with radial basis function (RBF)*, a neural network that enables software to improve its own performance through machine-learning algorithms. The key technical challenge will be to integrate these two techniques, which are proven but have yet to be combined, to create an intelligent tutoring system that processes documents rapidly and precisely in response to the needs of the learners. The proposed *system will include a smart searching capability that is expected to improve retrieval of relevant documents for on-line courses* (current web search engines retrieve only 30 percent of relevant documents plus many irrelevant ones). The system also *will sort documents by topic into possible course paths*, reducing the time required to organize courses. In addition, the proposed system *will develop an internal model of each student to provide customized instruction and automatically tag courseware to keep track of it among the enormous volume of on-line educational material.*⁷³

„The system, created by the start-up company Knewton (US), has given the university a fresh way of addressing the continuous problem of students being unprepared for college math. But it also offers a glimpse into what many more students will experience as teaching increasingly shifts from textbooks and lectures that feed the same structure of information to a class of 300,

⁷³<http://jazz.nist.gov/atpcf/prjbriefs/prjbrief.cfm?ProjectNumber=98-09-0012>

regardless of individual expertise, to machines that study their users' learning patterns and adapt to them.

That excites some educators. George Siemens⁷⁴, a data-mining expert at the Canadian distance-learning university Athabasca, calls the traditional approach an inefficient model “that generates a fair degree of dropouts.”

Knewton dismantles that model. Ms. Allison's 8:35 a.m. class is not a lecture. Although students are supposed to show up at a fixed time, and an instructor is there to work with them, the action is on screen. Knewton allows Ms. Allison to skip past some concepts she gets, like factors and multiples. When she struggles with inverting linear functions, the software provides more online tutoring. Two students who complete the same lesson might see different recommendations as to what to do next, based on their proficiency...What time of day does a student best learn math? What materials and delivery styles most engage the student? Say you have the same concept explained in a video, in a textbook-like format and in Socratic steps. Knewton will associate a student's “engagement metrics” with those styles and use that to help determine the next step.” mention the article „Big Data on Campus”, by Marc Parry, Published in July 18, 2012 in The New York Times⁷⁵

As it said in “Adaptive learning white paper” under the site of Knewton - “Knewton improves learning outcomes” - there are many degrees and types of adaptive learning:

- single-point vs. continuous adaptivity,
 - adaptive testing vs. adaptive learning,
- but often these distinctions aren't made clear⁷⁶.

⁷⁴ George Siemens is writer, theorist, speaker, and researcher on learning, networks, technology, analytics and visualization, openness, and organizational effectiveness in digital environments. He is the author of *Knowing Knowledge*, an exploration of how the context and characteristics of knowledge have changed and what it means to organizations today, and the *Handbook of Emerging Technologies for Learning*. Siemens is a researcher and strategist with the Technology Enhanced Knowledge Research Institute at Athabasca University. *Knowing Knowledge* has been translated into Mandarin, Spanish, Persian, and Hungarian. Previously, he was the Associate Director, Research and Development, with the Learning Technologies Centre at University of Manitoba. His PhD, with University of Aberdeen, focused on how individuals sensemake and wayfind in complex information settings. In May 2012, he received an honorary doctorate through Universidad de San Martin Porres. (<https://tekri.athabascau.ca/content/george-siemens>)

⁷⁵ http://www.nytimes.com/2012/07/22/education/edlife/colleges-awakening-to-the-opportunities-of-data-mining.html?_r=1

⁷⁶ <http://www.knewton.com/adaptive-learning-white-paper/>

As we know, certainly is that an adaptive learning system responds to the performance or activity of a user.

„Taking in consideration single-point adaptive learning vs. continuous adaptive learning for example, we can see that a *single-point adaptive learning system evaluates a student's performance at one point in time in order to determine the level of instruction or material he receives from that point on*. These recommendations do not adapt to user activity and performance as the student moves through the course materials. On the other hand, *a computerized learning system that is continuously adaptive responds instantaneously (or near-instantaneously) in real-time to each individual's performance and activity on the system*.

Single-point adaptivity is generally used to evaluate proficiency in certain areas or sort students into appropriate levels, whereas continuous adaptivity is used to teach students and enable them to master various concepts and skills. For example, imagine a course that provides a diagnostic exam, the results of which determine the rest of the course. Such an experience would be an example of single point adaptivity. If, however, multiple diagnostics are employed in a course and recommendations are constantly updated based on other user data, the experience would be an example of continuous adaptivity.

When Knewton refers to adaptive learning, we mean a system that is continuously adaptive — that responds in real-time to each individual's performance and activity on the system and that maximizes the likelihood a student will obtain her learning objectives by providing the right instruction, at the right time, about the right thing. In other words, while adaptive testing answers the question, “How do I get the most accurate picture of a student's state of knowledge with a fixed number of questions?”, adaptive learning answers the question, “Given what we understand about a student's current knowledge, what should that student be working on right now?”

To provide continuously adaptive learning, Knewton analyzes learning materials based on a multitude of data points — including concepts, structure, and difficulty level — and uses sophisticated algorithms to recommend the perfect activity for each student, constantly. The system refines recommendations through network effects that harness the power of all the data collected for all students to optimize learning for each individual student.

Whether they offer single-point or continuous adaptivity, most adaptive learning companies today are building adaptive applications based off their

own content. Knewton, on the other hand, is not an app but a platform that will make it possible for anyone to build her own adaptive applications, using whatever content she likes.” in „Knewton adaptive learning”,⁷⁷

We can say, towards the end of this paper, that *Adaptive Learning Systems (ALS) can be implemented on the Internet for use in distance learning and group collaboration applications.*

The field of *distance learning* is now incorporating aspects of adaptive learning. Initial systems without adaptive learning were able to provide automated feedback to students who are presented questions from a preselected question bank. That approach however lacks the guidance which teachers in the classroom can provide. Current trends in distance learning call for the use of adaptive learning to implement intelligent dynamic behavior in the learning environment. During the time a student spends learning a new concept they are tested on their abilities and databases track their progress using one of the models. The latest generation of distance learning systems take into account the students' answers and adapt themselves to the student's cognitive abilities using a concept called „cognitive scaffolding” (is a learning process designed to promote a deeper learning. Scaffolding (Sawyer, 2006) is the support given during the learning process which is tailored to the needs of the student with the intention of helping the student achieve his/her learning goals). A current successful implementation of adaptive learning in web-based distance learning is the Maple engine of WebLearn. WebLearn is advanced enough that it can provide assessment of questions posed to students even if those questions have no unique answer like those in the Mathematics field.

Group collaboration is also a hot field in the adaptive learning research area. Group collaboration is a key field in Web 2.0 which extends the functionality of distance learning. Adaptive learning can be incorporated to facilitate collaboration within distance learning environments like *forums* or *resource sharing services*.⁷⁸ Some examples of how adaptive learning can help with collaboration include:

- Automated grouping of users with the same interests.
- Personalization of links to information sources based on the user's stated interests or the user's surfing habits

⁷⁷<http://www.knewton.com/adaptive-learning-white-paper/knewton-adaptive-learning>

⁷⁸ “[Towards web-based adaptive learning communities](#)”

<http://www.ia.uned.es/~elena/papers/gb-aied03preprint.pdf>. Retrieved August 17, 2008

In conclusion, adaptive learning is a method behind which learning outcomes are achieved well than in traditional way, being that “computers adapt the presentation of educational material according to students’ weaknesses, as indicated by their responses to questions. Adaptive learning systems endeavor to transform the learner from passive receptor of information to collaborator in the educational process”.⁷⁹

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⁷⁹ http://en.wikipedia.org/wiki/Adaptive_learning