Personalized Adaptive Learning: An Emerging Pedagogical Approach Enabled by a Smart Learning Environment

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Abstract. Smart devices and intelligent technologies are enabling a smart learning environment to effectively promote the development of personalized learning and adaptive learning, in line with the trend of accelerating the integration of both. In this regard, we introduce a new teaching method enabled by a smart learning environment, which is a form of personalized adaptive learning. In order to clearly explain this approach, we have analyzed its two pillars: personalized learning and adaptive learning. From this analysis, we have also explored the core elements of personalized adaptive learning and its core concepts. On this basis, we further construct a framework of personalized adaptive learning. We hope this paper will provide readers with a clear understanding of personalized adaptive learning, and serve as an endeavor to contribute to future studies and practices.

Keywords: smart learning environment · data decision-making · personalized learning · adaptive learning · man-machine collaboration

1   Introduction

With the development of technology, technology-enhanced learning has gradually entered classrooms and experienced four changes [1]: a) e-learning, b) m-learning, c) u-learning, and d) s-learning (Smart Leaning). Against such background, the technology-enhanced learning environment has also evolved from the e-learning environment to smart learning environment (SLE). As a high-end form of e-learning [2], SLE has features of tracking learning process, recognizing learning scenario, awareness of physical environment, connecting learning communities, easy, engaged and effective learning. [3], which bring learners more flexibility, effectiveness, adaptation, engagement, motivation and feedback [4]. Therefore, SLE should be able to promote the development of personalized learning and adaptive learning effectively.

In fact, personalized learning and adaptive learning have always been the core goals of a SLE. Huang [3] defines SLE as a learning place or activity venue for promoting effective learning. Kinshuk mentioned that personalized learning and adaptive learning are two kinds of this effective learning that SLE mainly focuses on in an interview [5]. The development of current technologies has made personalized learning increasingly adaptive, adaptive learning increasingly personalized. Such a trend is much more obvious in smart technology-enabled SLE. A revised teaching method, personalized adaptive learning, will come along with this trend. The new personalized learning approach is automated and uses decisions based on data gathered by an automated system; it accommodates learning to learners' real-time learning conditions, and makes the learning content and activities meet learners' individual characteristics and needs. In this paper, we aim to explore the core concepts of a new form of personalized learning and construct an appropriate framework in order to provide a reference for scholars to carry out follow-up research and for educators to explore practical ways to implement personalized and adaptive learning in the age of automated learning support systems.

2   Analysis: Comparing the two pillars of personalized adaptive learning

2.1   The differences and similarities between personalized learning and adaptive learning

Personalized adaptive learning is formed by the combination of personalized learning and adaptive learning. A variety of past definitions are shown in Table1. The left side is a list of definitions of personalized learning. Three common core elements are highlighted, namely *individual differences*, *personal needs* and *personal development* (a.k.a individual vision). The right side is a list of definitions of adaptive learning. Three elements, *individual differences*, *individual performanc*e and *adaptive adjustment* can be extracted from these definitions. In that sense, this revised form of personalized adaptive learning in not new. Rather, it builds of prior attempts to make learning more individually meaningful.

Table 1. Comparison between Personalized Learning and Adaptive Learning

Personalized learning	Adaptive learning
Personalized learning refers to instruction in which the pace of learning and the instructional approach are optimized for the needs of each learner. Learning objectives, instructional	Adaptive learning refers to the technologies monitoring student progress, using data to modify instruction at any time. [7]

approaches, and instructional content (and its sequencing) may all vary based on learner needs. In addition, learning activities are meaningful and relevant to learners, driven by their interests, and often self-initiated. [6]

The pedagogy of personalising learning is learner-centred. It is an inclusive process which challenges those involved to meet the needs of all learners, particularly those learners who are vulnerable or hard to reach. [8]

Adaptive learning technologies dynamically adjust to the level or type of course content based on an individual's abilities or skill attainment, in ways that accelerate a learner's performance with both automated and instructor interventions [9]

Personalized learning refers to a learning paradigm that aims at promoting students' individual development, emphasizing that the learning process should adopt appropriate teaching methods, techniques, content, starting points, processes, and evaluation methods to meet the individual characteristics and development potential of students, so that all aspects of students could be developed fully, freely and harmoniously [10]

Adaptive learning strategies create a student experience that is modified based on a student's performance and engagement with the course materials. At its heart is an approach to instruction that relies on technology and data about student performance to adjust and respond with content and methodologies that develop a pathway to the student's mastery of a particular learning objective. [11]

Core Elements: individual differences, personal needs, personal development (vision)

Core Elements: individual differences, individual performance, adaptive adjustment

Intuitively, both personalized learning and adaptive learning focus on individual differences which, mainly individual characteristics, is the purpose of differentiated instruction. Therefore, both contain *differentiated instruction*, which in the past has been reserved for special needs students. Furtherly, the individual differences in personalized learning includes two parts: individual characteristics and non-individual characteristics. The latter is actually one aspect of personal needs and personal development. According to the definition of personal needs, the gap between the current situation and the intended state of a learner, the difference of students needs is determined by the current state and the intended state. The former can be part of individual characteristics, and the latter can be attributed to personal development. In this way, the core elements of personalized learning can be refined into two aspects: *individual characteristics* and *personal development*. One new aspect of personalized adaptive learning is the recognition of individual learner interests and desires as relevant to education.

The above definitions of adaptive learning do not show it emphasize the personal development of students. Therefore, the individual differences in adaptive learning are mainly related to the differences of individual characteristics. Thus, the core elements of adaptive learning can be modified into *individual characteristics*, *individual performance* and *adaptive adjustment*. Comparing the new core elements of both learning methods, personalized learning does not mention the implementation strategies, but adaptive learning does (adaptive adjustment). A second new aspect of

personalized adaptive learning is an emphasis on designs and implementations that in fact support individual development.

2.2   Constructing the relational diagram among related learning methods

It can be concluded from the above, there is no limit to the number of students for personalized learning, adaptive learning, and differentiated instruction. Therefore, they are not individualized instruction. However, the most dependent on high-end technology of adaptive learning, it is more concerned with the specific situation of each individual than the other two methods. In addition, from the perspective of personality, differentiated instruction, focusing on the difference of individual characteristics, has the lowest personalized level; adaptive learning comes second, it rises to the level of individual performance; personalized learning is the highest, reaching the pursuit of personal development. These are visually depicted in Fig.1.
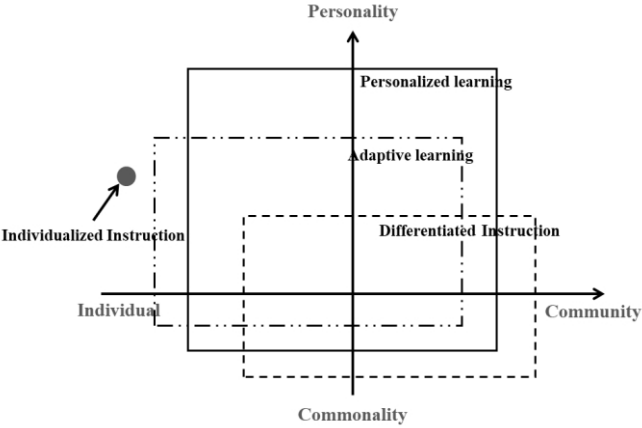

**Fig. 1.** Relationships among Related Learning Methods

3   Core concepts: The values of Personalized Adaptive Learning

Combining the core elements of personalized learning and adaptive learning, the core elements of personalized adaptive learning can also be proposed: *individual characteristics*, *individual performance*, *personal development*, and *adaptive adjustment*. The first three represent three personalized levels of personalized adaptive learning. The fourth indicates that adaptive adjustments strategy of teaching to achieve these three personalized levels. Like adaptive learning, this strategy is inseparable from the empowerment of technology. Based on these four elements,

personalized adaptive learning can be defined as a technology-empowered effective pedagogy which can adaptively adjust teaching strategies timely based on real-time monitored (enabled by smart technology) learners' differences and changes in individual characteristics, individual performance, and personal development.

The assumption behind this core concept is the same as that of adaptive learning, namely, the appropriate is the best. Because each individual is different in all aspects and is in a state of constant change, it is necessary to personally monitor them in real time and adjust the teaching in an adaptive manner to ensure that the teaching strategy is always suitable for the individual student. In addition, this concept, like smart education, needs to adhere to the view that "technology promotes education rather than leads education" [12]. This is because, so far, few technologies were created for teaching, and the convenience pursued by technology is not what education seeks [13] which is the effectiveness of promoting human development.

4 Framework: The Portrait of Personalized Adaptive Learning
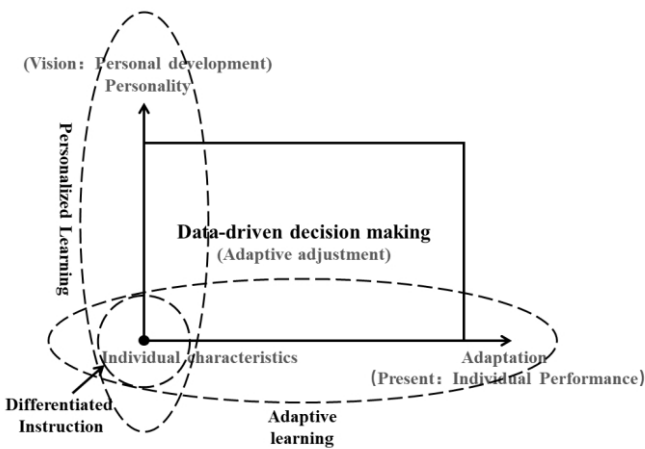
Fig. 2. Personalized Adaptive Learning Framework

Based on the above core elements and core concepts, a framework of personalized adaptive learning is constructed. As shown in Fig. 2, the horizontal axis acts as an adaptation axis to characterize the current individual performance and the vertical axis is used as a personality axis to characterize the personal development. The two-axis intersection acts as individual characteristics to represent differentiated instruction shared by personalized learning and adaptive learning.

Fig. 2 indicates three ways to achieve personalized adaptive learning: 1) Adjust the teaching strategies based on the differences in individual characteristics (circular); 2) on this basis, adjust the teaching strategies combined with the differences and changes in current individual performance (horizontal ellipse); 3) on the basis of 1), adjust the teaching strategies combined with the differences and changed in personal development vision (vertical ellipse). All of three approaches can be implemented by adaptively adjusting teaching based on data-driven decision-making. Therefore, the framework depicted in Fig. 2 takes data-driven decision-making as the core hub.

Acknowledgements

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