From One-size-fits-all Teaching to Adaptive Learning: The Crisis and Solution of Education in The Era of AI

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Abstract. With the change of micro environmental variables such as internet technology, AI technology, the upgrade of education consumption, there has been a profound change in education, and then the value network created by undergraduates, teachers, employers and other stakeholders will also be changed. The crisis faced by education is the multiple trust crises among stakeholders, and the contradiction between the personal needs of undergraduates (personal desire for development, personal maturity cycle, personal growth rate, etc.) and the One-size-fits-all teaching is the main aspect of the multiple trust crises. Therefore, establishing the concept of adaptive learning and shifting the focus of reform from One-size-fits-all teaching to personalized education is the way for educational reform in the future. The reform should firmly establish the principles of cognitive science obeying, interest activating, diversity cultivating, and balance keeping. Evidence-based education, mastery learning, etc. are the core elements of design of adaptive learning environment. The theoretical base of this research is Piaget's cognitive developmental psychology and adaptive learning theory. It applies educational theories and educational techniques, such as evidence-based education, OBE, mastery learning, etc., to the construction of the adaptive learning environment. It provides an overview of the main modules and algorithms of the environment, with the aim of using the top-level design to enable the hidden functions of education by the soft environment.

1. Introduction

With the booming of mobile Internet, cloud computing, and big data technologies, education has transformed from one of the most data-poor areas to one of the big data gold mines. It has made a substantial breakthrough in artificial intelligence technology in the field of education[1]. With the improvement of the copyright protection mechanism and the development of third-party payment tools and new media technologies, educational consumption upgrades such as knowledge payment have also undergone a qualitative leap[2]. The changes in macro-environmental variables such as technology, economy, and society have led to profound changes in education. The benign side is to further realize the sharing of educational resources, the elimination and breakthrough of various restrictions and obstacles in learning[3]. The downside, however, is the polarization that is exacerbated by the so-called digital divide. The value network of students, teachers, employers and other stakeholders has also undergone profound changes, and the crisis is also accompanied. This article answers the following questions: What are the main crises facing education? Why? How to solve?

2. Value network analysis

Education is complex and involves many stakeholders, including but not limited to: students, schools, teachers, training institutions, employers, and the interests of these stakeholders are complex[4]. The
local trust crisis between two stakeholders can be explained by the game theory such as Principal-agent Theory, Adverse Selection and Signalling Model[5]. Globally, the game relationship can be explained by the tetrahedral topological value network of multiple trust crises, illustrated in Figure 1.

Figure 1. Tetrahedral Topological Value Network Model of Multiple Trust Crisis

In order to simplify the model, it is necessary to make the dimensionality reduction based on the relevance of the interests and appeals, and to group some stakeholders into one. The most important role is the student, so it is student-centered for interest analysis. Suppose that the school and the teacher can be grouped into the same subject, and the parents and employers are also grouped into another subject. The 4 nodes in the value network constitute 4 subjects. The line (arc) represents the relationship between 2 subjects, the plane (ring) represents the relationship between the 3 subjects, and the tetrahedron represents the relationship between all subjects. Next, the network analysis of multiple trust crisis is carried out with representative points, lines and planes as the analysis objects.

Value Network Theory[6] believes that the advantage of a node on a value network is not based on its internal resources, but on the basis of the entire network resources; The stronger the node is dependent on the original network, the more it will lose the flexibility to migrate to the new network, and the deadlock occurs further with the original network; The decline of a node cannot be based on its own reasons, but also on the changes and trends of its value network.

2.1 Points analysis

2.1.1 Points analysis of teacher(F-T1). From the perspective of teaching service methods, traditional education is a teacher-centered One-size-fits-all education, unified training program, outline, teaching materials, test questions, graduation standards, etc., suitable for large-scale streamlined education. The so-called personalized education, at best, is only a static group individualized education, that is, classifying students according to the initial conditions, and then performing One-size-fits-all education according to the established training programs, and lacking real-time feedbacks for individuals.

2.1.2 Points analysis of teacher(F-T2). From the perspective of professional management of school, under the guidance of new managementism, the teaching process and results are tilted towards KPI performance[7], which may cause some teachers to trigger short-sighted behavior because of KPI, or leading to the reverse phase-out of other excellent teachers (bad money drives out good money).

2.1.3 Points analysis of teacher(F-T3). From the perspective of professional characteristics of teacher, university teachers' work is characterized by multiple tasks (teaching, research, social services, etc.), and it is not easy to quantitatively evaluate the performance, especially teaching tasks. Because if the quality of teaching is measured by time, then improving the quality of teaching must occupy more time for teachers to prepare, but there's no corresponding increase in teaching time; If the quality is measured by students' grades, then it will evolve into test-oriented education that out of trend.

2.1.4 Points analysis of teacher(F-T4). From the perspective of path dependence, vested interests in the value network will also strengthen the One-size-fits-all education because of the path dependence. For example, the publishing house continues to supply paper materials suitable for One-size-fits-all education. In summary, it can be seen from the four characteristics of the teacher side that whether it is
convenient for school management, maximizing the personal interests of teachers, or the path dependence in the value network, it will generally strengthen the One-size-fits-all education.

2.1.5 Points analysis of student (F-S1). From the perspective of intergenerational differences between students, the 00’s generation who grew up with the growth of the Internet come to the university. According to the research report of Tencent CDC, 00’s generation's Attack, this generation has a stronger personal development desire than 90’s generation, and the individual differences are larger. Some students are precocious and some are late, so the learning style and learning content that should be adapted, and should be different throughout the learning process.

2.1.6 Points analysis of student (F-S2). From the perspective of the source structure of students, compared with the Double First-rate universities, the level of undergraduate students in private universities will be relatively complicated. For the same level of students, the range of enroll scores are larger. Students with multiple starting levels are also a challenge to teaching.

2.1.7 Points analysis of student (F-S3). From the perspective of educational consumption upgrade, the content of education is gradually being divided, and the awareness of students' consumers is on the rise, and transform from the teacher-centered to the student-centered.

2.1.8 Points analysis of student (F-S4). From the perspective of the individual cognitive development level, cognitive development is uneven. Piaget's cognitive development psychology believes that children should generally complete the formal operational thinking skills before the age of 16, that is, they should have abstract thinking ability, hypothesis setting and verification ability before entering the university, and also believe that cognition ability cannot be a class transition. However, only 40% to 60% of college students have formal operational thinking skills[8], which leads to students who do not have formal operational thinking skills do not understand the abstract courses. Cognitive development level does not support the cross-level jump from the previous layer of the formal operation (specific operation) to the latter layer (post-formal operation).

2.1.9 Points analysis of student (F-S5). From the perspective of diversity, the individual endowment of students is different, and the diversity of individuals is the wealth of the group. In summary, the above five characteristics can reflect the students' desire to personalize their development subjectively. In addition, it can be seen from the characteristics F-S1, F-S2, F-S3 that the trend of the node to the entire network environment variable is the student's personalization.

2.1.10 Points analysis of student (F-U1). From the perspective of job division, the refinement of the division of labor is the trend, and the knowledge and skills students learn at school are too rough.

2.1.11 Points analysis of student (F-U2). From the perspective of knowledge update, for high-tech industries, especially those that are subject to Moore's Law, the rate of knowledge update is very fast, and the knowledge or skills learned at school may be outdated at the time of graduation. And the rate of knowledge update will continue to accelerate[9].

2.1.12 Points analysis of student (F-U3). From the perspective of human resources, one of the biggest challenges faced by employers is to hire, retain and motivate top talent. For social job seekers, information can be obtained through background investigations, etc., but for cold start students, the employer knows very little, so incomplete information is a basic feature.

2.1.13 Points analysis of student (F-U4). From the perspective of organizational culture, the organizational culture of each employer generally differs, and there are special needs for the cultivation of talents. Therefore, there are many kinds of orientation training classes in universities. In summary, the above four characteristics can reflect the individualized requirements of employers for
students, which also objectively promotes the growth appeal of students to individualized development. In addition, it can be seen from the characteristics F-U1, F-U2, F-U3 that the trend of the node to the entire network environment variable is the high growth rate of the employer.

2.1.14 Points analysis of student(F-B1). From the perspective of operational methods, both physical training institutions and online education platforms are essentially commercialized, catering to market demands and pursuing surplus maximization. Taking the online education platform as an example, the core competitiveness of the platform is generally content, and the intelligent recommendation algorithm that supports content distribution. The most mature application area of intelligent recommendation algorithm is e-commerce. The interest appeal of e-commerce platform and merchants is oversold. For consumers, overbought parts can be hoarded or shared, which is realistic and feasible for both buyers and sellers. However, if this recommendation algorithm is transplanted into the field of education, it is not feasible from the perspective of cognitive development, because the knowledge that can be internalized in a certain period of time is limited, and the recommendation algorithm must be studied in combination with the rules of education. Otherwise, It can lead to cognitive overload and even more serious consequences.

2.1.15 Points analysis of student(F-B2). From the perspective of the source of demand, some of the demand comes from consumers, and some of the demand is created by the training institutions, that is, the supply-side reforms. For example, in the era of information explosion, some people have knowledge anxiety, and training institutions use this psychology to further create an atmosphere of knowledge anxiety, and then use content services to satisfy this created demand. And content services are gradually becoming more granular (personalized). In summary, from the above two characteristics, it can reflect the strengthening of the individualized needs by the training institutions, and also objectively promote the growth appeal of students to individualized development. In addition, it can be seen from these two characteristics that the trend of the node to the entire network environment variable is the high dependency of the training institution on the network.

2.2 Lines analysis
First, analyze the relationship between students and teachers. From the characteristics F-T1~F-T4 and F-S1~F-S5, the following conclusions can be drawn: One of the main contradictions of current undergraduate education is the individualized needs (personal desires for development, maturity cycles, growth rates, etc.) of students and the One-size-fits-all education. The One-size-fits-all education fictionalizes secondary students in the course design, and then carries out the design with the secondary students' standard[10]. This is a poor learning experience for students at the two poles. The top students are bored or even lose interest. On the other hand, underachievers feel strenuous. The greater the score polarization in the grades of the teaching classes, the more serious this phenomenon.

In addition, in the feature F-T2, students' evaluation of teachers will have subtle changes in teacher behavior and teacher-student relationship: teachers have psychological pressure and burden, and do not dare to strictly control students. Teachers and students can only be purely teaching and studying relationship, gradually lost the role of cultivating students[11]. Combined with the feature F-T3, the teacher's extra energy will be transferred to other businesses outside the teaching. Teachers are professions that require conscience and morality. However, in the face of KPI performance appraisal, it is not known how many proportions cannot pursue the maximization of personal interests. That is to say, if the school's design of the professional team and the teacher's individual assessment mechanism tends to be utilitarian, it may strengthen the One-size-fits-all education.

Second, analyze the relationship between students and training institutions. From F-S1~5 and F-B1~2, in order to meet the individual needs, the services of training institutions are all-in-one and highlight utilitarianism in marketing methods. This stimulates students' utilitarian awareness, such as "7-day crash" and "100% employment". Utilitarian awareness in turn reinforces the individualized needs.
Finally, analyze the relationship between students and employers. From the perspective of job supply and demand matching, the employer has certain expectations for the corresponding graduates of the corresponding schools, and graduates can only give non-deterministic delivery. In order to reduce the risk of non-deterministic delivery of job seekers, employers prefer the graduates from prestigious university, or have special threshold requirements for graduates from non-prestigious university. From the perspective of employment competition pressure, due to the information asymmetry of recruitment and job search, high-ability job seekers must spend corresponding education costs (including money and time) in order for the employer to believe that they are highly capable. It is the cost of signal transmission. According to the Ministry of Education's 2017 National Education Development Statistics Bulletin, the national gross enrollment rate of higher education reached 45.7% in 2017. Under the guidance of marketization, the popularization of higher education has also increased the cost of signal transmission. That is, the pressure of employment competition has become greater. The increasing pressure on employment competition will in turn stimulate job seekers to further increase the cost of education. Such a vicious circle.

2.3 Planes analysis
First, analyze the relationship between students, schools, and training institutions. Students will seek training institutions for individualized needs that are not available at school. The One-size-fits-all education deadlock will make the training institutions profitable, and the value network will further strengthen the deadlock. The training institutions are a barometer of the quality of school education, and the prosperity of training institutions is a sign that the school education need to be changed.

Second, analyze the relationship between students, employers and schools. Students and employers fall into the cycle of “employment pressures increase–education costs increase”. On this basis, the tripartite relationship analysis is carried out again, and the addition of the school further strengthens this cycle: to strengthen the arms race of education through expansion of enrolment and new major. The new major is static group personalization, which cannot meet the dynamic individual needs.

In summary, through the network analysis, the mistrust between the two has evolved into a multi-trust crisis. The rationality of each of them leads to the overall irrationality, gradually falling into the deadlock of refined Bayesian equilibrium and strengthening this state.

Observing each deadlock of line and plane, the constraint conditions all include "personalized education for students are not satisfied", so one way to solve the tetrahedron stalemate is: From the characteristics of F-S1~F-S5, school provides real-time, personalized education based on individual conditions through new educational techniques. Then the line relationship directly connected with the student node will be improved, and the constraint condition for the establishment of the original deadlock will no longer be satisfied, the plane and tetrahedron relationship will also be automatically improved. That is to establish the concept of adaptive learning, and shift the focus of reform from One-size-fits-all teaching to personalized learning, which is the only way to reform in the future.

3. New solution design
Traditional educational decisions are generally made in the absence of data[12]. With the development of technologies such as intelligent terminals, cloud computing, big data, blockchain, and the rise of educational technology such as adaptive learning, mastery of learning, and EBE (evidence-based education), new idea for smart education have been provided[13], and promotion of teaching paradigm. Educational technology is a study and ethical practice that promotes learning and performance through the creation, use, and management of appropriate technical processes and resources.

Through the theoretical research, it is found that the organic combination of the educational technology tools can help provide real-time and personalized education according to the individual situation of students in the open education scene. According to the theoretical review, expert consultation and empirical research by other scholars in the early stage[14], the adaptive learning environment program is designed. The following take e-commerce major which have faster knowledge update rate as an instance, to design the adaptive learning environment. Improving the
relationship between line, plane, and tetrahedron under the premise of conforming to the point characteristics of students is a necessary condition for the adaptive learning environment program can be implemented. For now, it is especially important to establish design principles that follow the science of cognitive development, interest activating, diversity fostering, and equilibrium maintaining.

First, cognitive developmental psychology should be followed. The design principle of adaptive engine should follow Piaget's cognitive development theory (F-S4). The mastery of learning theory believes that it is necessary to pass current stage in order to enter the next stage, so the design of learning path should be considered individual differences and prevent any student from falling behind.

Second, is interest activating. If students are not interested in learning, but the goal is clearly, generally speaking, it is driven by utilitarian motives. However, utilitarianism cannot be a lasting growth motivation. Students will give up after the test. If the students are not interested, the external incentives may be effective but not meaningful. On the other hand, if the students are interested, external incentives are not necessary. Therefore, when designing a personalized training system, it is necessary to introduce an interest activation mechanism, especially for students in lower grades.

Third, is diversity cultivating. The differentiation of One-size-fits-all education is not the point of view or personality, but the score, which is not conducive to the cultivation of diversity. The factors affecting the cultivation of diversity should be fully considered when training modules.

Finally, is equilibrium. As the pressure of employment increase, under the guidance of utilitarian pragmatism, the teaching content is tilted from truth pursuit to procedural knowledge. Traditional education is to train students to master the current knowledge and skills. However, for major with faster knowledge updates, some knowledge are no longer applicable when graduate. Action learning theory believes that learning is the sum of insightful questions and procedural knowledge, so balance the proportion of insightful question and procedural knowledge, according to individual characteristics, the equilibrium of battle-ready forces of graduation and career stamina should be one of the design principles of adaptive learning environment. Student-centered does not mean blindly meeting the needs. Therefore, we must balance the general education and the individual needs. Incentives should be motivated by means of EBE and reputation mechanism design. The performance of the teacher’s current KPI and the quality of the student’s subsequent life should be balanced.

In the design of adaptive learning environment, fully refer to the concept of open education, CDIO talent training mode and OBE, combined with the characteristics of e-commerce major to optimize it locally. The core logic diagram of the adaptive learning environment is illustrated in Figure 2.

![Figure 2. The core logic of the adaptive learning environment](image)

3.1 Job recommended program
OBE(Outcome-based education) is a training model that focuses on what abilities and what can be done after a student is educated. All educational activities, educational processes, and curriculum design revolve around achieving the intended learning outcomes. The job recommendation program is one of the results of OBE, and the reverse customization design of the training program and knowledge system benchmarked with the student's career direction after graduation. The content of the
recommendation program mainly comes from the general education plan, major education plan, job descriptions of enterprises, professional reports, industry white papers, etc. The unstructured data published by the network is transformed into structured data by web crawler, data cleaning, natural language processing, feature extraction and other technologies, and then classified into four types of recommendation plans by classifiers based on the open education ability index system including: Operations class (data analysis, content / event / user operation, etc.), Design class (UI and UE design), Planning class (product planning, product management, etc.), To-Be-Directed class (for lower grade).

3.2 Knowledge Graph
The knowledge graph uses the Neo4j graph database, and its content is based on the complete set of e-commerce and surrounding knowledge systems. Each concept corresponds to an entity with attributes (metadata) such as ID, difficulty, course hours, project stack matched with course group, type, etc. The course group and project stack are derived from the project-oriented curriculum architecture model in the education training model of our school. The relationship between concepts includes inclusion, pre-requisite, and mapping. The structure of the knowledge graph is illustrated in Figure 3.

3.3 Category knowledge
According to the recommendation plan, the complete set K of knowledge graph is divided into category knowledge subsets K’, and the TF-IDF algorithm is adopted. As illustrated in Figure 4.

Figure 3. Internal structure of knowledge graph

Figure 4. the core logic of from knowledge graph to customized dynamic electronic textbooks
The core algorithm selects the relevant feature keyword to generate subspace $K'$ from the feature space K according to the recommendation plan P. The core algorithm is as follows: Steps 2-4: calculating the word frequency and the inverse document frequency; steps 5-7: determining the weight of TF-IDF, accumulating the feature keyword subspace $K'$; and steps 8-9: calculating the feature keyword relationship named Relation' corresponding to $K'$. Python pseudocode as shown in Table 1 below:
Table 1. TF-IDF algorithm for generating category knowledge K’

| Step | Python pseudocode |
|------|-------------------|
| 1    | input P(p1, p2, ..., pm), K(k1, k2, ..., kn) |
| 2    | for i in range(1, M): |
| 3    | for j in range(1, N): |
| 4    | tkj = kij / pkj, idkj = log(M / pkj) |
| 5    | for j in range(1, N): |
| 6    | Pkj = Σ(1 to M)(tkj * idkj) |
| 7    | if Pkj > THRESHOLD: K’ += kj |
| 8    | for <ki, kj> ∈ Relation: |
| 9    | if (ki ∈ K’) and (kj ∈ K’): <ki, kj> ∈ Relation’ |
| 10   | return K’ = {K’, Relation’} |

3.4 Pre-test feature of Student

The pre-test feature of students adopts the representation based on vector space model, which includes four dimensions: knowledge level feature L, cognitive feature A, target feature G, and interest feature I. Students need to participate in the evaluation of the above four dimensions before learning. The system will generate the learning characteristics of the concept ci (li, ai, gi, ii), and then generate the student profile(SP). Suppose there are n concepts, then SP=((l1, a1, g1, i1), (l2, a2, g2, i2), ..., (ln, an, gn, in)). The student profile is dynamically updated, and the explicit acquisition part is updated at the beginning, middle, and end of each semester; the implicit acquisition is updated in real time.

3.5 Dynamic customized training program

Based on the integrated training goal system of our school’s open education, different training directions (4 types of recommendation plans) correspond to different training plan templates, the category knowledge is customized according to the dynamic student profile and templates, and then generated the dynamic customized training program. Essentially a multi-objective optimization algorithm, the goals of optimization include but are not limited to the shortest learning path and moderate learning difficulty (not too difficult or too easy). The core algorithm is as follows: Step 2: according to Relation’, exhaust K’s all possible paths (concept sequence sets) K’T(M); Steps 3-5: filtering out the conceptual sequence set K’G(The number is still M, and the number of concepts of K’Ti is larger than the number of concepts of K’Gi) that students need to continue learning according to the student profile; Step 6-8: calculating the distance between the conceptual difficulty vector and the student cognitive feature vector by using the cosine similarity formula, and the distance determined by the appropriate coefficient is the student's target conceptual sequence K''(min Distance = the easiest, max distance = the most difficult, and too simple or too difficult are not suitable); Steps 9-10: Find the corresponding relationship Relation’. Python pseudocode as shown in Table 2 below:

Table 2. Feature matching algorithm for generating training program

| Step | Python pseudocode |
|------|-------------------|
| 1    | input K’ = {K’, Relation’}, SP = {L, A, G, I} |
| 2    | K’T = Topology(K’, Relation’) |
| 3    | for i in range(1, M): # M concept sequences, each with N concepts |
| 4    | for j in range(1, N): |
| 5    | if Lj < Threshold(G, I): K’Gi += kj # kj ∈ K’T |
| 6    | for i in range(1, M): |
Disi = cos(A, Difficulty) # Difficulty ∈ K’G

K’’ = Alpha(A, G, I) * Median(Dis)

for <ki, kj> ∈ Relation’:

if (ki ∈ K’’) and (kj ∈ K’’): <ki, kj> ∈ Relation’’

return K’’ = {K’’, Relation’’}

The K’’ is then divided into course groups or courses to generate a customized training program.

3.6 Wiki learning resource library

The Wiki learning resource library (WLRL) is a collection of learning objects, including but not limited to software, audiovisual publications, e-books, electronic documents, web links, discussion groups, electronic sandboxes. WLRL follows the IEEE's LOMS (Learning Object Meta-data Spec) on the bottom layer, and uses Wiki technology on the upper layer to facilitate the dynamic update of students, teachers, experts and other stakeholders.

3.7 Customized dynamic electronic textbooks

According to the dynamic student profile, dynamic electronic teaching materials and supporting learning resources are generated. The resources are different from person to person, and the learning objects are preferred in the most interesting and most acceptable way for each individual. Tracking data points in the UI interface to make diversified formative evaluation, forming a two-cycle improvement, using data to drive continuous improvement of electronic teaching materials and supporting learning resources. The cycle of single cycle improvement is generally a semester, while the double cycle improvement is almost real time.

4. The conclusion

This study discusses that the education crisis in the open education scene is not caused by its own reasons, but that the environmental variables of the value network have undergone many changes. The only way to avoid sinking with the original network is to cater to the situation and construct a new value network, from the One-size-fits-all education value network to the adaptive learning value network. The theoretical starting point of this research is Piaget's cognitive development psychology and adaptive learning theory. At the same time, the application of educational theories and educational techniques such as open education, EBE, OBE, mastery learning, and action learning to the construction of adaptive learning environment. The main modules and algorithms in the environment are briefly introduced, aiming to play a soft environment to promote the secret function of teaching through the top-level design.

There are applicable conditions in this adaptive learning environment, including but not limited to the following: Students' maturity is different, so traditional fixed administrative classes are not suitable for adaptive learning environments, and more flexible class organization is needed; Fixed tables and chairs in the classroom will limit the effectiveness of team learning; In order to improve efficiency, for non-integrated universities, the preconditions for teaching students in accordance with their aptitude are due to enrolment matching with school; Schools must have been matching teaching models and support for teacher-student interaction tools; Because students need to use electronic equipment in the classroom, the classroom performance assessment method needs to be upgraded, which means that there must be sufficient support in the school rules and regulations; The adaptive learning environment has higher requirements for students' self-discipline, so it is necessary to improve the self-discipline effect by adding a third space outside the dormitory or classroom; It also proposes new requirements for collaboration with AI for future teachers.

Subsequent work includes but is not limited to the new student purity measurement model, academic maturity evaluation model, student talent pool, learning process monitoring, anomaly detection, private blockchain and credit certification. The new student purity measurement model can guide the placement and formation of the learning team on the one hand, and can be used to evaluate
the gain of diversity at the time of graduation. The academic maturity evaluation model can be used to
determine whether a student meets the graduation criteria and matches the student to the employment
unit. Information transparency is the trend of the times, using blockchain technology to prevent
academic information from being tampered with. Online learning is an effective complement to
traditional learning. It is connected to the off-campus MOOC through the credit certification system.

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