Model Research of Middle School Students’ Mental Health Data Management Platform Based on Fuzzy Clustering Algorithm

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Abstract

The advent of cloud computing and big data era has brought both opportunities and challenges for the mental health education in schools at the same time. Mental health educators in schools must figure out how to apply the advantages brought by cloud computing and big data era so as to eliminate their impact on us. Also, they should emancipate their minds, update their concepts, further enhance their own data literacy, facilitate middle school students to establish a big data awareness of mental health education, realize individualized education, construct a safeguard mechanism for the mental health of middle school students, and lay a solid foundation for the future development of psychological health education in schools.

Keywords: Fuzzy Clustering Algorithm, Mental Health of Middle School Students, Data Management Platform.

1. RESEARCH BACKGROUND

1.1 Research overview

Fierce competition, heavy school work and super-test-oriented learning can cause mental stress and depression in students; comfortable and nanny-style life can lead to confusion and helplessness when students confront with difficulties by themselves; the busy working schedule of parents and the popularization of electronic products result in less family communication and an increased probability of children’s psychological loneliness; the adversarial physiology period is inherent in the growth of adolescents, all of which exert a general effect on the mental health of students and potentially threaten their life and study (Li and Qiu, 2014). Increasing attention from parents, schools and the society is attached to the issue of contemporary students’ mental health. How to deal with students’ psychological health problem has become a key and difficult focus in the related study. Due to the substantial number of students, it is difficult for mental health counselling workers to conduct detailed counselling and tracking for each student individually, thus failing to meet the existing psychological counselling needs. In the meantime, a number of students take the attitude of avoiding psychological problems so that the problems cannot be solved in time, and many tragedies that should have been completely avoidable have appeared. To realize the further development of mental health education is an important issue that must be faced by mental health educators in schools (Bai and Mei, 2014).

1.2 Research objectives

The arrival of cloud computing and big data era has brought tremendous changes to people’s production and life as well as new ways of thinking and management reform to all industries and fields around the world (Du and Niu, 2014), and also has exerted a certain impact on the behavioural habits and patterns of students to some extent. Teachers and students should locate a way to face the opportunities and challenges brought by cloud computing and big data era. This paper employs mobile Internet and big data-related technologies, builds on the existing experience of psychologists, integrates the theme of cloud computing and big data with the expert decision-making system, establishes a service platform for students’ mental health, provides students with intelligent diagnosis, self-healing solutions and other comprehensive solutions through a self-healing drift bottle system, adopts technical means to explore ways to address mental health problems of students (Song and Wang, 2013).

2. THE NECESSITY TO CONSTRUCT AN INFORMATION-BASED MENTAL HEALTH COUNSELLING PLATFORM
In case of psychological problems, students in adolescence would not easily listen to the counselling from the outside world. Groups who are in contact with students demonstrate ring-shaped characteristics according to the degree of closeness and the degree of psychological counselling willingness, as shown in Figure 1. It is indicated that the outer the ring is, the more students are willing to accept psychological counselling. For this purpose, if students experience substantial psychological changes, the best way would be to actively seek help and to achieve psychological counselling and tutoring in a self-healing way. Different counselling resources cannot often wait around, so new scientific means and models are needed to address students’ real-time psychological counselling. When students encounter some problems, they can pass their doubts to senior schoolmates with similar experiences by means of mobile terminals. If students need expert guidance, they can also communicate in privacy with experts through text, audio and video remote (Chen, 2013). Students can communicate with teachers and class supervisors anonymously and can give their opinions and refutation to the online parents group and have a discussion within the group. Although students’ psychological health counselling has become a topic concerned by most schools, due to differences in regional development, teachers’ inadequate counselling ability, discrepant supporting resources, different modes of implementation and other restricted factors, the traditional mode of psychological counselling is exposed to a number of dilemmas in the implementation process. The implementation effect is difficult to be effectively guaranteed and the realization model cannot be efficiently promoted. In face of the bottleneck constraints of region, resources, mode and other aspects, information technology is applied to construct a mental health counselling drift bottle platform based on big data and the expert decision-making system, which is an effective way to carry out mental health counselling in a wide, quick and high-quality way (Liu and Xiao, 2015).

![Mental Distance Map](image)

Figure 1. Mental Distance Map

3. THE DESIGN OF INFORMATION-BASED MENTAL HEALTH COUNSELLING PLATFORM

3.1 Key technologies

Big data refers to a large-scale collection of data that vastly outgrows the capabilities of traditional database software tools in terms of acquisition, storage, management and analysis, which is featured with a massive data size, fast data transfers, diverse data types and a low value density. This platform makes use of the big data of students in school, carries on a modelling analysis on students’ grade fluctuation, attendance, expenses, violations of discipline and teachers’ comment and other information in their daily learning life, extracts and updates personal characteristics profile concerning students’ character, emotions, psychology, preference, etc., judges students’ psychological problems and pairs them with the optimal counselling form and counselling materials in accordance with the pre-setting and the rule of inference that requires continuous learning, iteration and optimization (Zhang and Wan, 2016). HTML5 is the fifth major change in the application of Hypertext Markup Language (HTML) under the core language and the standard universal mark-up language of the World Wide Web. HTML5 is designed to support multimedia on mobile devices. Meanwhile, new features are introduced, and the way users interact with documents can be truly changed, such as new parsing rules, increased flexibility, new
properties and the elimination of obsolete or redundant attributes. Its characteristics provide the webpage with a better meaning and structure. The platform’s client side is a web APP developed on basis of HTML5, which has a shorter start-up time, a faster networking speed and a more efficient connection efficiency, and realizes page-based real-time chats and more optimized online communication (Lin, 2016).

3.2 Design principles

The platform should be equipped with strong data collection, processing, analysis and information generation capabilities. The unbalanced, scarce and deficient high-quality resources in various districts are one of the main factors restricting the rapid large-scale effectiveness of the traditional mental health counselling model (Wang, 2016). One of the inherent technical advantages of the information platform is to break through the limitations of the physical region, which enables the efficient integration of cross-regional or even cross-border high-quality resources, achieves more advanced concepts with more broad horizons, and implements psychological counselling services without time and space constraints. Different from the traditional listening and speaking counselling or even the theoretical tutoring counselling, big data platform tends to show more respect to students’ preferences and habits and provides comic books, story novels, songs, even films and other forms of counselling resources, so that students subtly restore their mental health in their most preferred learning and entertainment. In addition, the platform should possess capabilities of self-learning and summarizing student psychology with characteristics of the times and constantly self-generate psychological counselling cases based on historical service conditions (Peng and Shu, 2014), so as to improve the temporal self-adaptability of the system. Figure 2 illustrates the flow chart of students’ mental health drift bottle system.

![Flow Chart of Drift Bottle System for Students’ Mental Health](image)

The platform should possess multi-dimensional intelligence to obtain students’ psychological dynamic ability, afford active and passive counselling services, be interconnected with the school teaching information-based platform to acquire students’ grade changes, attendance, violation of discipline, teacher comments and other information in the daily learning life without awareness, draw support from the expert decision-making system to infer real-name students’ personality traits and psychological fluctuations, track and forecast students’ psychological counselling needs in real time, actively push psychological counselling materials according to the actual situation, remind corresponding teachers and parents to make offline observation, counselling and care, and strengthen the psychological counselling effect in advance through the O2O model (Chen, 2016). When a student anonymously logs in the platform, takes the initiative to exchange feelings and conducts psychological counselling, the platform makes text exchanges through the cartoon images of an intelligent robot, sends key words to the expert decision-making system for judgment after understanding the meanings of words, develops real-time intervention programs, implements mental health counselling, and makes anonymous one-to-one communication and counselling between students who seek online counselling and senior schoolmates who previously had similar problems and have received successful counselling (Sheng, 2014).

3.3 System structure

According to the core requirement of platform informatization, the system structure of student mental health drift bottle platform based on big data and the expert decision-making system consists of basic layer, data layer, analysis layer, decision layer, interface layer and application layer. The basic layer includes hardware and equipment,
network environment, dynamic environment, operating system, database software, etc. required by platform construction. Data layer mainly consists of three types of data: cartoon, story novels, songs, even film and television and other forms of diversity of resources needed by psychological counselling; expert team’s professional skills and other relevant information as well as the situation of previously served anonymous students; performance changes, attendance, violation of discipline, teacher reviews and other information in the daily learning life of real-name students acquired by the teaching information-based platform in schools (Zhu, 2015). Analysis layer is primarily responsible for two aspects of the work. On the one hand, it is in charge for distinguishing and classifying the content of psychological counselling materials stored in the library and generating new counselling materials according to its own service cases. On the other hand, personal characteristic outline information is extracted from massive student information such as personality, emotion, psychology and preference. Decision-making layer judges students’ psychology problems, pairs them with the best counselling form and counselling materials in accordance with the pre-setting and the rule of inference that needs continuous learning, iteration and optimization, and optimizes the rule of inference based on the relevant feedback results. Interface layer comprises SMS interfaces and interfaces that exchange data with the peripheral system. Application layer provides students with a friendly and passive service interface through mobile phones, computer clients and other channels, collaborates with the instructional platform in schools, and proactively pushes early psychological counselling materials to students (Sun and Zhang, 2015).

3.4 Functional modules

The platform comprises five modules: student information base, expert team database, psychological counselling database, decision-making analysis system and drift bottle system. Student information base includes information such as grade fluctuation, attendance, violations and teacher comments. Expert team database consists of fundamental expert documents, expertise and other information. Psychological counselling database contains comics, stories, novels and other content and provides text, pictures, audio, video and other forms of presentation. Decision analysis system incorporates content identification classification, feature extraction, rule base, decision-making machine, learning devices and other modules. Drift bottle system contains a back-end management platform based on fundamental informational maintenance and analysis on students’ mental health as well as a front-end APP interactively applied by students (Yu and Li, 2017). In the traditional clustering algorithm, all the samples are equally involved in the clustering process, and accordingly, samples can easily influence the clustering effect. In order to weaken the impact of outlier sample on the clustering effect, the application of this idea in the PCM algorithm accelerates the convergence speed, but the defect of consistent clustering of PCM algorithm has not yet been fundamentally solved. Its weight is calculated as follows:

\[ \varphi_j = \sum_{k=1}^{n} \exp(-\alpha \|x_j - x_k\|^2) \]

where \( \alpha \) is the constant and \( j=1, 2, \ldots n \). This method takes into account the degree of closeness among the sample points, and the disadvantage is the substantial amount of computation. Another formula for weights is as follows:

\[ \varphi_j = \sum_{k=1}^{c} \exp(-\alpha \|x_j - x_k\|^2) \]

where \( \alpha \) is the constant and \( j=1, 2, \ldots n \). This method considers how close the sample is to each centre. Concerning IPCM parameters in the calculation method, literature review improves the formula of parameter, \( \eta_i \), which is calculated by sample variance without updates, thus simplifying the iterative process.

The computational formula is \( \eta_j = \frac{\sigma^2}{m^2 c} \)

where \( m \) is the weight index of fuzzy membership degree; \( c \) is the number of categories; \( \sigma^2 \) is the sample variance, which is calculated as follows:

\[ \sigma^2 = \frac{1}{n} \sum_{j=1}^{n} d^2(x_j, x), x = \frac{1}{n} \sum_{j=1}^{n} x_j \]  \hspace{1cm} (1)

In terms of the defects of IPCM algorithm, in order to enhance the robustness of the algorithm, we introduced the idea of sample weighting to relax the restrictions on the typical values and improved the calculating formula of parameters to reduce the number of iterations. The new objective function was defined as follows:
\[ j_{m,p}(U, T, V) = \sum_{i=1}^{n} \sum_{j=1}^{m} u_{ij}^m t_{ij}^2 + \sigma^2 \sum_{i=1}^{c} \sum_{j=1}^{m} u_{ij}^m (\phi_j - t_{ij})^p, \text{ where } d_{ij}^2 = |x_j - v_i|^2 \text{ is the constraint} \]

condition of the j-th, \( \sum_{i=1}^{c} u_{ik} = 1 \forall k. \)

The necessary conditions where the objective function achieves the minimum value are:

\[
t_{ij} = \frac{\phi_j}{m^2 c d_{ij}^2} \left[ \frac{1}{m} \sum_{i=1}^{n} u_{ij}^m - 1 \right], \forall i, j \tag{2}
\]

\[
u_{ij} = \frac{1}{\sum_{k=1}^{c} \left( \frac{n}{m} \right)^k \sum_{i=1}^{n} u_{ij}^m}, \forall i, j \tag{3}
\]

\[
u_i = \frac{\sum_{j=1}^{n} u_{ij}^m r_j}{\sum_{j=1}^{n} u_{ij}^m r_j t_{ij}}, \forall i \tag{4}
\]

### 3.5 Key business process design

In data layer, the platform is interconnected with the school teaching information-based platform and acquires student information such as the fluctuation of grades, attendance, violations of discipline and teachers’ comments in the daily learning life without any awareness. Analytic layer extracts and updates the information of the acquired real-name students including personality, emotion, psychology, preferences and other personal feature profile. Decision-making layer offers the learning profile features and its changes based on the analysis layer, judges students’ psychological risks and pairs them with best counselling forms and counselling materials according to the rule of inference. Application layer is linked with the teaching information-based platform in accord with the results of the decision-making layer, actively pushes counselling materials in line with their preferences to students in the form of drift bottles, reminds teachers and parents to do offline observation, counselling and care work and accepts their feedback at the same time, makes an analysis based on the feedback data of teachers and parents and students’ psychological counselling records, and enriches data and rules of data layer, analysis layer and decision-making layer. Figure 3 illustrates the business process of online psychological counselling services.

![Figure 3. Online Psychological Counselling Flow](image)

In the application layer, students’ emotional control signals or psychological counselling needs are obtained by means of drift bottle, and the relevant information is transmitted to the data layer. Data layer stores the received information and triggers data analysis requests. Analysis layer accepts the request and identifies and classifies the data information. Decision-making layer judges students’ psychological troubles in accord with the rule of
inference and the identification results provided by the analysis layer, and meanwhile arranges anonymous one-to-one paired communication and counselling between students who seek online counselling and senior schoolmates who previously had similar problems and have received successful counselling. At the client side, students receive counselling and mental health tutoring assistance by responding to the drift bottle and continue interaction through drift bottle. Analysis is made based on online interactive data, and the corresponding data and rules of data layer, analysis layer and decision-making layer are enriched.

3.6 Safety mechanism

Psychological counselling involves the privacy of students and the relevant data is sensitive. In order to protect students’ privacy, corresponding security mechanisms must be taken to strengthen the security management of platforms and data. The security mechanisms adopted by the platform include network security management, account security management and data security management. Network security management concerns internal and external network interconnection security management. The platform network should be divided into independent networks and be separated with other networks by setting up the firewall policy. Account security management should focus on the strict control of the related platform accounts and account access permission, the regular replacement of passwords, the saving of the operation records of each account and regular audits. In terms of data security management, it is necessary to strengthen the security of sensitive data and carry out data security management mainly through the recording of data in and out, separate storage, encrypted transmission and data operations of recorders, regular audits and other measures.

4. CONCLUSION

This paper aims at students’ possible psychological problems, proposes to build a service platform for students’ mental health based on mobile Internet and big data, focuses on the design of the platform’s technical realization, explores the implementation of APP client-side functions of the self-healing mental health drift bottle system, and guides the further study on this service platform. The further research emphasizes the psychological health feature mining and identification in the platform decision analysis module, so as to further enhance the self-healing psychological counselling effect. Under the background of cloud computing and big data, everything is constantly changing. Only by understanding such changes can we analyze their causes in depth and further address the problems. The advent of cloud computing and big data era has led to the coexistence of new opportunities and challenges for the mental health education in China. Psychological health education for secondary school students should draw on advantages and avoid disadvantages, establish and improve the scientific cloud computing and big data management system, and lay a solid foundation for the further development of the mental health education in schools.

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