International Journal of Humanities and Social Science Research
ISSN: 2455-2070; Impact Factor: RJIF 5.22
www.socialsciencejournal.in
Volume 3; Issue 3; March 2017; Page No. 23-28

Rational review of online marking in the past twenty years in China

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Abstract
Online marking is a revolution in the history of marking in the last century and has been carried out in China for twenty years. In this period, a series of related researches appeared and greatly promoted the extensive use of it and made it to be more reasonable and scientific. This paper reviewed and combed the researches in the past twenty years, and summarized its characteristics and gave the suggestions about future research.

Keywords: online marking, marking quality, examination

1. Introduction

Online marking named paperless marking is a new method of marking based on the computer network technology, image processing technology and database technology and started since late 1990s in China (Zhao, Y., 2009)[1]. This new method can not only release markers from business and tiredness of the previous manual marking, but also increase the efficiency, accuracy, rationality and fairness of marking and it represents the direction of marking work in the future. To promote this new method of marking be scientifically operated and applied, relevant regulation method issued by the Ministry of Education in China and a series of relevant academic researches and studies appeared and it greatly promoted the extensiveness and profoundness of marking and thus increased people's confidence and recognition of it. In order to learn experience and obtain lessons from the existing researches, promote the research of marking online in the future better, this paper intends to review and summarize the existing researches in the past twenty years, and summarize the results and methods of the online marking therein.

2. The Advantages of Online Marking

As a new method of marking combined with the modern information technology, online marking has more advantages than the traditional one. Zhao Yang & Zhu Jingjiang pointed out that online marking could make the scoring of objective questions automatic and directly present students' answers of the subjective questions on the computer screen so that the marker could score them just by knocking the keyboard or moving the mouse, which was convenient and prompt for the markers. In the whole process, it cut back work links and reduced the difficulty of marking work because of system scheduling and network transmission and it greatly enhanced the markers' enthusiasm and thus could tremendously improve the work efficiency (Zhao, Y., 2009; Zhu, J. J., 2015) [1, 2].

Wang Wencheng, Peng Maoling, Wu Lifang & Li Jianfang, *et al.* believed that online marking could grasp the scoring standards better, enhance the consistency and ensure the scientificalness and accuracy of the scoring with the function of error control mechanism of double and multiple evaluation and the consistency test of marking results; In addition, it could avoid the possible coarse error caused by manual operation through the function of automatically adding scores together, recording scores, and statistical analysis etc.. (Wang, W. C., 2013; Peng, M. L., 2012; Wu, L. F., 2015; Li, J. F., 2005) [3, 4, 5, 6]. Wu Lifang &Liu Chao thought that the computer-aided online marking system could monitor the whole process in real time and discover the problems in time so as to ensure the accuracy of the markers' grasping marking standards and guarantee the quickness and flexibility of marking management (Wu, L. F., 2015; Liu, C., 2004)[5,7].

Zhao Yang, Zhu Jingjiang & Wang Wencheng argued that the online marking system could monitor the entire process and shield the candidates' information automatically, that is, what the marking experts reviewed were only images of candidates' answers distributed randomly and could not see the candidates' paper answers and personal information at all, and then submitted immediately after reviewing, which guaranteed the confidentiality work, increased the transparency of the review process, eradicated the possibility of human intervention on the exam scores, avoided the possibility of illegal cheating, and effectively maintained the fairness and justice of the examination and the interests of the majority of candidates. Besides, Hao Jinghong stated that online marking could also widen the gaps among candidates' scores, which was conducive to the selection of talent (Zhao, Y., 2009; Zhu, J. J., 2015; Wang, W. C., 2013) [1,2,3].

Zhao Yang held that online marking system scanned the candidates' answer into computer images and then stored them in the computer server. In this case, one could immediately get related information of a candidate's answering paper, for example, the situations of answering and expert's marking etc., with inputting the candidate's admission ticket number into the computer. In addition, the online marking system could check the overall progress of marking at any time, the scoring situation of each marking expert, etc., all of these facilitated convenience of inspection on marking (Zhao, Y., 2009) [1].

Zhou Weiping & Zhang Jianliang, *et al.* argued that the most important advantage of online marking system was its powerful data collection function. It could deal with different

types of examinations, identify the students' answers intelligently, and timely provide the data analyses after the examination. It would help teachers to easily and precisely find out both learning differences and the weakness in students' learning, as well as problems existing in all aspects of teaching and the original causes, etc. So it could pertinently promote teachers' teaching and students' learning. (Zhou, W. P., 2015; Zhang, J. L., 2014) [8, 9].

3. The Disadvantages of Online Marking

3.1 The Aspect of System Configuration and Operation

Fan Peng put forward some problems existing in online marking below: 1) The printing costs of the answer cards adopted in online marking had ever increased. 2) The marking places required a high configuration of terminal equipment. 3) The high-speed scanning reader machine was rather expensive. 4) The servers, storage, and switching equipment used in marking were also a significant investment (Fan, P., 2009) [10]. Ruan Shaolin stated that some online marking systems were limited by investment, cost, function and technology, so they could not be applied directly in such small-scale examination areas as schools etc. (Ruan, S. L., 2010) [11].

Ruan Shaolin also put forward that the recent OMR system could only identify the filled areas, but not identify hand-written symbols such as the"√" and "×", etc. (Ruan, S. L., 2010) [11]. Han Cunxin, Cai Wei & Luo Li, *et al.* pointed out it still existed a few of papers missing scanning and with unclear image. (Han, C. X. & Fan, B., 2007; Cai, W. & Lou, Q. H., 2008; Luo, L. & Wang, F., 2007) [12, 13, 14]. Zhao Yang stated that there also existed some problems in online marking of college entrance examination: 1) The single form of identification technology. 2) The high precision of printing and cutting of answer papers. 3) The fixed style of answer sheet required by the identification technology 4) Too large storage space occupied by the image saving format (Zhao, Y., 2009) [1].

Cai Wei *et al.* thought that a part of important error control functions were lost caused by unstable software equipment in some provinces and cities; a set of matching test management measures had not formed yet; and the dynamic statistical function in the process of marking was not perfect, either (Cai, W. & Lou, Q. H., 2008) [13]. Han Cunxin & He Qingxia pointed out the concurrent access problem might cause "bottlenecks" in distribution of papers, that is, some terminals were idle while others were heavily occupied and finally led to low efficiency of the whole system (Han, C. X. & Fan, B., 2007; He, Q. X. & Chu, Q. J., 2005) [12, 15].

3.2 The Aspect of Review in Process and Results

Gao Bingcheng & Jia Zhixian pointed out that there existed consistency problem both among markers and within themselves in online marking, that is, there were differences in scoring speed, average score, standard deviation and scoring rate, etc., which would lead to low reliability among markers as well as within themselves (Gao, B. C. & Qin, X. F. 2007; Jia, Z. X., 2014) [16, 17]. Besides, Qi Dong also argued that there was no effective solution to the "lax-lax-strict-strict" problems in random matching of markers. (Qi, D., 2005) [18].

Gao Bingcheng held that the error threshold value caused by unscientific scoring criteria and reference answers needed to be demonstrated combining specific subject each time, which lacked consistent standards. (Gao, B. C. & Qin, X. F., 2007) [16] He Qingxia also pointed out the current implementation mechanism was impossible to instantly adjust the arbitration threshold value based on the immediate situation of marking. (He, Q. X. & Chu, Q. J., 2005) [15].

Wang Wencheng & Cai Wei put forward that online marking technology could cause serious "man-machine confrontation" (i.e., the markers scored randomly under the control of all indices) phenomenon. Actually, excessive pursuit of scoring consistency among markers might lead the scores to deviate from real ability of the candidates and then resulted in the "legitimacy" score error in compliance with the scoring consistency test (Wang, W. C., 2013; Cai, W. & Lou, Q. H., 2008) [3, 13]. Han Cunxin & Deng Xiugong stated that heavy workload coupled with the piecework payment made each marker was always cutting down the schedule during marking resulted in some markers' conservative scoring, which was very dangerous for the competitive selection test (Han, C. X., 2007; Deng, X. G., 2016) [12, 19].

Zhang Jianliang thought there was no trace after marking was the biggest shortcoming of online marking. It was terribly inconvenient for students' timely correction and reflection (Zhang, J. L., 2014) [9]. Shan Shenghu & Deng Xifang also pointed out that the online marking markers actually marked the scanned image instead of the students' answer papers, and the last thing left to the student was just a cold score, which was not conducive to the emotion cultivation between teachers and their students and went against with the goal of "emotion, attitudes and values" in the three-dimensional objectives of new curriculum. (Shan, C. H. & Deng, X. F., 2015)[20].

Zhou Weiping stated that it was only in large-scale examinations that online marking played role and what the teachers could do was to terminally evaluate the marking data. It played slightly roles in the adjustment of teachers' education and teaching (Zhou, W. P., 2015) [8]. Ma Shihua held that the dynamic statistical function in the process of marking was not perfect yet, and the full statistical analyses and application of marked examination data had not yet been carried out (Ma, S.H., 2004) [21].

Han Cunxin & Ma Shihua thought that online marking made it difficult to look into the situations of candidates' cheating in the same examination room. The scanned images of students' compositions were distributed to the markers randomly, which meant the numbers of "answering papers" in each marker were not continuous. In this case, even if the candidates in the front and near positions plagiarized each other, their compositions that were originally put together would be broken up (Han, C. X. & Fan, B., 2007; Ma, S.H., 2004) [12, 21]. Fan Peng also held that the images of answers distributed to each marking terminal only involved answers to some questions or several questions. It was unclear and invisible to judge unusual issues such as similar answers, plagiarism, etc., comparing with traditional one. (Fan, P., 2009) [10].

3.3 The Aspect of Impact on Students and Teachers

Shan Chenghu & Deng Xifang thought that excessive critical examinations and online markings certainly made students, especially the backward students lose enthusiasm of learning and finally become insensitive to learning and give up it and

it was obviously incompatible with experiential teaching spirit of "process and method" emphasized by new curriculum (Shan, C. H. & Deng, X. F., 2015) [20]. In addition, Zhou Weiping suggested that the analyses provided by online marking system hardly helped with excellent students. Many of the typical solutions to these questions came from the top students' answers, which might result in their complacency and do harm to their learning (Zhou, W. P., 2015) [8].

Han Cunxin & Fan Bin believed the marking teacher's eyesight was heavily damaged for staring long hours at a computer screen (Han, C. X. & Fan, B., 2007) [12]. Zhao Haiyan pointed out that the average method was generally used to calculate score of a candidate and its disadvantage lay in aggravating tendency to mean and it was unbeneficial to identify the high-capacity candidates.(Zhao, H. Y. & Chen, Z. G., 2011) [22]. He Qingxia believed that insecure factors might exist in the process of online marking, for example, unpredictable viruses and malicious attacks (He, Q. X. & Chu, Q. J., 2005) [15]. Gao Bingcheng & Chen Xiaosu suggested that it was necessary to organize technology development for data encryption transmission and the identity verification of remote login markers in the process of marking online (Gao, B. C.& Qin, X. F., 2007; Chen, X. S. & Zhang, L. L. & Wu, Y. Y., 2006) [16, 23].

4. The Measures to Improve the Quality of Online Marking

4.1 Strict Selection and Training Marker

Fan Peng & Ma Shihua thought the key to control marking errors was to strengthen the construction of online marker team for subjective questions, to pay attention to the links of selection, training, management and evaluation, to do a good job in training of online marker, to make them familiar with the relevant requirements of online marking as soon as possible (Fan, P., 2009; Zhao, H. Y. & Chen, Z. G., 2011) [10, 22]. Liu Jianhua & Ma Rui *et al.* also believed that the solid and effective pre-job training was the fundamental guarantee of marking work being smoothly carried out. So the must was to feasibly do a good job in four trainings below: 1) Induction training, mainly including the ideological politics education and confidentiality regulations, etc. 2) Trial marking training, mainly including discussion and formulation of the detailed marking rules, operation of online marking system, as well as trial and test marking. 3) Quality control training, mainly including re-marking, random inspecting, retrieving, and modifying of an e-paper and processing the wrong ones, etc. 4) Psychological stress and emotion conditioning training, including relax training and abdominal breathing training, etc. (Liu, J.H. & Ma, R. & Gao, G.M. & Liu, H.M., 2012) [24].

4.2 Strengthening Regulation of the Markers

Liu Jianhua & Ma Rui *et al.* thought regulation of the online markers could follow three items below. 1) Improving the marking organization. 2) Strengthening the incentive mechanism. 3) Introducing the psychological intervention. This required the relevant marking agencies could optimize marking progress management and organize psychological counseling, and reasonably arrange work time. (Liu, J. H., Ma, R. & Gao, G. M. & Liu, H. M., 2012) [24]Chen Yi also pointed out that timely detecting and adjusting markers' work and rest state could improve the quality and efficiency of marking, and thus ensure the fairness of marking (Chen, Y., 2014) [25].

Wang Wencheng thought in order to strengthen markers' mastering grading standards, what the feasible was to first make markers review the sample paper marked by the experts, and then calculate the difference between each marker and the panel, then determined whether the error was within the allowable range or to calculate correlation coefficient of the sample paper mark marked by the panel and the marker, and then assess the consistency between them. In addition, he also mentioned two solutions to "lax-lax-strict-strict" problems in matching of markers. 1) Comparing the standard deviation, average, and validity of marks, and marking speed of the same marker in different time interval. And the same applied in the re-evaluation to evaluate lax-strict degree of markers' grasping scoring standards in this way and determine whether they are consistent or not. 2) Calculating tend-mean degree, whose evaluation index was the arithmetic mean of markers scored by all markers for the question. Considering the average of all candidates' final marks for each question as the reference point and the closer the average of marks marked by the same marker was to the final average above, the smaller scoring error was (Wang, W. C., 2013) [3].

4.3 Improving the Design and Management of Online Marking System

Luo Youhua & Liu Tieming stated that online marking was a complicated system program. The key to its successful implication lay in doing a good job in four aspects below. 1) Equipment settings and network construction; 2) answer sheet scanning and data electronizing; 3) real time error monitoring; 4) examination organization and regulation (Luo, Y. H. & Liu, T. M., 2009) [26]. In order to minimize the errors caused by automatically marking objective questions, Yu Guojun suggested adding the error querying and correcting module as an auxiliary subsystem into online marking system. Extracting the possible wrong papers images via view and storage procedure, and then correcting the wrong ones in a manual way (Yu, G. J., 2009) [27]. Jia Zhixian suggested clustering the marks marked by whole markers using spectral clustering algorithm, and then categorizing the marking results. It provided a feasible method for analyzing marking qualities this way. Further, it could effectively detect some problems existing in subjective question marking, combining with metric dimension parameter of marking results (Jia, Z. X., 2014) [17].

Fan Peng put forward that to ensure normal operation of the entire marking system, it was necessary to reform the original enrollment examination management mode based on new circumstances and features. And it was also important to establish a set of new management measure according to the properties of online marking. (Fan, P., 2009) [10] Chen Guanru pointed out it was necessary to take the advantages of online marking system and cursor reading machine as well as overcome their shortcomings so as to design and develop the online marking system integrating examination management, paper production, objective question identification, subjective question evaluation and mark management. (Chen, G. R., 2009) [28]

4.4 Control Strategies for Marking Error

Cai Wei put forward five methods based on controlling "marking" with "marking" of controlling marking error in online marking as follows: consistency error control among markers, consistency error control within the marker himself, error control of double marking, error control among marking points, and spot-checking supervision. Meanwhile, he also put forward four measures for machine control error in online marking system, that were, randomly distributing composition papers; keeping independence of marking terminal; rapidly and accurately carrying out data statistics; efficiently and conveniently dialoguing via network. (Cai, W. & Lou, Q. H., 2008) [13] Gao Bingcheng summarized some effective strategies such as giving timely feedback, strictly requiring, training, and diminishing error threshold value etc. to reduce the difference of markers. (Gao, B. C.& Qin, X. F., 2007) [16] Wang Wencheng put forward several error control strategies for subjective questions marking as follows: 1) strengthening markers' grasping the marking standards, 2) controlling "lax-strict" problem in matching markers, 3) computing discrete degree, 4) improving validity of scoring (Wang, W, C., 2013) [3].

Luo Youhua & Liu Tieming pointed out that the real-time error control mechanism for online marking could be "checked" from five aspects below. 1) The computer could automatically take OCR/OMR identification on the objective items of candidates' answer cards and mark them comparing with the standard answers; 2) Adopting "one paper-four marking" model; 3) Controlling error of consistency both among markers and within the marker himself, and error between double marking and scoring points via computer statistical technique in real time; 4) Random monitoring by the Inspection group; And 5) Dealing with the abnormal marking situation. (Luo, Y. H. & Liu, T. M., 2009)[26]

4.5 Improving the Validity of Scoring

In order to improve the validity of scoring, Zhao Haiyan suggested reforming the traditional marking method. Under the premise of double marking validity, arbitrary value method could control towards-mean tendency in a more valid way. Meanwhile, the methods of both adopting the higher mark and adopting the lower mark were beneficial for controlling fluctuation of scores when necessary. And adopting the higher mark was better for controlling towards-mean tendency than adopting the mean mark, and was helpful to discriminate students with high-ability (Zhao, H. Y. & Chen, Z. G., 2011) [22].

Wang Wencheng thought that monitoring the markers' marking could improve the effectiveness of scoring. The more effective the scorer was, the closer personal measure was to the standard ones. The markers' marking validity specifically represented in three aspects below. 1) The marks scored by both scores were valid if their difference not exceeding the difference threshold. 2) If the difference of marks given by between the third marker and one of the above double marking markers was not exceeding the difference threshold, the both marks were valid, that is, the above two markers together determined the final score. 3) If the score given by the fourth marker was largely different from the tri-marking mark while smaller than half of the maximum error allowed by this item, it was also valid (Wang, W, C.,2013) [3].

4.6 Improving Technical Means and Enhancing Image Recognition

Ruan Shaolin suggested replacing machine with image recognition software supported by digital image processing technology to complete automatic marking task in the marking process. It could not only greatly reduce the cost of marking, but also penetrate this scoring method into more subtle areas with highly flexible system (Ruan, S. L., 2010) [11].

Xiao Lifeng designed the processing of image preprocessing system as gray level image binarization and then image skew correction. It made the entire scanning process clear and easy to be implemented drawing on the advantages of many image processing methods. (Xiao, L. F., 2009) [29] Luo Li suggested coarsening image at first to solve the image continuity problem, and then thinning image to solve the single pixel problem. (Luo, L. & Wang, F., 2007) [14] In order to meet the actual work and image processing needs, Zhang Ling put forward correcting the skew images with improved invertible method and adopting dynamic threshold tri-value image and neighborhood iteration to enhance the image identification (Xiao, L. F., 2009) [29].

5. Rational Review of the Existing Research

In summary, the existing researches on online marking mainly focused on three aspects such as advantages, disadvantages and measures to improve the quality of online marking. As for superiorities of online marking, they were fully affirmed in the previous researches possessed the advantages of swiftness, convenience and flexibility and it could promote examination and selection with better fairness. As for the inferiorities of online marking, there were also appeared extensive studies focused not only on the problems of cost, technology, management and concrete operation, but also on specific issues such as scoring, marking trace, and similar answers, etc.. And regarding to the method to improve the quality of online marking, the recent studies indicated that it was necessary to strengthen selection, training and management of the markers, further refine online marking management system, enhance image recognition and improve marking validity. Undoubtedly, all of these measures are reasonable.

However, there still exist some issues not deeply studied. This study will discuss relatively prominent two of them. The one is how to take the advantages of online marking, especially its fastness and convenience of data analysis to analyze the features of students' learning in a more profound way and find out the mistakes and deficiencies so as to making it could play a more effective role in the daily teaching guidance. Although some researchers had realized and mentioned it, few of them conducted further explores and studies from the current perspective, resulting in the data coming from online marking being still basically separate from the daily teaching. According to our investigation, in the current primary and secondary school what the teachers and students mostly did was to query final marks and their ranking and few of them further analyzed the data obtained from online marking to found the problems existing in teaching and then improve and refine the teaching. Actually, there were just several chances for them to access marking system each year. Further investigation for its reasons indicated most teachers were unfamiliar with online marking system and they did not know

how to operate it, how to analyze with the data obtained from it, how to correctly and properly analyze and how to get truly helpful teaching information by analysis. This case reflected quite a few teachers possessed weak data analysis skills to some degree and the lack of depth and maneuverability of recent researches on the mutual relation between online marking data and actual teaching.

The other is how to organize and arrange to make online marking more reasonable, that is, to make the final marks marked by the marker more accurate. At present, many researchers were very concerned about the quality of online marking and thus proposed a series of measures. But deliberating over these existing measures, the majority were on perspective of reasonableness and effectiveness of online marking, the few aimed directly at correctness and accuracy of final marks. Even if some measures aimed at the accuracy of final results, the most of them were vague and unspecific so that the online marking organizers and markers could not actually grasp and operate them. Our investigation in the primary and secondary schools indicated that there were always students told their teachers of their inaccurate marks after each online marking and the teachers seemed accustomed to this case. Then, the teachers always required their students to check carefully scores by themselves and the students who found wrong marks could told immediately to the teachers to correct. As a result, almost every teacher had to correct dozens of paper grades after each online marking. In this case, the online marking did not save the teachers' time in the actual teaching of primary and secondary schools, but added an extra process.

Therefore, it is necessary to strengthen researches on accuracy of online marking and data analysis and application after the online marking in the future. Only in this way can the online marking system, whose development and construction were invested substantially financial and material resources, play a more actual and valuable role. And can the new procedures and methods based on modern information technology be up to their reputations for accuracy and precision.

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