Impact of information entropy on teaching effectiveness*

WANG Zhi-guo

(Huaiyin Teachers College, Huai'an, Jiangsu 223001, China)

Abstract: Information entropy refers to the process in which information is sent out from the information source, transmitted through information channel and acquired by information sink, while the teaching process is the one of transmitting teaching information from teachers and teaching material to students. How to improve teaching effectiveness is virtually how to increase the transmission of effective information in teaching.

Key words: information entropy; teaching effectiveness; effective information

At present, we live in the times when information develops at a high speed. Teaching process is the one where information is sent out, transmitted, transformed and stored; one of its core problems is "how to improve the teaching effectiveness within the unit time", that is how to increase the transmission of effective information in teaching (XIANG Zhi-ping, 2000). In order to solve this problem, we use the concept of information entropy put forward by C.E. Shannon and relevant modern educational thoughts and modes to probe into the approaches to and methods (WANG Yu-tian, 1968) for improving teaching effectiveness.

1. Requirements of Modern Teaching Modes on Teaching Effectiveness Improvement

During the 18-19th century, teaching mainly adopted the transmission-reception mode; after the 20th century, teaching modes gradually changed into self-study—tutorship,guidance—discovery and situation-imitating, etc. (YE Shang-xiong, 1993). In recent years, various teaching modes oriented towards students, teachers and subject knowledge have emerged unceasingly, such as success-education teaching mode, mood-adjustment mode, subject teaching mode (CHEN De-hua, 2000). The specific requirements of these teaching modes on teaching efficiency are:

First, put forward some new teaching thoughts and approaches. Teachers are required to organize all teaching activities, meet the new requirements brought forward by students in teaching activities, control the whole teaching process skillfully, create the best teaching results successfully, and thus finally transmit a great deal of effective information within a shorter lecturing time so as to improve teaching efficiency.

Second, take advantage of modern educational techniques to enhance teaching efficiency. With extensive performance ability, modern educational technology can transcend the limitation of time, space, macro and micro to provide students with rich sensing material, fully embody teaching ideas and programs in teaching, stimulate students' study motivation and their interest in active participation in teaching activities and study, expand the direct experiential scope of students, as well as express teaching contents vividly and specifically. In addition, by virtue of modern educational technology, it is easy to conduct individual teaching, offering students sufficient

* Fund project: Philosophy and Social Science Fund Guidance Project of Jiangsu Provincial Department of Education (04SJD880009); Modern Educational Technology "Eleventh Five-year" Plan Topic of Jiangsu Province (2006—R—2871)

WANG Zhi-guo, male, professor of Department of Physics, Huaiyin Teachers College; research fields: college physics teaching and higher learning.

freedom of choice, bringing their personalities and strong points into full play.

Third, motivate the enthusiasm of students, cultivate their good study habits, and complete teaching process through "interactivity" and "double-center" between teachers and students with enhancing teaching effects within unit time as the final purpose.

In a word, modern teaching theory demands teachers to transfer a large amount of effective information to their students within the limited time by means of any modern technique available.

2. Impact of Information Entropy on Teaching Effectiveness

Education is an information system, while teaching is a typical information transmitting and processing process. Regarding teaching process, information source is the information set required to be transmitted in order to realize certain teaching objectives. It is stored in books, teaching tools, teaching plans as well as in the brains and behaviors of teachers. The information channel refers to teachers and their operational systems, which fulfills the transmission task with light and sound signals as the carrier. Information sink refers to students, i.e. the recipient of educational information. The nature of the research on educational system is the study on information, information transmission and processing. To improve the transmission of effective information in teaching process, the following problems should be solved (WANG Xi-ming, 2003):

2.1 Improve the quality of information sent out by teachers

In teaching, students can obtain information from information source through two channels, one is their teachers, the other is the teaching materials. Both are called information channel. The maximum information quantity that information channel transmits within unit time is called information channel volume, which is mainly affected by two factors. One is signal transmission form. Based on the research, the time needed by people to identify signals in various forms transmitted through information channel is not the same, e.g. 2.8s is needed for language description; 1.5s for line expression; 1.2s for black and white photo display; 0.9s for color photo display; 0.7s for object display (LI Cheng-zhong & WANG Xu-sun, 1968).

As is demonstrated above, object display only needs one quarter of the time needed for language description. Additionally, information channel volume is also affected by the number of signal categories transmitted at the same time.

Teachers are usually dominant in teaching (LU Wen-hua, 2000). Information sent out by teachers is the primary information, while others exist as auxiliary information. The purpose of information transmission is to eliminate the uncertainty of information sink; any information whose uncertainty has been reduced is effective information. In teaching, nonsense words uttered by teachers are ineffective information, so are the expressions which can't be understood by students. As a result, in order to improve the emission quality of information, several main factors affecting information emission quality in teaching should be taken into consideration: volume of teachers' knowledge(X_1), teaching methods(X_2), teaching experience(X_3) and expression ability(X_4). Given the above are matters with the same probability, the following formula can be deduced: $H(X) = -\sum P(Xi)\log P(Xi)$, which reflects the quality of information provided by teachers in teaching, and can be regarded as the mathematic mode to determine information transmission quality, measure and evaluate information quality.

2.2 Reduce the interference in information transmission

In information transmitting process, it is inevitable that interference exists. Teaching-concerned interference can be classified into three categories: the first is control interference, which occurs in the distinguishable process of people's controlling the passage. For instance, invalid information transmitted by teachers in teaching process will increase the uncertainty of transmission and students will have more doubts. The second is natural interference resulting from the discernible state which is affected by outside factors. Effects caused by noise, high and low temperature, noise and light reflection, as well as bad weather in teaching process all fall into this category. The third is subjective interference, i.e. interference brought out by students' misunderstanding due to their subjectivity.

As is demonstrated above, when interference exists, the information quantity that students receive will reduce to $I(P) = H(X) - H(X/Y)$, thus we can reach the conclusion $I(P) < H(X)$, which means teaching quality will decline. If teaching quality needs improving, interference must be decreased, that is to minish $H(X/Y)$. Then how to reduce interference? The following aspects can be taken into account: firstly, as for control interference, invalid information mustn't be transmitted, let alone inaccurate and false information. Teachers must be well-prepared for classes and provide great lectures to students (WANG Wei-dong, 2000) to make signals true and real. Secondly, as to natural interference, methods are applied as following to resist interference: repeated transmission—repeating the key points of teaching; proofreading transmission—interactive examination, collateral evidence; transmission through various passages—applying several ways to transmit the same information. Success education, innovation education and trial education modes have applied the above approaches properly. Finally, as to subjective interference, "emotion adjustment method" can be adopted to arouse the attention and recognition of students to reduce incorrect understanding.

2.3 Enhance the effectiveness of received information on students

Effective information is determined by the following factors: one is objective factor, that is, the inherent value of information; the other is subjective factor. To students, information emission, transmission and environmental interference are objective factors, while the subjective factors lie in students themselves, information cannot be effective unless it is absorbed and transformed by students.

Students should possess certain receptive ability. Even when teachers have much strong transmission ability, the transmission results will be not good to students with bad receptive ability, which requires teachers to regularly guide students in "assimilating" relevant knowledge already existing in brains through reviewing and summarizing chapter knowledge structure to form scientific structure of every subject; when students' existing subject structure encounters inconsistent new knowledge, teachers should give in-time guidance to students in reconstruction of the existing subject structure, i.e. under instruction, adaptive psychological activities will occur to students, whose existing subject structure will become more inclusive and universally applicable.

At the same time, students should also possess certain information transformation ability. Only transformed information can be stored and used. The receiving information that cannot be transformed will result in invalid information in the end. So this requires that the activeness and initiative of students should be brought into full play in teaching. Some teaching modes have already paid attention to this.

With respect to different students, the degree of absorption and transformation of information will be different, in other words, the effective information they receive is different. As to a group of students, an effective

information distribution is inevitably formed, which is equivalent to "effective distribution" put forward by Bures and Gonthier, i.e. I=UH. Because $U \leq 1$ in this formula, the effective information is always less than the original information; that is, information loss is unavoidable in classroom teaching. However, as long as we design good teaching modes in the light of teaching laws, the value of U can approximate 1, thus teaching efficiency can be enhanced as much as possible.

Students' absorption and transformation of knowledge are a complicated process, which is related to the advanced nerval activity in people's brain, especially closely related to that of hippocampus and temporal lobes (Calvin, 1996). In addition, the process is associated with non-intelligence factors such as attitude, interest, emotion and so on. To our delight, a vast number of related proactive researches and explorations have been conducted in the different teaching modes, which will surely create successful experience for improving class teaching quality and efficiency.

To increase teaching effectiveness, first of all, the effectiveness of teachers' teaching should be improved, because teachers, who are in the leading position, are the major aspect of the contradiction between teaching and learning; in the second place, the learning effectiveness of students should be enhanced, for learning of the students, who are in the subjective position, under certain condition, will change into the major aspect of the contradiction between teaching and learning from the minor aspect; in the third place, the adapting degree and combination effectiveness in teaching and learning process should also be heightened, because this process is in the dynamic combination between teaching and learning all the time. Only under the guidance of such scientific thoughts can teachers control the whole teaching process and realize the increasing improvement of teaching effectiveness and performance.

Therefore, on the whole, to properly solve the problem of transmission of effective information in teaching process, teachers should not be the "play" key of a radio and continue their lectures regardless of the knowledge received by students, nor should they mistake students as the "record" key and put them in a passive position. What teachers should do is to emphasize "students-centeredness" and bring the activeness, initiative and pioneering spirits of students into full play to ensure that correct information in teaching process can be absorbed, transformed, stored and used by every student.

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(Edited by ZHANG Dong-ling)