

## Conceptualization of Assessment as a Formative System in Teaching and Learning: A Cybernetic Model

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### Abstract

A cybernetic model of assessment and learning is proposed. The basic proposition is that all assessment could be viewed as formative in learning, which has two implications: 1) assessment is a complex subsystem of learning, which is also a complex system by itself, as articulated in cybernetics; 2) this assessment subsystem has a formative nature in that regardless of its forms and approaches, it controls or regulates the learner's learning by influencing his/her decision-making in learn recognition of assessment as a controlling or modeling system in learning may also help clarify the relationships between assessment and other subsystems in learning.

**Key words:** Assessment; Formative; Cybernetics; Control system; China's EFL teaching and learning

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### INTRODUCTION

Assessment is an indispensable part of teaching and learning. However, perceptions of assessment vary. A majority of teachers, students and educational administrators still take it as an external force for

evaluation of learning. Though many are familiar with the concepts of summative and formative assessment, confusion still arises when these two types of assessments are applied to real teaching and learning. We believe this is because the relation between assessment and learning has not been well explained and the nature of assessment is far from clear to many teachers and educators.

The present research proposes a cybernetic model to explain the relationship between assessment and learning and illustrates the nature of assessment as a formative controlling system in EFL teaching and learning.

The construction of the model is based on our over 20 years' of teaching experience. And its application has helped large size as well as smaller classes in scaffolding students' learning process and improving teaching efficiency (Cao, Zhang, & Zhou, 2004; Cao & Chen, 2013). We believe it was the dynamic use of assessment as a tool for controlling teaching and learning that contributed to successful management of classroom activities.

### 1. CYBERNETICS, SYSTEM AND CONTROL

Cybernetics is not a new science but its application to education is relatively unfamiliar to many researchers in the field of EFL education. Cybernetics began as an interdisciplinary study in the 1940s and in the few decades since its inception, has been applied in the study of many sciences such as engineering, biology, physics, and sociology ... (cf. Beer, 1967; Glasersfeld, 1995; Heylighen & Joslyn, 2001), connecting the fields of control systems, electrical network theory, logic modeling, neuroscience, management and more recently social sciences.

Cybernetics is interested in systems and studies them. A system consists of elements that are interrelated. For instance, a building is a system, whereas a pile of loose

sand or bricks is not. Rapoport (1968) defines system as “a whole which functions as a whole by virtue of the interdependence of its parts” (p. xvii). The items or parts are not discrete points but are connected by a network of relationships. The whole is not the sum of the parts and it functions only as a whole.

Cybernetics is the science of control and communication (Wiener, 1948). It is interested in the kind of things that can be controlled (Beer, 1967) and is often concerned with how system stability is maintained with “control mechanisms” (Pask, 1961, p.12). In cybernetics, control is synonymous with *connectiveness* and is an attribute of a system where individual parts function through some form of control relation as a meaningful whole (Beer, 1967). The key idea underlying control is feedback (Ramaprasad, 1983; Kluger & DeNisi, 1996; Wiliam, 2012) which is defined in a broad sense as actions took by an external agent to provide information regarding some aspects of one’s performance. Feedback in cybernetics is seen as a loop or a cycle where information about the result of a transformation or an action is sent back to the input of the system in the form of input data. The consequences of the action triggered by the feedback are themselves served as feedback to further action. In this way, the system’s equilibrium is maintained.

Cybernetics is applicable when a system being analyzed is involved in a closed loop where action by the system generates some change in its environment and that change is reflected in that system in some form of feedback that triggers a system change. With its key words like system, control, feedback, cybernetics is becoming important in the vocabulary of professionals in virtually all fields including education.

## 2. ASSESSMENT AS A CONTROLLING TOOL IN THE TEACHING AND LEARNING SYSTEM

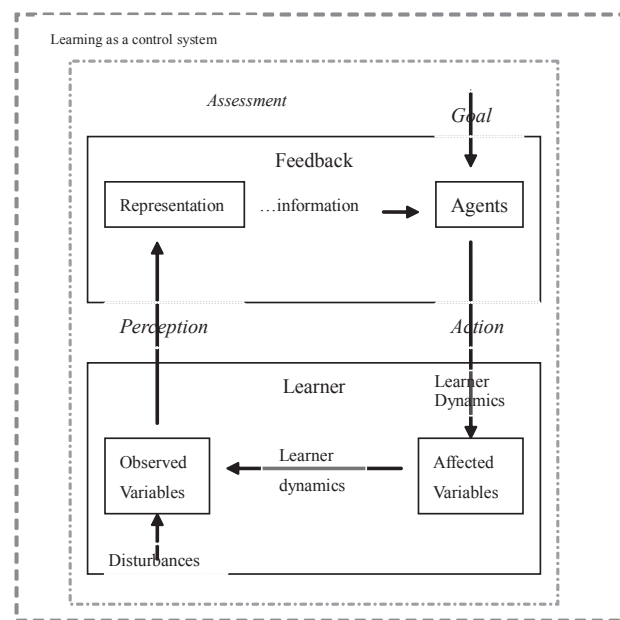
In his work *The Human Use of Human Beings* Wiener explained the relationship between communication and control:

When I communicate with another person, I impart a message to him, and when he communicates back with me he returns a related message which contains information primarily accessible to him and not to me. When I control the actions of another person, I communicate a message to him, and although this message is in the imperative mood, the technique of communication does not differ from that of a message of fact. Furthermore, if my control is to be effective I must take cognizance of any messages from him which may indicate that the order is understood and has been obeyed. (Wiener, 1950/1954, p.16)

Here, Wiener (1950/1954) depicted a mechanism of control through communication. The purpose of communication is seen as control, which means to

influence actions of another person by giving a message of order. The message is information fed-forward to the communicated person. If that person takes the message and acts upon it, feedback messages from that person to the initial communicator should be recognized. This forms a feedback loop: A to B to A, which might generate a new feedback loop with A’s further action upon the feedback messages he gets from B. Now it is not difficult to see the applicability of Wiener’s logic to the relationship between assessment and learning as the mechanism of assessment in learning is similar to the communication and control relation. Assessment (i.e., “take cognizance of any messages from him”) is an important tool that makes alignment between communication and control possible, and likewise, makes learning happen.

With learner, teacher, feedback, and other agents, such as administrators, parents and peers, etc., learning is a typical system as articulated in cybernetics. The following is a multiple layer model that tries to explain the mechanism of assessment in the learning system.



**Figure 1**  
The Learning and Assessment Hierarchy and the Control Mechanism Manifested in a Feedback Loop (cf. Cao, 2012, p.84)

Note. This is not a full description of the whole learning system, but it depicts the part of the learning system that highlights *assessment* as a controlling sub-system.

Figure 1 means to show the first/outer layer of the assessment model by articulating the hierarchical learning and assessment relationship. In cybernetics, the system components are often recognized as *functional*, and may or may not correspond to *structural* units (Heylighen & Joslyn, 2001). The bigger frame indicates learning as a control system whose elements are not fully demonstrated in this figure, for the major purpose of Figure 1 is to

highlight the learning and assessment relation. A major message from this figure is that assessment functions as a formative subsystem in the larger system of learning. Like learning, assessment is also a *control* system. Therefore, assessment is a control system by itself and a controlling subsystem in the learning system.

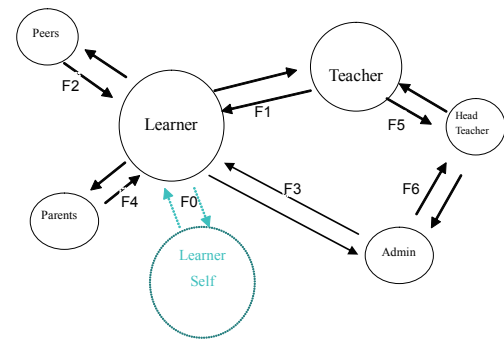
Adapted from some cyberneticians' illustrations of a control system (Heylighen & Joslyn, 2001), Figure 1 is also an illustration of the control mechanism of assessment as a complex system. At least two subsystems are described in the assessment system: feedback as a controlling subsystem and learner as a controlled subsystem. The figure describes the controller-controlled relation between feedback and learner, as articulated in cybernetics. The feedback system is in the position of a controller while the learner system is the controlled. The overall scheme of assessment as a control system is represented in a control/feedback<sup>1</sup> loop (involving both the controlling and the controlled subsystems). In the controlling system, the agent(s) are responsible for the system's interaction with the learner system, but the learner system also affects the controlling system by changing the state of representation, which is generated from perception of observed variables in the learner system. The feedback/controlling system may change the state of the learner system in any way, including the destruction of the learner system, through affecting dynamic learner factors while the action of the learner system on the feedback system is formation of a perception of the learner and representation of the observed learner variables in the feedback system as further information to be taken up by the agents.

A reciprocal controlling-controlled relationship between feedback and learner is assumed (e.g. some learners simply do not really welcome feedback so the feedback system is destructed), but since the highlight is the learning and assessment relation, the reverse relation is not elaborated in more detail here.

Figure 2 illustrates the second layer of the assessment model which further depicts some important elements of assessment as a complex system and describes their relations.

Here we see a multi-dimensional cybernetic system of assessment in spite of its limitation of a two-dimensional visual representation. First, it is a complex cybernetic model in which feedback is an important element/subsystem in the assessment system. Second, the figure shows a social construction of the assessment system.

The two figures above actually illustrate the integrated parts of one model. Assessment is viewed as a part of learning, as determined by the hierarchical feature of complex systems (Figure 1). Learning is a complex system that is self-regulatory, and assessment is a subsystem that helps the learning system achieve self-regulation/ dynamic homeostasis. Similarly, assessment is also a complex system in which feedback functions to maintain system equilibrium. The control mechanism of assessment is realized through power management among the feedback loops (Figure 1 & Figure 2).



**Figure 2**  
**Assessment as Co-Construction Through Feedback as Articulated by Cybernetics (Cao, 2012, p.86)**

Note. 1) The feedback concept is inclusive of all assessment forms that can send information about learning back to the system agents; 2) F0-F6 symbolize non-synchronous feedback loops but the numbers do not signify a sequence of the loops.

Several social factors (represented as *agents* in Figure 1) constitute the physical dimension of the assessment system (see Figure 2). They work as agents for feedback to take place and function in loops. It is postulated that learning takes place through interactive formative feedback between or among system agents (e.g. teacher, peers, learner reflective self, parents and administrative personnel), and assessment works in the form of feedback from agents to the learner, who takes the information and acts upon it by altering his/her own learning behaviour. Interestingly and importantly, learner in this control system is not totally left to the role of a passive recipient of feedback, but has a role to play in the controlling system as one of the agents in the form of a reflective self (see Figure 2). In addition, feedback will not actually be a loop without the learner in the controlled system taking in the message and acting upon it due to learner dynamics (e.g., interferences from social contacts, or hindrances from cognitive or affective factors).

A second feature of the social dimension of this model is characterized by its multiple but non-synchronized feedback loops between the learner and several other system agents. Two characteristics could be captured in this social construction of learning: the co-construction of formative feedbacks from different social agents and

<sup>1</sup> *Feedback* in this part of analysis has two meanings. Here it means information exchange between the two subsystems forms a cybernetic "feedback loop." A co-incidence is that the controlling subsystem itself as a component of the bigger assessment is *feedback*, which is a substantiation of assessment and it means information about learner's learning sent back to the learner from various sources.

the variability of strengths and timing effects of feedback loops. This model shows a network of several social factors working as agents for feedback to take place and function in loops in the role of controller, which is marked as F0-F6 (F meaning feedback). However, in this model, the order of Feedbacks (F1, F2, F3...) is more symbolic than prescribed. There is an innate relationship between feedback loops but their presence and working order of importance or immediacy vary from learner to learner. Personal construct in this model is embedded in the social construction. It could be helpful to look at this dimension in a social interactional approach (Pask, 1996), e.g. by referring to the concept of mediation in the psychology of Vygotsky (1978).

Applying socio-cybernetics thinking to our suggested model, we define assessment as an evolving complex system where management could help control the uncertainty or chaos of the system in which the instructor acts as a general manager or organizer and the learner as a project manager. In a cybernetic approach, assessment could be viewed as a complex system of self-regulation. The learner together with individual dynamics is the key component/sub-system while some social factors co-construct the system of assessment through feedback.

To make a closed feedback loop (Figure 1), the following requirements are to be met:

- 1) the perception of the learner variables (cognitive, affective, psychological, etc.) is formed and represented in the feedback system;
- 2) the learner information is taken up and acted upon by the agents;
- 3) feedback from the agents is sent to and received by the learner;
- 4) feedback is taken up and acted upon by the learner;
- 5) affected learner variables (with feedback effect) are observed and sent to the controlling system.

In sum, the above depicted model conceptualizes assessment as a formative subsystem in learning. First, assessment and learning relation is seen in a hierarchical system in which learning is a complex system while assessment is a controlling subsystem in learning. Second, assessment as co-construction in the learning system functions through feedback. Third, feedback is effective or formative only when it is taken up and acted upon by the learner. However, not all feedback effect is necessarily positive (i.e., being formative is not identical with being constructive/helpful for learning). Fourth, management is needed for a well-organized assessment system to function as an efficient controller in the learning system. Fifth, harmony among the agents within the learning system is the ideal state.

However, this model does not aim at building a framework that can include all learning factors, but at providing a model that can help explain the relationship between assessment and learning in the context of classroom learning and teaching. Learning as a larger

system is not demonstrated fully in these two figures. This model is largely a model of human involvement and therefore other physical elements in the environment such as subject matter input, school facilities, accessibility to computer and Internet, class sizes, financial and other backgrounds of individual learners, school inspection, etc. are not included in the model, although they are also indispensable elements in the learning system that have relevance to assessment.

### 3. FITTING THE MODEL IN CHINESE EFL CLASSROOM CONTEXT

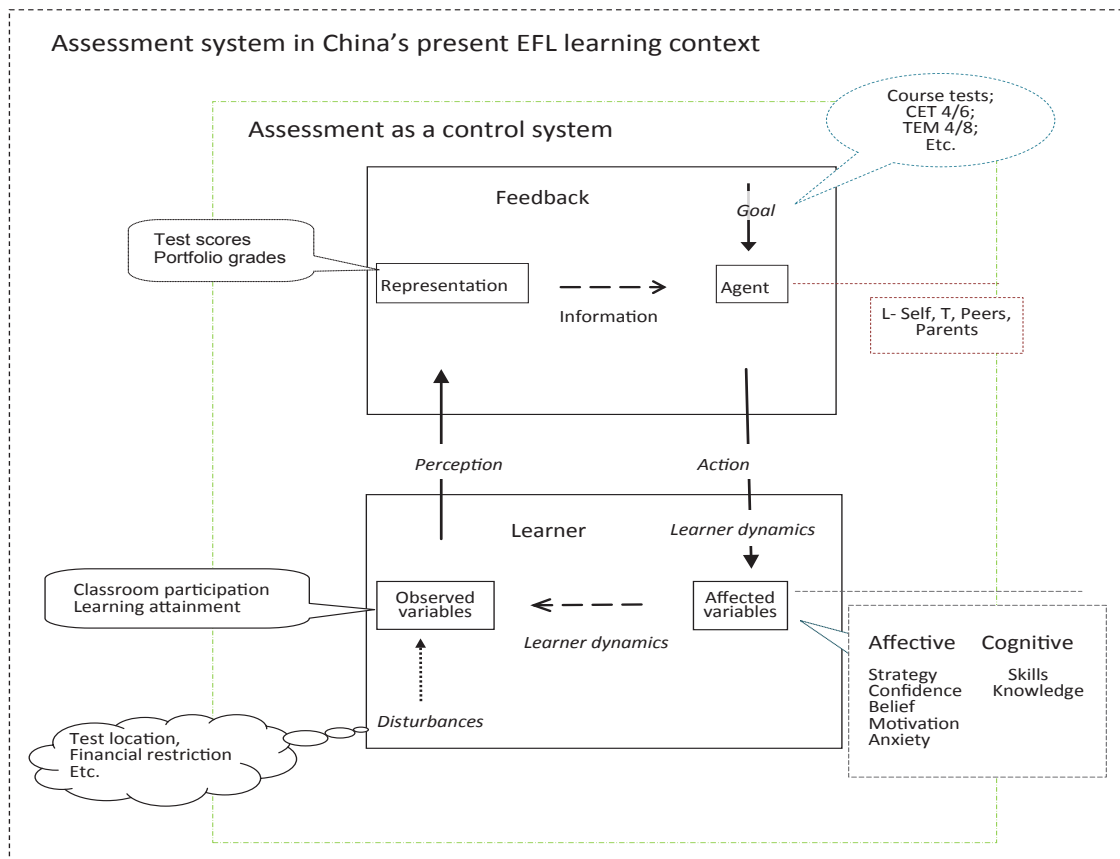
Revisiting the general cybernetic model for illustrating the feedback mechanism (see Figure 1) and accommodating it in China's present EFL learning context, the following figure (Figure 3) shows a specified version of the control system.

In China's EFL learning context, feedback from national tests (e.g. TEM4/8, CET4/6), which have a summative orientation, functions in goal-setting. System agents are substantiated in assessment stake holders including the learner, teacher, parents, peers and other relevant social relations. Feedback from agents will affect learning by altering cognitive, meta-cognitive or affective variables through working on learner dynamics (time allocation, adjustment of learning strategies, choice of learning partners, etc.). Changes will be observable in classroom participation, learning attainment recorded in portfolios and other performances like learning contests. The perceived changes will be aggregated into grades or scores. These representations of the learning attainment will become sources of new feedback for circulation of another feedback loop. Ideally the feedback loop is a closed one and can function as a system controller in sustaining learning. However, there is always a chance that the loop is not closed during the process of information transmission. For example, there is often the case in EFL teaching that the teacher gives little feedback on students' learning or teacher feedback is often ignored and fails to affect learners' cognitive variables. Another illustrative point is that affected learner variables are not duly perceived because of some disturbances from outside the system (irrelevant external tests, for example). Thus the information is lost midway, not achieving a desired constructive impact on learners' future learning.

While at the micro level the social aspect of assessment displays a salient influence on students' learning, at the macro level, the assessment policy does not seem to be aware of the full potential of this assessment aspect. Having been dominated with summative tests for a long time, the system is still in an apparent lack of balance among elements of different features. The consequence of cumulative effects from summative tests is that the assessment system is playing a destructive role in learning in a certain degree, which is an exhibition of the double-

edged nature of assessment. A suggested remedy for this problem is for policy makers to keep highly responsive to negative feedback from various sources and seek for a balance among the system element, for example, by

strengthening assessment for learning at the assessment policy level as a control over the exponential effect of summative tests.



**Figure 3**  
**Substantiation of the Cybernetic Model in China's EFL Education Context** (cf. Cao, 2012, p.168)

## CONCLUSION

The major proposition in this model is that the assessment is a co-constructive and formative system in learning. One major argument is that assessment controls learning through feedback as articulated in cybernetics. Another argument is that the assessment is an open system, in which the social agents co-construct through interactive feedbacks. All assessments are formative in the sense that no matter the assessment is designed for formative purposes or summative purposes, it will inevitably have an impact on learning. Assessment is formative in two possible directions: enhancing learning or deteriorating learning. This double-edged-sword nature of assessment asks for a dynamic management of assessment implementation.

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