

Applying sequential analysis to explore online teaching preparation behavioral patterns

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Abstract: In-depth exploring of users' actual behavioral patterns in e-Learning systems will be able to find out the limitations during their teaching/learning process and provide a good reference for intelligent system to provide auxiliaries to the process instantly. Instructional design (ID) is an important and highly complex behavior in the realm of teaching. This research adopted the sequential analysis, observed and analyzed online teaching preparations of 100 teachers. The study detected the teachers' sequential behavioral patterns and also proposed further suggestions for online intelligent ID systems according to the analysis method and the patterns we found out.

Keywords: Instructional design, sequential analysis method, behavioral pattern

1 Introduction

Instructional design is an important and highly complex behavior in the realm of teaching [1] [2]. For many years, model development for instructional design has been highly diversified (e.g. [3] [4] [5] [6] [7]), and each approach has projected different views and models (e.g. ADDIE, ASSURE, Dick & Carey, R2D2, etc.) Some of the previous studies related to the practice of instructional design used questionnaires to explore the activities and principles to the actual practices of instructional design followed by teachers. Some researchers also used case studies to observe the process of instructional design within a more concentrated scope [8] [9] [10]. Many such studies indicated that the teachers' ID behaviors vary according to the teaching scenarios and that these behaviors often do not tend to lean toward the one-way linear model (e.g. [11] [12]). However, it is difficult to observe the actual behavioral patterns of teachers in larger samples and establish a practical behavioral pattern, because it's difficult to track the process of ID behaviors and quickly form the sequential patterns through questionnaire surveys or case studies.

We consider that an in-depth understanding of actual sequential behavioral patterns in instructional design behaviors by teachers may provide references for ID-model design. These patterns can be compared with existing theories in order to verify their similarities and dissimilarities as well as to explore the consistency between theories and practices [13] and find out the limitations during teachers' ID process. Moreover, in the e-Learning context, the patterns can serve as references for intelligent systems to provide auxiliaries instantly to the process of ID on an intelligent online ID system. Nowadays, teachers often need to collect learning resources, draft teaching plans, develop teaching materials, and conduct teaching activities through online environments. The forms of ID behaviors, order

of processes, as well as modes of instructional design have also changed in response to these new technological innovations. Therefore, the process related to online ID behaviors of teachers in an e-Learning system has drawn extensive attention as a research topic.

This study tries to adopt the lag sequential analysis method [14] to detect the online ID behavioral patterns. This method is used to calculate/analyze the orders of multiple series of categorized behaviors and trace overall behavioral patterns [15], and it has also been increasingly used in analyzing interactivities of online learning [16] [17] [18] [19]. To sum up, this study tries to detect/analyze sequential behavioral patterns displayed by teachers in online teaching preparation through online empirical observation and to provide some suggestions for intelligent system to set up auxiliaries to the process of online instructional design.

2. Method

2.1 Participants

We hosted an online-ID workshop in 2004 inviting school teachers of all school levels to participate in an online instructional design project. A total of 100 participants participated in the workshop. With regard to their teaching background, most teachers belonged to the categories of 0 to 5 (93%) and 6 to 20 (6%) years of service; only one teacher had had a tenure of over 20 years. 12% of the teachers worked in elementary schools, 49% in junior high schools, 38% in high schools, and 1% in colleges.

2.2 Tool & Procedure

Behavioral observations pertaining to online teaching preparation required an online ID environment with a recording function to record the operation process. Therefore, we used the WIDE (Web-based Instructional Design Environment) online ID system [20]. This system provides teachers with an environment for general online teaching-preparation activities. None of the participants had had exposure to this system before the workshop. The experiment was conducted in a computer room in the following steps (1) System-operation training (60 minutes) (2) system trial (30 minutes) (3) Conduct online teaching preparation (4 hours): Each teacher selected a unit of his/her subject and completed teaching preparation by using the online ID system within 4 hours. During the observation period, the system automatically recorded all the processes of operation followed by the teachers into the database.

2.3 Data coding

The ID system was equipped with an automatic recording mechanism. When a teacher clicked on a certain function button or opened a certain webpage, the system would record the operation automatically and store it in the database. Since this study incorporated a sequential analysis of the teaching-preparation stage, all operations conducted by the teachers on the ID system needed to be coded. For this purpose, we referred to various ID models (e.g., ADDIE, ASSURE, Dick & Carey, R2D2, etc.) and related research literature (e.g., [3] [4] [5] [6] [7]) in order to form a general framework and define a scheme that would accommodate teaching-preparation behavior categories as well as some examples of online operations belonging to each category, as shown in Table 1.

Table 1 Behavior-Category Codes Scheme for Online Teaching Preparation
(Teachers using the online instructional design system for teaching preparation)

Code	Description	Operation Examples
Analyzing Learning Resources (A)	Teachers analyze the lesson topic and collect relevant online learning resources or supplementary materials as references in teaching-activity arrangements and teaching-material preparation.	<ol style="list-style-type: none"> 1. Add online learning resources relevant to the lessons to the resource list 2. Upload supplementary documents related to the lesson to the resource list
Designing Lesson Plans (D)	Teachers draft the lesson plans (including lesson information and teaching activities).	<ol style="list-style-type: none"> 1. Add to or modify the content of lesson information 2. Add to or modify the content of teaching activities
Developing Teaching Material (Dv)	Teachers select or edit the material; subsequently, they upload their teaching materials that might include teaching handouts, webpages, or slides.	<ol style="list-style-type: none"> 1. Upload slides or teaching-handout files 2. Use the system to edit digital teaching materials or webpages
Other Operations (O)	This includes the behaviors that cannot be included into any of the above categories.	<ol style="list-style-type: none"> 1. Logging in and out of the system 2. Editing personal files

The teaching-preparation operations undertaken by the teachers were recorded according to the classifications in Table 1. We also captured the operation logs pertaining to the 4 hours of analysis for all the teachers. Since our focus was on the inter-category sequential pattern (to check, for instance, whether the teachers carried out a series of “develop” operations after a series of “design” operations), we recorded the behavior codes of serial repetitions under a “behavior section” in order to accommodate a sequential analysis as well as to facilitate observations on the behavioral sequential model. This was done in order to prevent the repetitive sequence of operations belonging to each category from interfering with the result of the sequential analysis. In the 4 hours of analysis, a total of 1359 behavior sections were collected.

3. Results & Discussions

Based on the data recorded in the database, we conducted a sequential analysis [14]. The adjusted residuals table was listed in Table 2. We discovered that the level of immediacy reaches a significant level when the value (Z) recorded in the table is greater than +1.96. We also traced a behavioral transfer diagram (as shown in Fig. 1) based on this table.

Table 2 Adjusted Residuals Table
(Z-scores)

	A	D	Dv	O
A	-9.22	3.73*	-3.54	8.63*
D	-2.12	-18.68	19.27*	4.03*
Dv	-4.65	18.67*	-13.56	-3.88
O	16.54*	-3.44	-2.85	-8.91

* $p < .05$

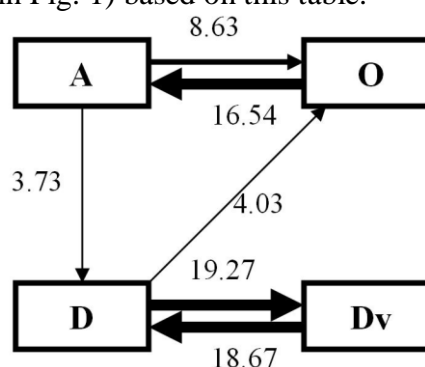


Figure1 Behavioral transfer diagram

In Fig. 1, the varying thicknesses of the lines indicate varying significance levels. From the information presented in Table 2 and Fig. 1, we organized the following behavior-switching trends: After ignoring the behaviors in the category of other operations (O), the behavior trends of online teaching preparation by the teachers could be stated as A->D, D->Dv, and Dv->D. In these sequences, “design” and “develop” behaviors demonstrated a high ratio of alternating applications. This shows that teachers tend to establish cross references between lesson-plan designing and teaching-material development, and they also tend to modify these repeatedly. Besides, our analyses revealed that “design” tasks are closely related to “develop” tasks. “Analyze” tasks, on the other hand, are mostly carried out independently. These findings indicate that the teachers tend to focus more on “designing lesson plans”; tasks pertaining to the “develop” and “analyze” categories serve as auxiliaries to references vis-à-vis amendments in the “design” tasks. In the overall process, “teaching material development” and “lesson-plan design” demonstrate a high ratio of counter-referencing and counter-influencing, but “learning-resource analysis” tasks occur more independently and are less connected to “design” tasks.

From the above discussion, we can find that the dynamic nature of this practical behavior pattern [21] characterizing online teaching preparation makes it different from the pure one-way linear ID models. On the other hand, this pattern can be classified as a dynamic “bi-circular liner pattern.” Formation of such a pattern is probably related to the nature of the Internet, because the Internet offers a higher level of convenience and richer online learning resources, which indirectly increases the ratio and opportunities for teachers to freely refer to the results produced in all behavior categories.

Further, we discussed means to set up intelligent automatic auxiliaries to the process of online instructional design. We suggest that the lag sequential analysis calculation may be added to the online ID software to detect teachers’ behavioral patterns instantly to assist teachers during their online ID process. From the pattern, we can assert that the “analyze” behaviors displayed by the teachers are more independent; however, the results of the learning-resource analysis (based on relevant websites, materials, or documents) can be used as instant cross-references to design teaching activities and develop teaching materials during both the D and Dv process. We suggest the use of an automated intelligent agent as the guiding-reminder provider that can provide automatic online feedback and guidance [22]. For example, during the process of editing teaching materials or lesson plans, agents can detect the users’ ID patterns and provide active guidance/feedback instantly in order to reinforce teachers’ interactivities among “analyze (A)” and “design (D)”/“develop (Dv)” behaviors. (e.g.: D->A or Dv->A). During the process of online teaching preparation, the agent can also run a process of automatic data mining, when teachers key in relevant keywords; the agent can automatically provide relevant information for reference.

4. Conclusion

This study tried to apply sequential analysis to explore the teachers’ behavioral patterns of their teaching preparation in an online environment. We also suggested the use of the sequential analysis calculation and intelligent-agent technology as an auxiliary tool for online ID systems. As for the limitations of this study, owing to the high degree of complications associated with whole practical online instructional design activity, we focused only on the initial exploration of the behavioral patterns related to the timed teaching-preparation practices followed by a group of teachers (subject and school system unspecified).

In the future, further analysis can be undertaken on the entire process of instructional design as well as the differences in the ID behaviors displayed by teachers from various school systems and teaching various subjects.

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