# An Approach to Organizing Pedagogical Texts Based on a Projection from a Hybrid Text-Researcher Space onto Ability Space

**Maryam Tayefeh Mahmoudi & Kambiz Badie**
Info-Society Dept.,
Iran Telecom Research Center, Tehran, Iran
Emails: {Mahmodi, K_badie}@itrc.ac.ir

## Abstract

In this paper, a new approach is presented for organizing pedagogical texts for researchers, based on a kernel projection from a hybrid text-researcher space onto the researcher's ability space, where the text-researcher space includes text's features as well as the researcher's reasoning styles and intention in doing research. The approach has been applied to organizing pedagogical texts for the topic of clustering that is a major issue in research areas of Informatics and Computational Sciences.

It is expected that the proposed approach can be equally applied to organizing pedagogical texts in any domain with no particular emphasis on the related domain knowledge.

***Key words:*** *Pedagogical text, text organization, text's features, reasoning style, intention, projection.*

## 1. Introduction

Pedagogical Texts can be particularly effective in the cases where teaching or transferring skills to the researchers through texts is highly taken into consideration [2]. It should be noted that the classical texts containing the domain knowledge and used for education or tutoring purposes, are not necessarily capable of equipping the researchers with basic abilities in research [1,5]. This leads to the idea that a pedagogical text should not only cover the minimum required knowledge for researchers in a certain domain (or a set of domains), but should also contain some features, which can later assure formation of certain research abilities in the researcher based on their specific mental conditions.

In this paper, we propose an approach to organizing of such types of text, based on the idea that a kernel projection must principally exist between the two spaces; one including a variety of features to be included in the text as well as the reasoning style and the intention of the researcher, and the other including the ability which is to be ultimately formed in the researcher through studying the text.

Although a fully reliable projection may not exist from the beginning, we however argue in the paper that it can be evolved through an adaptive process within which the learner can act as a source of modification feedback.

The paper has been organized as follows: Section 2 addresses some basic features for research pedagogical texts, while role of analogy in research conduction and additionally the abilities generated due to that, is discussed in Section 3. Section 4 discusses the kernel projection from the text-researcher space onto the ability space, and finally concluding remarks and future works are discussed in Section 5.

## 2. Basic Features for Research Pedagogical Texts

Text Organization for pedagogical purposes should be performed such that the following phases can be performed with respect to research tasks efficiently.

***Phase 1: Model Retrieval***
In this phase, it is essential to retrieve the scenarios that can best fit the desired research task. For this purpose, a similarity assessment function is required to assess which scenario(s) are sufficiently similar to the current situation in research.

***Phase2: Elaboration***
Having retrieved the appropriate scenario(s), a process is required to demonstrate whether or not they can be sufficiently appropriate. In case of any discrepancy, phase 1 will be repeated.

***Phase 3. Adaptation***
Once appropriate scenario(s) was (were) retrieved, an adaptation process will then be necessary to adapt the related framework(s) such that the outcome can best fit the current situation.

***Phase 4. Justification***
In this phase, the researcher gets to know about the validity of the adapted framework, either through experimentation, implementation, simulation, or some validation process based on formalistic approaches.

***Phase5. Learning & Error Interpretation***
Once justification was performed, the mal-performance (error) obtained is to be interpreted with the aim of reorganizing the essential knowledge to be used in previous phases.

To organize a text with the above impacts, it is essential to conceptualize the researcher's conceptual frameworks regarding a key issue in terms of the combinations of some modes with that key issue [3,6]. For key issues, we make use of those scientific concepts, which are concerned with basic methodology and have "action type" structure, e.g. concepts such as processing, recognition or clustering, which can equally be used in a variety of technical disciplines. By mode, we mean a scientific concept, preferably in terms of an adjective, which describes an aspect of the related key issue within the related scientific discipline, e.g. concepts such as fuzzy, neural, statistical, which characterize the different perspectives that can influence the way a key issue can be implemented.

Regarding the above discussion, each combination of mode and action can be considered as a central issue, which is to be explained thoroughly in the pedagogical text, so as to make a mental reference for the researcher.

In our approach, following types of features can be considered, when it comes to organizing a pedagogical text.

(I) Features concerning organization of the chapter related to each central issue.

*a. Introduction Layer*
which is responsible for providing an overall brief explanation for each central issue.

*b. The Layer Containing the Spectrum from Approach to Tools (including 'approach', 'framework', 'algorithm' and 'tools')*
which is responsible for providing detailed explanation with respect to the way a central issue can be materialized.

*c. Application Layer*
which is responsible for explaining the possibilities of applying a central issue from two different viewpoints; (i) scope of application for the central issue, and (ii) the very objective(s) that the central issue may follow with respect to different entities.

*d. Reference Layer*
which is responsible for indicating which major references (either articles, papers, chapters, or books) can be utilized as side resources for deepening researcher's studies. It should be noted that different styles of reasoning can be used, including Formalistic, Qualitative Domain-Theory Based, Reasoning in Experimentation for the purpose of justification, and Scenario-Based Reasoning, which respectively relate to mathematical/logical, intuitive, practical, and imaginative senses. (Table 1)

Table 1. Relations between Styles of Reasoning and Senses in Research with respect to the ingredients of "from Approach to Tools" spectrum.

| **Approach/ Framework** | **Algorithm** | **Tools** |
|---|---|---|
| Qualitative Domain Theory Based Reasoning, Scenario-Based Reasoning | Formalistic Reasoning | Reasoning in Experimentation for Justification |
| Intuitive and Imaginative sense | Mathematical/ Logical senses | Practice Sense |

As it is seen from the table, whenever Qualitative Domain Theory Based or Scenario-Based Reasoning is more important to the researcher, researcher's tendency would be more toward "Approach", while in case of Formalistic (mathematical/logical) reasoning, "Algorithm" would be selected as the researcher's tendency.

Finally, when some sort of experimentation is preferred, “Tools” will be the choice for the researcher.

*(II) Feature concerning complementary format for presenting an overall picture of the chapter*

In this respect, a table is constituted within which items such as a brief explanation of the essential algorithms (or approaches) for each issue, as well as advantages & disadvantages, and also the related applications are to appear.

*(III) Feature concerning indication of how an issue can be applied to possible entities*

In this respect, the possibility of applying a central issue is examined for a variety of entities, where some specific actions are emerged as promising application areas for future research.

*(IV) Feature concerning the way a new research topic can be generated*

In this respect, the correlation between an issue and possible combinations of entity and action are examined in some manner to conclude how new combinations of entity and action can be employed to implement some other goals within certain modes.

## 3. Analogical Reasoning and the Abilities to be generated in Researcher

### 3.1. Role of Analogy in Research Conduction

As discussed in section 2, we presuppose that the process of research is based on an analogical process, within which the frameworks already experienced in the past are stored in terms of some cases (or scenarios), and based upon the current research situation, some of these cases are recalled, and the related frameworks are then adapted in some manner to produce a final framework that can best fit the current situation.

The frameworks considered above can be viewed as some guides or references patterns, which can help researchers, utilize best their basic abilities based on their current situation in research. To describe a situation, a variety of concepts such as the major specifications of the considered task in research problems; i.e. the researcher wants to “retrieve” something, to find proper “references”, to “interpret” a situation, to “validate” some results, etc, are taken into account. By framework, we mean a set of factors, which can help the researcher perform the desired task in an efficient manner. For instance, if the desired task, is interpretation of the intermediate results in research, a framework should be finally adapted through analogical process telling the researcher what sorts of factors he/she has to consider to perform the research successfully.

An example is illustrated in Figure1, indicating a current research task of selection in terms of some concepts, and a retrieved similar scenario whose related framework is to be adapted for this current selection situation.

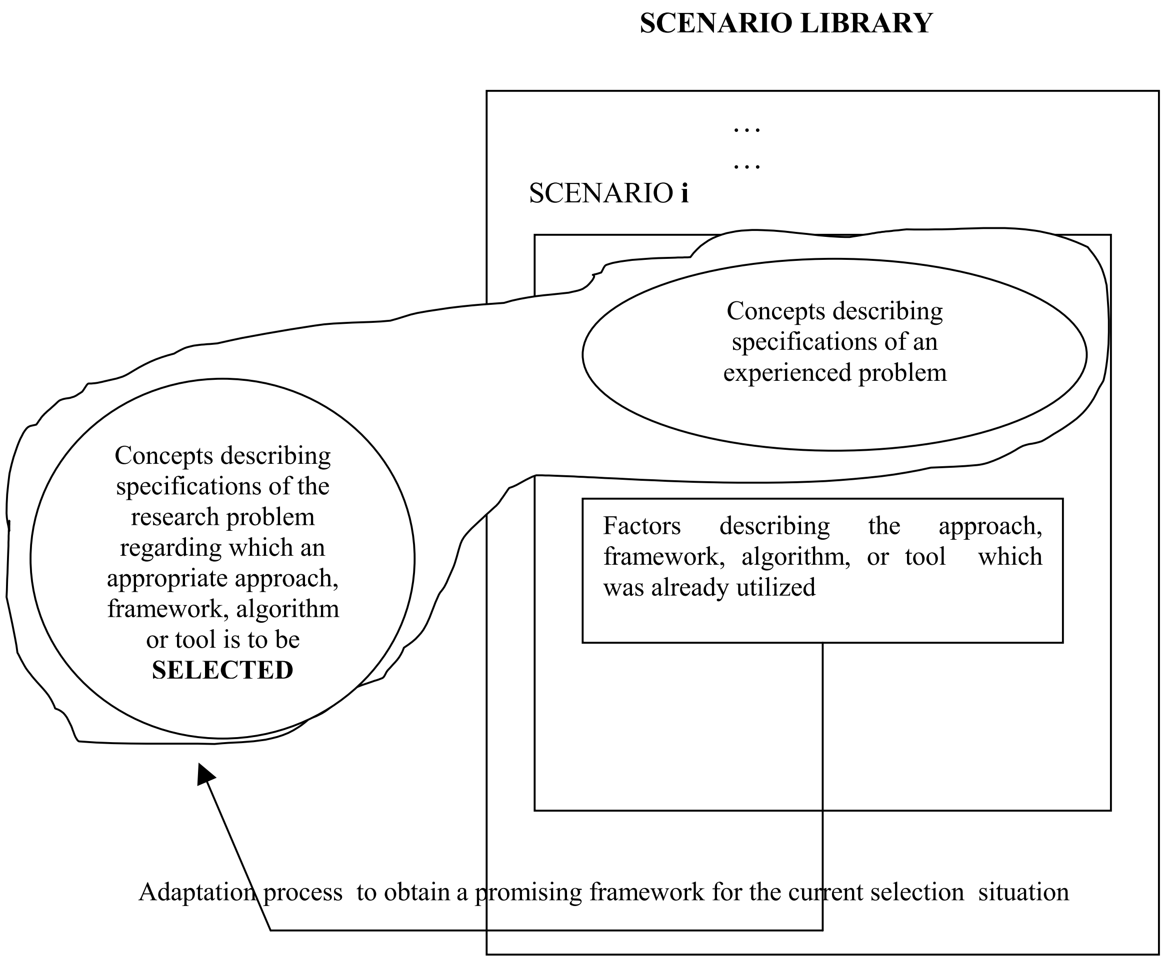


Figure 1. Adaptation process for the purpose of obtaining a promising framework for the current selection situation

## 3.2. Analogy-based Generation of Abilities in Research Conduction

Each task in research, discussed above, stands for a certain ability in the researcher, which could later be enhanced through the pedagogical text, taking into account a number of features which were already discussed in Section2. An overall investigation on the required task in research leads us ultimately to the following types of abilities:

*a. Ability in Selection*

This has a great role in selecting the proper approach, framework, algorithm or tool, which have been obtained through searching on Internet and global networks.

*b. Ability in Referencing*

To achieve proper answers (or solutions) for unknown items, a task significant to the researcher, is to refer to different types of textual information including monographs, papers, books, etc.

*c. Ability in Interpretation*

Within this context, the researcher needs some ability to interpret the intermediate results obtained within the research process (results obtained through formalistic reasoning, qualitative domain theory based reasoning, scenario-based reasoning, experimentation/simulation/implementation), preferably in terms of some hypotheses, theorems, lemmas or postulates to be furthely validated/verified.

*d. Ability in Reconsideration*

In case of any anomalies or misperformances for a, b or c, the researcher should be able to have reconsideration over the way tasks like selection, referencing, interpretation, topic generation or validation/verification are to be performed.

*e. Ability in Topic Generation*

Once a major research phase with predefined vision/objectives was accomplished, the researcher should be able to anticipate new directions for continuing his/her research work, or to generate new research topics as well.

*f. Ability in Validation / Verification*

In order to get assurance on the hypotheses, theorems, lemmas or postulates, the researcher needs to hold some ability on tasks such as validation or verification as well. Different styles of reasoning can be used in this respect.

## 4. The Kernel Projection Connecting the Text-Researcher Space to the Ability Space

*(I) Text-Researcher Space*
Text-researcher space in our approach comprises of three subspaces as follows:

a. Text's Features Subspace
This subspace includes all the features discussed before.

b. Reasoning Style Subspace
All possible kinds of reasoning such as formalistic reasoning, qualitative domain theory based reasoning, scenario based reasoning and reasoning for experimentation, as the essential types of reasoning in research activities, are included in this subspace.

c. Intention Subspace
This subspace includes the possible intentions that may exist in the researcher's model. Examples can be mentioned for a researcher who intends to perform Comparative Modeling or Prospect Anticipation in a certain areas.

*(II) Researcher's Ability Space*
This space consists of the researcher's abilities as discussed in section 3.2.

To explain how the first space can be projected onto the second one, a variety of rules can be employed, within which the propositions belonging to the text-researcher space constitute the condition part, while those belonging to the ability space constitute the action part [4].

As the initial step, these rules may be provided on the basis of human commonsense. However the text organized based on the ideas of these rules, can later be subject to modification based on the feedbacks from the researchers, and this process will be continued until the stage, where a kernel projection can be obtained satisfying the researcher's conditions most successfully. Some of the rules already used to materialize the initial kernel projection are illustrated in Figure 2.

| **Features** | **Reasoning Styles** | **Abilities** |
|---|---|---|
| Overall description | Domain theory-based | Referencing<br>Selection<br>Interpretation |
| For-Issue Algorithm | Formalistic | Selection<br>Interpretation<br>Referencing<br>Reconsideration<br>Validation |
| Utility Justification | Experimentation | Selection<br>Referencing |
| Research Topic Generation | Domain theory-based | Topic Generation |

Figure 2. Relations between text-researcher space & ability space

## 5. Concluding Remarks & Future Works

A new approach was presented in the paper for the purpose of organizing researcher's pedagogical texts, based on a kernel projection from a hybrid text-researcher space onto the researcher's ability space. It was discussed that the abilities in research emerged due to applying the essential text's features follow a process of analogical reasoning. Meanwhile, we explained that the simplest way for justifying the projection is a set of IF-THEN rules, within which the propositions belonging to the text-researcher space constitute the condition part, while those belonging to the ability space constitute the action part. Although these rules can initially be defined on the basis of human commonsense, they can however be subject to modification based on the feedbacks from the researchers as user's of pedagogical texts. Therefore, as a future work, a systematic approach to rules modification, preferably using advanced computational methods such as adaptive neuro-fuzzy systems, is suggested. This will ultimately lead us to computational assessment of the pedagogical texts provided on the basis of the proposed approach.

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