

MUHAMMAD SAEED *
SEHAR RASHID **

ALIGNMENT BETWEEN CHEMISTRY CURRICULUM AND TEXTBOOKS AT SECONDARY LEVEL

Abstract

This study was conducted to identify the degree to which the objectives of secondary level national curriculum (2006) of chemistry were aligned with the textbooks in Pakistan. The qualitative study was conducted by reviewing the national curriculum and the chemistry textbooks for grade 9 and 10 so as to find the degree of alignment. The analysis was done using two instruments after literature review: a) Curriculum-Textbook Alignment Rubric (CTAR); and b) Curriculum-Textbook Alignment Checklist (CTAC). The instruments were developed by the researchers and validated through experts' opinion. The instruments contained chapter-wise analysis besides other aspects such as physical features, typography, content organization, assessment exercises etc. The outcomes of the study revealed that there were some gaps between curriculum and textbooks. The specific objectives of some of the units/chapters were partially aligned with its general objectives. The study lays great implications in the sense that it provides feedback to curriculum developers and textbook authors to consider alignment between objectives and contents, and between contents and assessment exercises. The study suggests adequate training for the curriculum and textbook developers to ensure alignment between national curriculum and textbook in the subject of chemistry.

Keywords: National Curriculum, Chemistry, Alignment, Secondary

Introduction

The progress of each country is mingled with its education system. A high standard education system has direct association with socio-economic independence; which safeguards the right of ideological freedom of nations. Every nation has its goals which are documented in the form of curriculum document.

* Associate Professor, Institute of Education & Research, University of the Punjab, Lahore-54590, Pakistan, email: drsaeed1961@hotmail.com

** MPhil Scholar, Institute of Education & Research, University of the Punjab, Lahore-54590, Pakistan, email: sehar_rashid12@yahoo.com

The curriculum document is considered to be the road map for the attainment of the national goals. For this purpose, the text books are developed in such a way that the contents presented in the books are aligned with curriculum document. If there is no alignment in the text books and curriculum document, it is tough to achieved national goals to the desired extent which badly affect whole system of education.

Superficially, the aim of education is two-sided. It ricochet the socio-political aspirations of a nation and also be responsible for the instructional framework which includes the process to select the right content and instructional strategies (Uppal, 2006). However, the latter is not a separate entity but just a process to secure the formerly aim. To achieve the socio-political aspirations, the instructional techniques should be so branded that its constituents endure in synchronize with the national aims.

The competent organizations like Ministry of Education set the education standards. Those educational standards are termed differently in different parts of world as in British Columbia, for instance, those “standards are called Prescribed Learning Outcomes (PLOs)” (British Columbia, 2012).

These standards serve to identify where the children should be within a clearly defined continuum of learning. Those renowned academic standards are considered as curriculum (Hentges, 2010). In English dictionary (2010), the curriculum has three parts i.e. the written, taught and tested.

The “written (intended) curriculum takes shape when the curriculum agencies adopt standards to outline what content and processes should be communicated in the schools. In theory, textbooks are developed on the basis of written curriculum” (Mahmood, 2011).

Because of it textbooks are supposed to be demonstrative of the socio-political vision of a nation. In one of his previous study, Mahmood (2010) states that; “Especially, in developing countries, it has been a regular practice to consider textbooks as the major

source of the teaching learning process to be undertaken in school. In most of major parts of the world, and for most of the teachers, a textbook is an authentic material to be presented in the classroom".

Even vitality of curriculum document is not ignored in the advanced countries, where teaching learning practices does not orbit around just textbooks. Ball and Cohen (1996) acknowledge that "commercially published curriculum" (textbooks are one example) are the most dominant tool in the process of teaching.

Instructional material (textbooks) is tangible and regular contrast to frameworks, objectives, assessments, and other mechanisms that seek to guide curriculum. They contained units, lessons and teaching methodologies for teachers along with activities for student.

That significantly affords curricular materials a uniquely intimate association to teaching. Curriculum materials are not only well-settled to effect individual teachers' work but in contrast to many other innovations, textbooks are already "scaled up" and part of the routine of schools (Ball & Cohen, 1996).

It is evidently conclude that accomplishment of educational objectives is intensely dependent on the degree of alignment between the textbooks and the curriculum guidelines marked by curriculum development agencies. "The textbook is an acceptable tool for instruction as long as it is ...kept in proper perspective" (Ornstein, 1994). Consequently it is inexorable to conduct studies to inspect the said phenomenon.

Volumes of researches are conducted around the globe in recognition with the significance of this issue (Kulm, Roseman, & Treistm, 1999; Lepionka, 2006; McCluskey, 2006; Rehman, 2004; Mahmood, 2010, 2011; Dalim & Yusof, 4-5 June 2013), but as Nicholls (n.d.) rightly argued "that methods for textbook research are under-consideration and in need of further research". The importance of such studies is conceivably vital mainly in the developing countries like Pakistan where textbooks are

perpetually the supreme important mean for the teaching learning process.

The conduction of such studies in Pakistan is supported by the outcomes of previous studies as Slater (1995) stated (as cited in Nicholls, n.d.) that initiative behind studies about textbooks is the fact that most “devastating wars of history were fought on ethnic, nationalist or sectarian grounds” as Pakistan is fought against the similar issues also. Thus, the inclination towards these researches could be supportive to recognize those essentials in the textbook that may be the fundamental reason of these complications in the social order.

Historically, representation of the extent to which the different fragments of teaching methodologies could jointly attain the aspired goals of education was termed as ‘alignment’ in educational perspective. These fragments were standard, curricula, assessment and instruction (Case, Jorgensen, & Zucker, 2006).

However, the current studies emphasis on the degree to which the assessments and educational standards are in synchronization. For instance, Web (as cited in Squires, 2005) defined alignment as “the degree to which expectations [standards] and assessments are in agreement and serve in conjunction with one another to guide the system towards students learning what they are expected to know and do”.

Previous research identifies that there was little alignment between the curriculum contents and textbooks and assessments (Squires, 2005). The extent towards such researches became the focus of attention universally after the ‘No Child Left behind Act’ in US (Case, Jorgensen, & Zucker, 2006).

Because of the inclination of the understanding that the deficiency of alignment between the curriculum document and the textbook is one basic reason for the letdown of students that eventually cause for the higher dropout rate (Washington State Institute for Public Policy, 2007).

The results of this study were prompting for more investigation as they identified frail alignment in almost 50% of the secondary level textbooks even in higher grades.

Numbers of studies have been conducted universally to indicate the alignment between the curriculum document and the relevant textbooks (Kulm, Roseman, & Treistm, 1999; Lepionka, 2006; McCluskey, 2006; Rehman, 2004; Mahmood, 2010, 2011; Dalim & Yusof, 4-5 June 2013). These research activities become initiated to conform that the education system of the country is achieving the educational goals of the nation. However, very limited efforts have been made in this concern in Pakistan.

There was little importance anticipated to the chemistry curriculum (Rehman, 2004; Dalim & Yusof, 4-5 June 2013). This study was aimed to identify the degree to which the alignment exists between the national curriculum document and the textbooks of chemistry at secondary level. The chemistry subject was selected in identification of its importance among other science subjects as it is fetching a mandatory part of the method of learning whatever the field of study is.

To recognize the significance of this area of research, some researches have already been done in Pakistan as well (Iqbal, Mahmood, & Saeed, 2009; Mahmood, 2010, 2011; Mahmood & Saeed, 2011; Shah, 2012), but the focus of all these researches was the elementary school subjects. To identify alignment between curriculum and textbooks, no sufficient research has been met at secondary level for the chemistry subject which is the target of this study.

These studies' recommendations are to further explore this area of research as textbook evaluation process in Pakistan need to be authenticated through the introduction of some validated rubric for this purpose (Rehman, 2004; Mahmood & Saeed, 2011).

Objectives of the study

The study was based upon following two objectives:

- To investigate the alignment between the national curriculum (2006) and the textbooks of chemistry for grade IX-X published by Punjab Textbook Board
- To propose remedial measures to minimize the identified gaps between national curriculum and textbook

Research Questions

The research questions of the study were as under:

- Are the general objectives of the teaching chemistry at secondary level aligned with the specific objectives which designed in the light of those general objectives?
- Are the textbooks of chemistry for grade IX-X aligned with the national curriculum (2006)?
- How far the chemistry textbooks are helpful in the achievement of desired learning outcomes through students' activities, assessment plans, etc.?

Methodology of the Study

The study was qualitative in nature and was mainly conducted through documentary analysis. The documents under consideration were:

1. National Curriculum of Chemistry for Class IX-X(2006), Ministry of Education, (Curriculum Wing) Government of Pakistan, Islamabad

2. Textbook for Class IX publish by Punjab Textbook Board, Lahore.
3. Textbook for Class X published by Punjab Textbook Board, Lahore.

It is important to mention here that the textbooks of chemistry (IX-X) were analyzed which have been written according to the national curriculum (2006).

Two instruments were developed for data collection: (a) 'Curriculum-Textbook Alignment Rubric (C-T Alignment Rubric)' and (b) 'Curriculum-Textbook Alignment Checklist (C-T Alignment Checklist)' which was designed after the review of different studies of the same nature (Appalachia Educational Laboratory, 2005; Washington State Institute for Public Policy, 2007; Mahmood, 2011; Mahmood & Saeed, 2011).

These tools were validated through experts' opinions of the field of curriculum/material development and training working at Institute of Education & Research, University of the Punjab. The first instrument i.e. C-T Alignment Checklist was a four point scale comprised of the items about the best practices around the globe about the alignment procedures.

The second instrument was named as C-T Alignment Rubric comprised of three major components. In the first component, the textbooks were examined at macro level examining about the physical features, typography, balance of division of units/chapters and curriculum linkage. The second component was the micro level review.

The learning goals were listed in the light of curriculum document used by the textbook development agency (Ministry of Education, Curriculum Wing Islamabad). There were two types of goals given in the said curriculum document: (a) General objectives, and (b) Specific objectives (these objectives were divided in units/chapters of the Textbook).

Initially the association between those specific objectives and the textbooks was investigated by determining the corresponding content against those objectives in every chapter. The instructional plans and students' activities were also taken into meditation in order to recognize how much the Textbook is helpful to reinforce concepts of the children for a topic in hand.

It was also identified through the same component of the rubric whether the assessment plan was compatible with the intended learning outcome and what level of Bloom's taxonomy of cognitive objective has been achieved with the help of a particular assessment item.

The third component of the C-T alignment Rubric was comprised of the chapter wise comments of the researchers about the elements examined in first two components in order to summarize the observations made in the second component. After completing the review of the textbooks with reference to the specific objectives, it was used to identify the alignment between the specific and the general objectives of teaching chemistry at secondary level.

Discussion of Results

On the basis of analysis made with the help of instruments, the conclusions and recommendations are as under:

C-T Analysis Checklist

The analyses made by the instrument according to the selected parameters are as under:

Objectives.

The specific objectives in the curriculum document were adequately aligned with the general aims given in the same document; while the chapter-wise objectives of the textbook were partially align with curriculum objectives.

Textbook content.

The contents of the textbook were adequately congruent with curriculum document, terminologies are well presented and the concepts are adequately enable students to understand the fundamental terms.

Learning activities.

Learning activities were partially aligned with the curriculum outlines and partially designed in accordance with the students' cognitive level. Learning outcomes were not helpful to develop scientific research attitude in the students according to the curriculum document.

Assessment of students' learning.

The assessment plans were partially aligned the specific objectives designed for the textbook and with the knowledge and skills curriculum document emphasizes. Assessment plans adequately measures students' lower cognitive abilities (knowledge and understanding) and partially measures students' higher cognitive abilities (application, analytical, critical and creative abilities).

C-T Analysis Rubric

The analysis made by this instrument according to the selected parameters was as under:

Physical features.

Even though physical features of the textbooks have no direct link with the issue of alignment between curriculum document and the textbooks, yet the studies like (Mahmood & Saeed, 2011) about the evaluation of textbooks suggest that these factors definitely have effect on the attainment of the objectives for which those textbooks are designed. Consequently, the textbooks were also reviewed with intention to examine these factors.

The title and back pages contain pictorial texts that are appropriate for the age group of secondary level. The text used is good for conveying social messages to develop good attitude of children towards life but not relevant to subject. Page size is satisfactory but binding conditions of textbooks are not satisfactory. Color scheme is used. Color scheme is well used to make the content eye-catching and interesting for students.

Typography.

The entire features of typography used for the textbooks are practically good.

Chapter/Unit Division.

There were no recommendations regarding to the weightage in the curriculum document for both textbooks. The unit-wise weightage presented in the books is not according to the content length of the unit.

Curriculum Linkage.

The curriculum linkage has been mentioned in the national curriculum for chemistry 2006. To identify the curriculum linkage between the textbooks, the textbooks of two grades above and three grades below were reviewed. The horizontal linkage found good but the vertical linkage was found to be faulty. The evidence of lack of vertical linkage in the text book of 9th is as under:

1. In vertical linkage of unit 1, the build on concepts topic “symbols, chemical formula” was present in VII and VIII grade rather than VI as mention in curriculum document.
2. In vertical linkage of unit 5, the build on concepts topic “state of matter” were present in VI grade rather than IV as mention in curriculum document.

3. In vertical linkage of unit 6, the build on concepts topic “properties of solution” was not present in VI grade as mention in the curriculum document.

Specific objectives.

As per researchers’ assessment, this is the weakest deliverable of the curriculum development process made. It contains some of the major issues of concern that need to be improved. The language used to define those objectives does not look to be reviewed. Therefore, several objectives were found meaningless. There were repetitions of the objectives within some chapters, such as:

1. Objective 1 under heading ‘understanding’ in chapter 4 is related to chapter 3 instead of chapter 4 of textbook of 9th class.
2. Objective 3 was repeated as objective no. 4 and 5 under heading ‘understanding’ in chapter 6 of textbook of 9th class.
3. Objective 8 under heading ‘understanding’ repeated as objective 3 under heading ‘society, technology and science’ in chapter 2 of textbook of 9th class.

According to curriculum document the objective written under heading ‘skills’ should be related to the laboratory work, but for some chapter the objectives under heading ‘skills’ were not related to the laboratory work such as, chapter 1 and 3 of 9th class textbook and chapter 9 and 14 of 10th class textbook.

Instructional plan and assessment activities.

No specific instructional plan was guided. The information was generally given in narrative form and teacher looks to have no other option except using ‘lecture method’ to explain the text. Some questions were found that the students have to apply their higher order cognitive skills.

Order/sequence of topics.

The order of topics is according to easy to difficult approach in the textbooks of both classes. This makes students to easily understand the concepts.

Irrelevant topics in the textbooks.

One of major challenges to degree of alignment between the textbooks and the curriculum was the fact that every chapter of both the textbooks contains the topics that do not match any learning goal. The following table contains this information.

Table 1 List of topics that do not correspond with any learning goal in the curriculum document chapter wise

Class	Chapter no.	List of Topics
9 th	1.	All topic have some relevance with the curriculum document
	2.	"theories and experiments related to structure of atom" at p. 28
	3.	"electron affinity" at p. 53
	4.	"dative covalent or coordinate covalent bond" at p. 63, "polar and non-polar covalent bond" at p. 64, "metallic bond" at p. 65, " dipole-dipole interaction" at p. 66, "hydrogen bonding" at p. 61, "covalent compounds" at p. 69, "coordinate covalent compounds" at p. 70, "metals" at p. 70
	5.	"compressibility", "mobility", "density of gases" at p. 77, "freezing point", "diffusion" at p. 88, "density", "rigidity" at p. 89, "density" at p. 90
	6.	"percentage" with all its subtopics at p. 100, 101, "solubility and solute-solvent interactions" at p. 105, "effect of temperature on solubility" at p. 105, " solution", "colloid" at p.107, " suspension" at p. 108
	7.	"concepts of electrolytes" with all its subtopics at p. 120, "electrolysis of water" at p. 122, "manufacture of NaOH from brine" at p. 126, "electroplating of silver" at p. 130
	8.	"significance of non-metal" at p. 149
10 th	9.	All topic have some relevance with the curriculum document
	10.	"general properties of acids" at p. 27, "general properties of bases" at p. 29, "indicators" at p. 35,"salts"with all its subtopics at p. 38, 39, 40, 41, 42, 43
	11.	"electronic or dot and cross formula" at p. 54, "coal" at p.61, "petroleum", "natural gas" at p. 63, "plants",

	"synthesis in laboratory" at p.64, "tests of functional groups" at p.71 with all its subtopics,
12.	"sources of alkanes" at p. 84, "physical properties of alkanes" at p. 85, "combustion" at p. 86, "uses of methane and ethane" at p. 86, "occurrence" at p. 88, 91, "physical properties of alkene" at p. 89, "hydrogenation of alkenes" at p. 89, "hydrohalogenation of alkenes" at p. 90, "uses of ethane" at p. 90, "uses of acetylene" at p. 93
13.	"amino acids" at p. 105, "fatty acids" at p. 106, "carbohydrate as a source of energy" at p. 102 under heading 'society, technology and science
14.	"greenhouse effect" at p. 122
15.	"water as solvent at p. 139, "disadvantages of hard water" at p. 143, "agricultural effluents" at . 145, "preventions of waterborne diseases" at p. 147
16.	"advantages of Solvay's process" at p. 163, "raw material", "process" at p. 164, "importance of fractions of petroleum" at p. 168

Relevance of assessment activities with the learning goals.

As evident from the table 1, there were numbers of topics in nearly every chapter of the textbooks that do not match with objectives of the relevant chapter in the curriculum document. Therefore, there were several assessment activities assessing the learning of that irrelevant topics, subsequently those assessment activities also become irrelevant to the learning goals.

Connection between general and specific objectives.

As per curriculum document of National Curriculum 2006, (Ministry of Education, 2006), the general objectives for introducing chemistry at Secondary level are as under:

1. Knowledgeable about the key concepts and theories of Chemistry
2. Able to think scientifically and use Chemistry content knowledge to make decisions about real-life problems
3. Able to construct new knowledge through reading, discussions, and research

4. Familiar with the natural world and respectful of its unity, diversity, fragility, and interconnectedness
5. Able to make wise judgments on statements and debates that claim to have a science base.

After the review of the specific objectives and the relevant content in the textbooks, the observations of the researchers about these objectives are as under:

Knowledgeable about the key concepts and theories of Chemistry.

This general objective was look appropriate for the students of secondary level but it has not been contented completely in form of specific objectives for the textbooks. The key concepts related to the chemistry were well addressed in the specific objectives but specific objectives related to the theories of chemistry were not stated clearly and meaningfully such as the 2nd objective of unit 2 of 9th grade chemistry.

Able to think scientifically and use Chemistry content knowledge to make decisions about real-life problems.

This was a most critical general objective to address as specific objectives in each unit of the textbooks of chemistry grade 9th and 10th. This general objective was not directly addressed as specific objective but by achieving the specific objective of the whole textbooks do able the students to think scientifically and use the chemistry knowledge to take their decision about real life problems to some extent.

Able to construct new knowledge through reading, discussions, and research.

In researchers view, there was not a single topic in the textbooks of 9th and 10th grade which will able the students to construct a new knowledge through reading, discussions and research.

Familiar with the natural world and respectful of its unity, diversity, fragility, and interconnectedness.

The understanding of key concepts in unit 1 and somewhat in other units of 9th grade chemistry textbook add its part to familiar the student with the natural world and general objectives under the heading of “society, technology and science” make the students respectful of nature’s unity, diversity, fragility and interconnectedness.

Able to make wise judgments on statements and debates that claim to have a science base.

This objective must be a default choice for the students of secondary level as it needs the wider and in-depth understanding of the scientific knowledge which is beyond the textbooks of chemistry at secondary level.

Conclusions and Recommendations

In the light of the results discussed in the previous section, the conclusions and recommendations are as under:

1. The binding quality of textbook for chemistry IX and X is not good and it needs improvement.
2. In the textbook for chemistry IX, the units of the key terms should be clearly written.
3. In the textbooks of chemistry IX and X, the content of the units/chapters having some of the topics which shows no linkage with the objectives of those units/chapters given in the curriculum document for chemistry grade IX, X 2006. The topics covered in the content of the units/chapters should be linked with objectives of that unit/chapter given in the curriculum document for chemistry grade IX, X 2006.

4. Some of the objectives of each unit/chapter of textbook for chemistry IX and X were not discussed in the unit/chapter. The content of each unit/chapter should cover all the objectives of that unit/chapter given in the curriculum document.
5. Activity plans given within the units/chapters were comprised of the questions to be answered rather than activity based learning. The activity plans should measure the activity based learning in the textbook of chemistry IX and X.
6. Many questions in assessment plans given at the end of the units/chapters not related to the content discussed in the unit/chapter, these questions should be linked with the content discussed in the unit/chapter of textbooks of chemistry for IX and X.
7. In the chemistry textbooks for IX and X, questions given in the assessment plans were not developed properly. These should be developed according to set principles/rules of MCQs, SAQs and ETQs. Especially multiple choice questions (MCQs) should be developed according to the specific test construction rules and these should be reviewed from some technical experts having desired competency in test construction.
8. There is need for improvement in regard to vertical content linkage in the textbook of chemistry for class IX.
9. Assessment plans and activity plans in each unit/chapter of textbook of chemistry IX and X were not compatible with the learning outcomes mentioned in the corresponding chemistry curriculum. Assessment plans and activity plans must be compatible with the learning outcomes mentioned in the corresponding curriculum document.

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