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Alignment Level of Science Textbooks with the National Standards for Earth and Space Science Curriculum in Saudi Arabia

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The current research aimed to investigate the alignment level of the content of science textbooks in Saudi public education with the national standards for earth and space science for (1-12) grades, and to determine the proposed aspects for treatment and development; a descriptive analytical method was utilized. Ten (10) analysis cards were designed for (1-12) grades, where each card included a list of learning outcomes covering the standards of earth and space science in each grade of the four levels (foundation, reinforcement, expansion, and concentration). The findings showed that the alignment level of science textbooks with the national standards for earth and space science curriculum in knowledge and understanding for (1-12) grades was moderate. While foundation was ranked first and rated high, reinforcement was ranked second and rated high, and expansion was ranked third and rated moderate. Concentration was ranked last and rated moderate. Accordingly, the study defined the proposed aspects of treatment and development. A set of recommendations was made to bridge the gap between the present science textbooks and the national standards for earth and space science in Saudi Arabia.

Keywords: *Alignment of curriculum, National standards for science, Content standards, Performance standards, Standards for earth and space science*

Introduction

The comprehensive transformation adopted by the Saudi Vision 2030 requires paradigm shifts in education, especially in science education because it is a basic component of community development in the industrial, technical, and scientific domains. Based on the latest international educational trends, science curricula have been developed and reformed to offer education that advances the economy. Since the early 1980s, many reformation projects of science have evolved, such as Science, Technology, and Society; National Science Education Standards; Project 2061 by the American Association for the Advancement of Science. In 2013, the National Research Council collaborated with some institutions and bodies to develop and approve the Next Generation Science Standards (NGSS) that offer accurate criteria to evaluate progress towards an international scientific perspective for science teaching and learning. They stress the importance of evaluating learning curricula collaboratively by a group of reviewers, educators, and experts through taking notes on the practices aligned with standards, supporting performance expectations and evaluation methods, and offering support to access all learners (Assadouy and Ashamrany, 2016; Asshaee and Shanyan, 2006; Kristen, 2016; Next Generation Science Standards, 2018).

Saudi Arabia was not far from the international educational reform of science curricula. The Education and Training Evaluation Commission (ETEC) has developed the standards of public education in collaboration with the Ministry of Education based on the implications and goals of the Saudi Vision 2030, the National Standards of Public Education Curriculum, and specialized frames of learning fields. Experts of education, universities, relevant experts of ministries and authorities, private sector representatives, the Australian Curriculum Assessment and Reporting Authority (ACARA) as an international center of excellence that offers consulting support and developing the members of the scientific committees, and the Excellence Research Center of Science and Mathematics collaborate to relocate the standards of curricula in Saudi Arabia. Development of standards went through a number of stages, namely diagnosis of reality and capacity building, analysis of national and international documents, benchmarking with (23) countries, and building frames and documents of standards. It went through stage evaluation and community participation with (450) specialists and experts (ETEC, 2018).

The National Standards of Public Education Curriculum is a general intellectual framework and a comprehensive vision of curricula. It covers the basics of building curriculum standards, vision, mission, characteristics of learners aligned with community needs, domains of the standards' structure of learning fields, guiding principles of curricula, as well as specifications, resources, and building of content and performance standards (ETEC, 2019b). The National Standards for Sciences are standards of learning fields in public education that aim to educate all learners scientifically by providing foundation knowledge in various science fields, empowering them of

the scientific and engineering practices and applications, and relationship to the issues related to human, society, and environment to prepare scientists, engineers, and technicians. Content standards define what a learner should learn, understand, and perform in sciences at all levels and grades. They aim to guide education and learning, build educational materials and resources, and evaluate learner performance according to levels and grades. On the contrary, performance standards describe the expected achievement level after studying sciences in the light of content standards. They are defined according to levels and grades.

According to the ETEC (2019a, pp. 6-7), the objectives of learning sciences suggest that a learner should:

1. Represent the relationship between science learning, thinking, and reflection on Allah's great creation and achieve Islam's mission regarding people's succession and earth settlement.
2. Praise the value of science, scientists, as well as historic transcultural, communities, and races contributions of sciences, especially the Islamic, Arabic, and national ones.
3. Form positive attitudes and orientations towards science, relative jobs, and future choices.
4. Perceive the nature of science as a method of thinking, developed, and changeable based on evidence, proofs, and arguments.
5. Have a deeper understanding of the comprehensive scientific knowledge in sciences and other fields to understand the surrounding natural phenomena comprehensively.
6. Make informed decisions based on evidence of the application, as well as current and future issues of science, considering the ethical and community effects of these decisions.
7. Develop thinking and scientific inquiry skills; master the design and production of scientific, engineering, and technical applications; find creative solutions to problems.

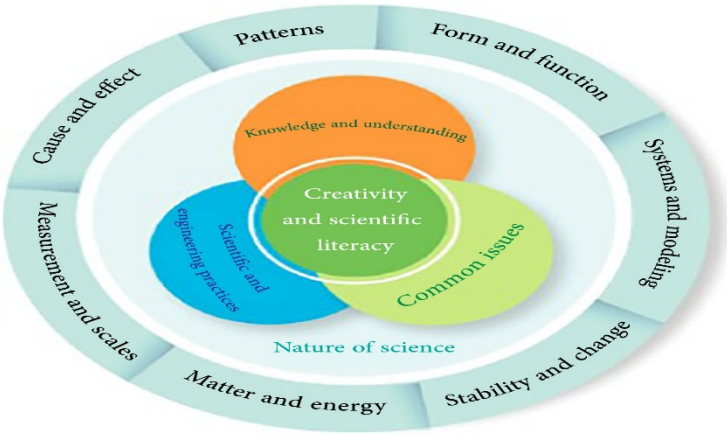

Figure (1): Document of the Specialized Framework of Science (ETEC, 2019a)

Figure (1) illustrates the basic components of the science learning structure through various levels. It is based on the nature of science, as well as the general trends, causes, and objectives of its learning. It suggests the national standards for science in public education that is perceived as a comprehensive unit of three interrelated domains, i.e. knowledge and understanding, scientific and engineering practices, and common issues to help acquire skills based on scientific inquiry and engineering design. It also shows the relationship between science applications and the common issues of all domains of scientific literacy, reflecting the nature, development, and ethics of science, as well as the relationship of science and the issues related to human, community, and environment to deepen the comprehension and integration of the central themes of sciences. This structure is framed by the following seven comprehensive concepts that provide learners with mental tools related to the content of science and unite the learning, applications, and common issues of science and engineering (ETEC, 2019a).

- Knowledge and understanding are key central ideas of science and engineering in the major science fields that enable learners to pursue learning, predict and interpret phenomena, and solve problems.
- Science and Engineering Practices (SEPs) are the behaviors of scientists in integration through searching, inquiry, developing models and theories on the natural world. Engineering practices are adopted by engineers in designing and building systems, including raising scientific questions, defining the problem of design, developing the use of models, planning and implementing inquiry, analyzing and discussing data, using mathematical and computational thinking, and scientific interpretations.
- Common issues tackle social problems resulting from interaction between science, engineering, technology, and community.
- Comprehensive concepts are seven unified concepts between all fields of science with applications. They are thinking tools and a linking method between the fields. They are form and function, systems and modeling, stability and change, matter and energy, measurement and scales, as well as cause and effect.

The specialized structure of science is the basic domain of standards' structure supported by three other domains in which science shares with other learning fields according to the nature of the field. Each domain includes a set of major and minor ideas shared with public education curricula, namely priorities, values, and skills. The domains integrate with the structure of cognitive science to support learner's understanding of the content and achieve the vision of curricula standards to make the learner proud of religion and language and contribute to national development with a creative, just, and productive personality (ETEC, 2018). Undoubtedly, all educational systems should pay attention to determine the alignment of curriculum and implications with references and standards based on the educational policies, development needs, perspectives, attitudes, social cultures, and learner needs developed according to organized strategies that link reality and

challenges of life, content and implications of curricula, educational practices, comprehensiveness of the knowledge and skill content, alignment with standards, and correlations across grades (Apthorp, Bodrova, Dean, and Florian, 2001).

The emergence of standards has motivated interest in curriculum alignment to define the level and type of correlation between educational policies and the documents of standards and their representation in the frames of curriculum and evaluation to provide accurate information that enables decision-makers of making appropriate decisions concerning the quality of curriculum and evaluation based on certain standards and supporting schools in choosing the materials and strategies of teaching, learning, and evaluation for achieving the high expectations of learners (CCSSO, 2002). These standards also increase the opportunities for professional development for teachers and the development of evaluation systems in schools. The Center on Standards and Assessment Implementation (CSIA) (2018) reports the importance of curriculum alignment with standards to provide learners with opportunities to access content and target skills. Additionally, knowledge, skills, and abilities should align with standards' documents that correlate with learners' progress from grade to another (vertical alignment) and that standards correlate within grade levels (horizontal alignment).

After the emergence of NGSS, ACHIEVE introduced a set of criteria that illustrate judgment on the alignment, design, and building of educational units concerning learners' understanding of phenomena or suggested solutions to problems whether in SEPs, Disciplinary Core Ideas (DCIs), and Crosscutting Concepts(CCCs) to maintain the cohesion of these units and ensures the integration of the content with other disciplines and key standards shared in mathematics, language, and social studies (NGSS, 2018). Reviewing the relevant educational studies illustrates the multiplicity of terms that express alignment, including adherence, match, and consistency. Alignment is the most common in curriculum analysis (Webb, Herman, and Webb, 2007).

Most of the reviewed literature presented approximate concepts of alignment. For example, Webb Horton, and O'Neal (2002) defined alignment as the extent to which the expectations (standards) and evaluation are in agreement to guide the system toward offering materials and methods that meet standards to achieve what a learner should learn and perform. Anderson (2002) provided a definition with correlated systematic dimensions of alignment as the analysis of the relationship between evaluation and objectives, on one hand, and evaluation, objectives, materials, and activities, on the other. According to Bhatti (2015), alignment is the agreement between curricular activities, evaluation, learning resources, and curriculum. Moreover, CSIA (2018) perceived alignment as the alignment of standards and curriculum to empower learners to access content and defined skills. While standards determine what a learner should know and perform, the curriculum illustrates acquiring knowledge, skills, and attitudes.

Shield (2005) reported that studies on alignment covering curriculum evaluation are deep because of being developed according to organizing strategies and link the content and the educational practices required by professional bodies of science education and learners' performance evaluation. Fan and Zhu (2007) used standards in revealing the difference between standards and educational materials, as well as the difference between what the teacher offers and selected educational materials. The levels of alignment studies aimed by international organizations varied. For instance, CCSSO (2002) revealed the alignment of the content of standards of (11) states and (4) areas with evaluation, content, and materials using a dual matrix for content. The content topics that a learner should know and learner's expectations (mental processes level) were included in the standards to understand the intersections and variance levels between the various domains according to certain standards. However, most of the variance aspects should be defined, and actions should be taken to bridge the gap between them (Porter, Smithson, Blank, and Zeidner, 2007). Kulm, Morris, and Grier (2000) examined thirteen (13) textbooks with scientific education reference. Twelve (12) teams of academicians and educators who were trained on evaluating textbooks using a four-point scale covering six (6) domains and twenty-four (24) items based on a set of indicators.

Many models emerged, including Leitzel and Vogler, English, La Marca, and Surveys of Enacted Curriculum (SEC) with the introduction of standards' movement that aimed at revealing the correlation between educational policies, documents of standards, and representation level within the frameworks of curriculum and evaluation. Their most significant features are

1. Leitzel and Vogler Model (1994) determines the interactive alignment between the key elements of curriculum: Planning, implementation, and evaluation (Figure 2).

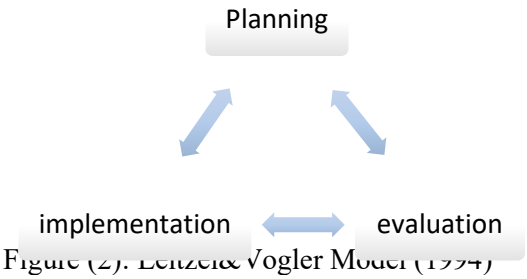

Figure (2): Leitzel& Vogler Model (1994)

2. English Model (2000) reveals the alignment and integration between three basic elements, i.e. curriculum, teacher, and test. It determines alignment between curriculum and evaluation (front loading) and the importance of defining the degree of alignment in curriculum development in a manner that matches evaluation (back loading) (Figure 3). It is a quality assurance operation.

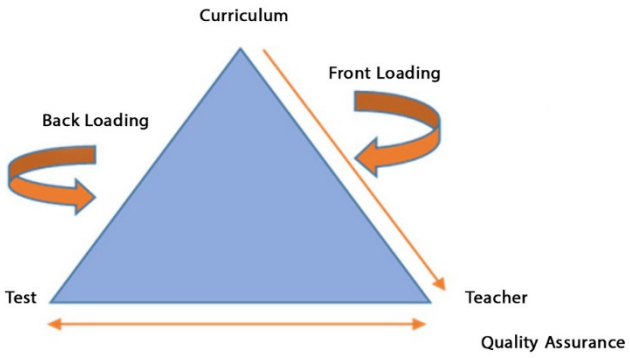

Figure (3): English Model (2000)

3. The La Marca Model (La Marca, Redfield, Winter, Bailey, and Despriet, 2000) studies alignment between content standards, performance, and evaluation. It evaluates learning according to six criteria, namely content match, depth match, concentration level, performance match, accessibility to all learners, and reporting in the light of other components of the educational system, e.g. learning activities, evaluation, and materials to employ alignment data in accountability, ensure learner participation, approve and use textbooks, and guide classroom practices, professional development, and policy making (Bhola, Impara, and Buckendahl, 2003). It also helps match the content included in the standards with the content of evaluation and match the level of cognitive depth concerning the level of mental processes and matching learner's expected performance. Concentration is measured based on the alignment of relative weight between the standards and evaluation items (Kaira, 2010).
4. SEC Model was developed by researchers and CCSSO in 2001. With the introduction of common standards in 2010, this model prevailed to compare the key issues of CCSS standards of language and mathematics with the content of state standards, lead change and development of curriculum, teaching content, and evaluation to achieve the expected standards (CCSS) and compare evaluation results among states (Porter et al., 2007). It uses a dual matrix that includes a list of main content issues and the expectations of learner performance. Each item of the content is encoded. The reviewers' task is to match the items with the content and the level of cognitive depth. It helps compare the content of the curriculum with the content of standards and evaluation.

It is noted that the alignment models agree in some analytical procedures, including the analysis of standards into elements tracked in the content of curriculum, evaluation, material, or activities of teaching and learning according to the criteria of the study objectives. Alignment should focus on the content or the cognitive field and its features. That is, the cognitive fields differ in alignment according to structure and nature.

Over the last two decades, studies addressed the alignment of science textbooks with international and national curriculum standards to identify the gap in the curriculum, teacher, or learner. They focused on the narrow level, i.e. analysis of textbooks based on National Science Education Standards (NSES) in the different target documents. The latest studies explored NGSS and other standards, such as the British standards CFBT. For example, Asshaee and Aloqeel (2006) and Asshaee and Shanyan (2006) showed the low level of the standards for earth in science textbooks for (1-8) grades. Alkasey and Hekmy (2018) evaluated the content of science curriculum for the primary stage in the light of NGSS and showed the low level of NGSS in these books, rating (41.33%). The alignment of standards for earth and space science was low, as well.

Saeed (2011) revealed the low alignment of the content of Palestinian science curricula content for the higher basic stage with national standards for science education of (5-8) grades. Similarly, Alkhalaf (2015) illustrated the low level of the standards' content of science education in the science textbooks for (6-8) basic grades in Jordan. The lowest standards were the standards for earth and space science that rated (22%). Alabdalia (2016) showed that only standards for biology and earth and space were implied in the science textbooks for (6-8) grades in Oman. Feteha (2017) reported a shortage of including the standards for earth and space science in the developed science textbooks for (6-4) basic grades in Jordan in the light of international standards for science education. Darweesh and Enseaw (2012) measured the achievement of British standards (CFBT) in science textbooks for the lower basic (1-4) grades in Palestine, concluding that they were relatively high. The five key domains, namely scientific research, life science, materials (characteristics of material), physical processes, and earth and science were somewhat balanced.

Many foreign studies measured the alignment of national standards and education results. For example, Çepni and Kara (2011) measured the alignment between Turkish biology textbooks and university entrance examinations and showed that exam questions were not totally aligned with curricula. ÇİL (2015) measured the alignment between Turkish middle school science curriculum standards and high school entrance examination to identify learners' mastering of these standards. The results showed moderate alignment between standards for science curriculum and high school entrance examination. Both standards and examinations almost address understanding, whereas examinations require higher cognitive skills, e.g. application, analysis and evaluation. Cahyati and Liliawati (2019) revealed that the topics of earth and space science for the third high grade in Indonesia were available by 5.88%. The Center for Geoscience Education and Public Understanding (2013) provided an evaluative perspective of earth and space education in US high schools and reported that concentration is not reflected in practice, graduation requirements, and assessments. Therefore, actions should be taken to raise awareness of earth and space science in high school and linking it to graduation requirements and assessments.

The present study is a part of a broad national project supervised by ETEC. In general, the research project focuses on analyzing the content of the public education curriculum, including science (McGraw-Hill Series) to determine its alignment with the national standards for science and to identify the type of processing required for developing these curricula to align with the national standards. The study covers earth and space science as an important field of sciences that directly relates to the local environment, social priorities and interests, and international problems. This field has to do with knowledge related to earth and space science in science textbooks for the four levels (foundation, reinforcement, expansion, and concentration).

Statement of the Problem

The Saudi Ministry of Education has sought to develop science curricula by "the Project of Developing Mathematics and Science" based on McGraw-Hill series (2009 edition) to benefit from advanced international experience in science teaching to fit modern trends. In 2013, an evaluation study was supervised by Excellence Research Center of Science and Mathematics and aimed at determining the alignment level of educational and technical specifications, as well as the presentation of content to teachers and learners. The study recommended updating science and mathematics curricula based on developing the continually updated original series and developing national standards that match the identity and culture of Saudi society (Project of Developing Mathematics and Science, 2009).

To achieve these attitudes, ETEC collaborated with the Ministry of Education and competent bodies adopted standards for public education curricula as the first national project based on Saudi Vision 2030 and its objectives. They aimed to contextualize the standards' implications in an applied educational context based on the teachings of Islam, interest in Arabic language, implications of identity and citizenship, as well as fostering the values of loyalty, national belonging, hard work, etc. Recognizing the interest in exploring the reality of current curricula and alignment with national standards to determine differences, gap, and treatment according to scientific bases, ETEC conducted studies to analyze the content of science curricula to highlight the alignment level with national standards for science and to identify the required treatment.

The alignment of the content of science curricula, in general, and earth and space, in particular, with national standards is important. This field directly relates to the environment, enables learners to have the minimum level of knowledge and skills to integrate into their environment, and links learners directly to reality via observation, experimentation, and field experience. The students who receive appropriate education in earth and space science are less ready to challenges and opportunities concerning international labor market or making informed decisions on vital issues, such as resource utilization, climate change, natural dangers, space exploration, and earth management (Awad, 2017; Center for Geoscience Education and Public Understanding, 2013). The relevant literature, such as Alkasey and Hekmy (2018), Asshaee and Aloqeel (2006), and

Asshaee and Shanyan (2006), showed the low level of standards for science, in general, and earth science, in particular, and recommended developing curricula continually to match the selected standards. Additionally, no local study addressed the alignment of earth and space science with the national standards at the four levels: Foundation (1-3), reinforcement (4-6), expansion (7-9), and concentration (10-12). Therefore, the present study is the first national-wide study of the aforementioned research project supervised by ETEC. The problem of the study has been defined in highlighting the alignment of science textbooks with the national standards for earth and space science for (1-12) grades in Saudi Arabia in 2019-2020. The study aims to answer the following questions:

1. What is the alignment level of science textbooks with the national standards for earth and space science in the four levels (foundation, reinforcement, expansion, and concentration) in Saudi Arabia?
2. What are the proposed aspects of treatment in science textbooks in the light of alignment with the national standards for earth and space science in Saudi Arabia?

Objectives

The study aimed to investigate the alignment level of the content of science textbooks in Saudi public education with the national standards for earth and space science for the four levels (foundation, reinforcement, expansion, and concentration) and to determine the proposed aspects for treatment and development.

Significance

- The study closely relates to the requirements of Saudi Vision 2030 to provide education that enhances the economy by preparing developed curricula based on basic skills.
- It defines the knowledge gap when applying the national standards for earth and space science to define the alignment of present curricula with these standards.
- It offers a real image to the decision-makers of the Ministry of Education on the alignment level of the content of earth and space science with the national standards in Saudi Arabia.
- It offers tools and manuals to analyze science textbooks in the light of national standards to benefit authors and to be a reference for the evaluation studies of curricula.
- It focuses on an important field, namely earth and space science.

Limits

Subject limits: The study was limited to science textbooks for (1-12) grades of the four levels (foundation, reinforcement, expansion, and concentration) of Saudi public education in the light of content and performance standards related to knowledge and understanding of earth and space science in the Document of National Standards of Science (first edition, 2019).

Temporal limits: The study was conducted in the second semester of 2019-2020.

Method

The study utilized the descriptive analytical method that helps make conclusions to develop, modify, or improve the phenomenon (George, 2009).

Definition of Terms

The study procedurally defines the following terms:

- Curriculum alignment is the level of achieving the national standards for science in the lessons of science textbooks (for the learner) in Saudi Arabia. It is measured by the arithmetic mean or percentage of achieving the learning outcomes derived from these standards according to the alignment model of ETEC.
- The National Standards for Science are the approved standards for science in Saudi Arabia. It comprises:

a. Content Standards are a general description of what a learner should learn, understand, and perform after studying science according to levels and grades. They aim to guide education and learning, building educational materials and resources, and learner performance evaluation.
b. Performance Standards are a specific description of the expected achievement level after studying science in the light of content standards. They are defined according to levels and grades. They are indicators that define the expected level of each learner.

- Earth and Space Sciences are a field of science that covers knowledge related to earth and space. They study what lies within and outside the earth's atmosphere.

Procedures and Tools

To answer the questions of the study, a six-step alignment model was developed. This model matches the nature and objectives of the study and the contents of earth and space science in the present targeted textbooks (Figure 4).

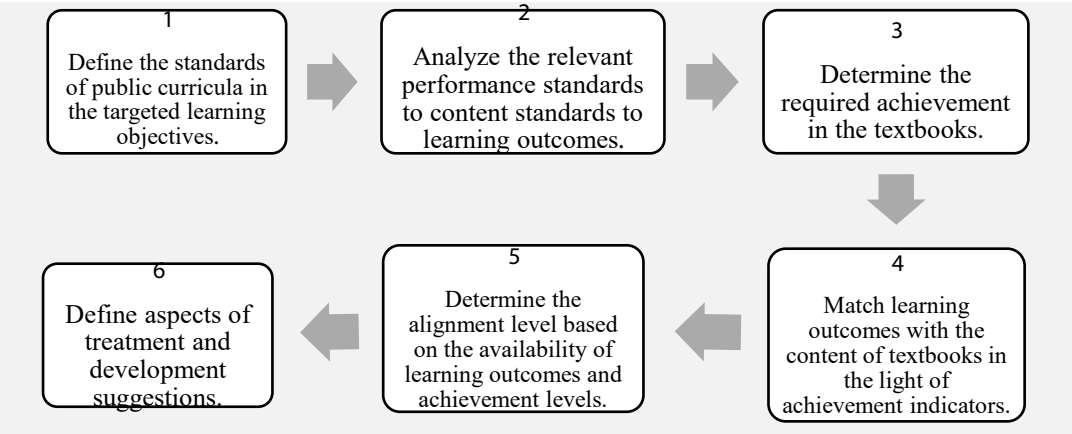

Figure (4): ETEC Model of Alignment

The following section describes the stages of the proposed model.

- Stage I: The standards of public curricula were defined based on the Document of Science Curricula Standards approved by the board of ETEC (ETEC, 2019a).
- Stage II: Performance standards related to content standards of earth and space science were analyzed to learning outcomes that include major ideas or concepts. They were listed under each standard according to systematic procedures in the alignment models, such as SEC to be tracked in the content of educational materials and evaluation (CCSSO, 2002). Content standards numbered (41), and performance standards numbered (137) distributed to four levels: Foundation (5 content and 23 performance), reinforcement (10 content and 41 performance), expansion (16 content and 44 performance), and concentration (10 content and 29 performance). The analysis was reviewed by three (3) analysts who considered the following issues: Deriving (2-5) learning outcomes from each performance standard and determining the derived outcomes that relate to the content of performance standards. The outcomes should have a source. They should be clearly formulated and can be measured and evaluated.
- Stage III: The required achievement indicators were determined to judge the availability of the learning outcomes clearly according to objectives or key ideas, direct content (examples, definitions, and explanation paragraphs), visual organization (maps, tables, figures, and images), and (pre, formative, and post) evaluation activities.
- Stage IV: Learning outcomes were matched with the content of textbooks in the light of the targeted achievement indicators using content analysis cards. Ten (10) analysis cards were prepared, nine (9) of which were used to analyze the content of textbooks for (1-9) grades, and one (1) card was used to analyze the content of earth science textbooks for (10-12) grades according to content and performance standards included in the national standards for earth and space sciences for the four grades developed, as follows:

- Selecting an analysis unit: Theme was the analysis unit.
- Defining analysis categories: They included content standards, performance standards for each level, and learning outcomes derived from performance standards. They covered four (4) basic analysis categories to measure the achievement levels: Lesson objectives (key ideas of the themes), direct content, visual organization, and evaluation activities.
- Developing the preliminary form and applying the tool to a pilot sample of the target textbooks.
- Verifying the construct validity of the tool: It is achieved in the analysis cards because they are related to the Document of National Standards for Science Curricula and the Specialized Framework of Science that were continually reviewed in eighteen (18) development workshops by ETEC or sixteen (16) broader workshops in nine (9) educational directorates by teachers, supervisors, universities, and competent bodies.
- Measuring tool reliability: The reliability was verified using coder reliability and Holsti Formula (Table 1).

Table (1): Reliability coefficients of analysis of earth and space science

Level	Coder 1	Coder 2	Agreement	Reliability coefficient
Foundation	47	47	36	76.6%
Reinforcement	85	85	80	94 %
Expansion	88	88	85	96.59%
Concentration	24	24	20	83%

Table (1) shows that the reliability coefficient values ranged (76%-96%), suggesting that reliability was high due to the clarity and accuracy of learning outcomes. The final form of the tool was obtained. Based on the analysis manual, two (2) coders were analyzed.

- Identifying the review mechanism of the availability of the learning outcomes and achievement levels. A four-point scale was used: Total (3), partial (2), low (1), and unachieved (0).

The range of achievement, length of category, and achievement level was measured (Table 2).

Table (2): Scale of the achievement of content and performance standards in science textbooks

Achievement level	High	Moderate	Low	Very low	Unachieved
Means	3 - 2.25	1.50 to less than2.25	0.75to less than1.50	More than 0 to less than 0.75	0
Percentage	100- 75 %	50 to less than % 75	25 to less than% 50	More than 0 to less than 25%	0%

- Stage V: Doing analysis and using the appropriate statistical processings, namely frequency, percentage, and arithmetic means.

Results and Discussion

Answer to the First Question

Table (3) illustrates the achievement level of content and performance standards for the textbooks of earth and space sciences at all levels.

Table (3): The achievement level of content and performance standards for the textbooks of earth and space sciences

Level	No. of content standards	No. of performance standards	No. of learning outcomes	Achievement level of learning outcomes				Means	Percentage	Achievement level
				Total	Partial	Low	Unachieved			
Foundation	5	23	47	23	14	5	5	2,47	82%	High
Reinforcement	10	41	85	41	18	19	7	2,32	77%	High
Expansion	16	44	88	34	27	9	18	2,06	70%	Moderate
Concentration	9	29	58	33	1	12	12	1,96	65%	Moderate
Total	40	137	278	131	60	45	42	2,20	73,5%	Moderate

Table (3) shows that the alignment level of of the content of science textbooks in Saudi public education with the content and performance standards for earth and space science for (1-12) grades was moderate with an arithmetic mean of (2.20) and percentage of (73.5%). This finding may be related to the moderate levels of expansion and concentration, introducing new standards, and novelty of standards if compared to the (2009) edition of the textbooks. It suggests that the textbooks require further development to respond to the modern trends and Saudi Vision 2030. Table (4) extends the alignment results at the foundation and reinforcement levels.

Table (4): Achievement level of content and performance standards at the the foundation and reinforcement levels of earth and space sciences for (1-6) grades

Achievement level of content and performance standards at the foundation level										
Content standards		No. of performance standards	No. of outcomes	Achievement level of learning outcomes				Means	Achievement level	Achievement feature
				Total	Partial	Low	Unachieved			
1.6.14.	Perceiving some components and determining some characteristics and relevant changes to the solar system	6	13	6	3	2	2	1.95	Moderate	
2.6.14.	Understanding the solar movement and activity and resulting phenomena	4	8	3	2	1	2	1.75	Moderate	
1.7.14.	Exploring earth materials and defining its layers and characteristics in the environment	4	8	3	2	2	1	1.88	Moderate	
2.7.14.	Describing the types, characteristics, uses, importance of stones, as well as changes due to natural factors	4	8	5	3	0	0	2.63	High	
3.7.14.	Identifying fossils and their formation and importance	5	10	6	4	0	0	2.9	High	

Achievement level of learning outcomes	Total	Frequency	23	14	5	5	2.17	Moderate
	47	%	48.93%	29.78%	10.63%	10.63%		
Achievement level of performance standards	Total	Frequency	16	3	4	0	2.52	High
	23	%	69.56%	13.04%	17.39%	0		
Achievement level of content standards	Total	Frequency	3	2	0	0	2.6	High
	5	%	60%	40%	0	0		
Achievement level of content and performance standards at the reinforcement level								
1.6.24.	Comprehending the movement patterns, resulting phenomena, and influences of some components of the solar system	6	12	7	4	1	0	2.5	High
2.6.24.	Comprehending the gravity effect and resulting phenomena in the movement of the solar system and galaxies	4	8	5	2	1	0	2.5	High
3.6.24.	Exploring and comparing the solar system to the galaxy and universe	5	11	2	1	6	2	1.27	Low
1.7.24.	Exploring the layers and components of the atmosphere, defining their characteristics, integration, continuous changes, environmental effects, and	6	12	6	2	4	0	2.16	Moderate

	benefits for the human being.								
2.7.24.	Illustrating the impact of interactions of the atmosphere and the hydrosphere on resource sustainability	4	9	4	1	2	2	1.78	Moderate
3.7.24.	Exploring the shapes, characteristics, and changing events of stone layers	3	6	2	3	0	1	2	Moderate
4.7.24.	Perceiving the causes and consequences of the movement of earth crust	4	9	7	2	0	0	2.75	High
5.7.24.	Identifying the causes and damages of earthquakes and volcanos and the locations that are mostly prone to earthquakes and volcanos	4	8	4	2	2	0	2.25	High
6.7.24.	Identifying the benefits of fossils in knowing the history of the earth and past change	2	4	2	1	1	0	2.25	High
7.7.24.	Identifying the factors and operations that affected and changed the earth's surface and history	3	6	2	0	2	2	1.33	Low
Achievement level of learning outcomes		Total	Frequency	41	18	19	7	2.09	Moderate
		85	%	48.2%3	21.17%	22.3%5	8.2%3		
Achievement level of performance standards		Total	Frequency	20	14	6	0	2.2	Moderate
		41	%	48.78%	34.14%	14.63%	0		

Achievement level of content standards	Total	Frequency	5	3	2	0	2.3	High
	10	%	50 %	30 %	20 %	0		

Table (4) shows that the content standards at the foundation level were high with an arithmetic mean of (2.6). Total, partial, and low achievement levels were rated (69.56%), (13.04%), and (17.39%), respectively. The results show that science textbooks treated the key ideas related to the solar and land systems, as well as relevant learning outcomes with a high degree concerning cognitive depth. However, some key ideas were missed, e.g. a detailed description of the events related to the sun, the moon, and their characteristics; highlighting safety and security measures of monitoring the sun and the emitted dangerous gases. The content standards (1.6.1.4) and (1.7.1.4) were moderate and scored (1.95) and (1.88), respectively. Furthermore, the textbooks lacked instructions on defining and describing solar movement and orbit patterns in the natural and experimental worlds mathematically and arithmetically.

The table illustrates that the content standards at the reinforcement level were high with an arithmetic mean of (2.3). Total, partial, and low achievement levels were rated (50%), (30%), and (20%), respectively. The performance standards were moderate with an arithmetic mean of (2.2). Total, partial, and low achievement levels were rated (48.78%), (34.14%), and (14.63%), respectively. The content standards (3.6.2.4) and (7.7.2.4) were low. The textbook for grade four did not achieve the content standards for exploring the solar system and determining the causes, description, and damages of earthquakes and volcanos. Key ideas were not covered in the science textbooks for grades five and six, e.g. the importance of space exploration, negative effects of climate change, and the most significant climate changes in Saudi Arabia.

The high alignment levels may be because the current textbooks were based on 2009 edition of McGrow Hill. Additionally, the foundation and reinforcement levels do not require deep conceptual and action knowledge. This finding matches Darweesh and Enseaw (2012) that showed high alignment of the standards for earth and space science but differs from Asshaee and Aloqeel (2006) because of the different analysis criteria and sample. The relative low level of some content standards may be because the national standards include modern knowledge that fits the Saudi aspirations, and the present textbooks were developed. This result agrees with the findings of Asshaee and Aloqeel (2006), Asshaee and Shanyan (2006), Alkasey and Hekmy (2018), and Feteha (2017).

Table (5) illustrates the alignment level of science textbooks for (7-9) grades with the national standards for earth and space science at the expansion level.

Table (5): Achievement level of content and performance standards at the expansion level of earth and space sciences for (7-9) grades

Achievement level of content and performance standards at the expansion level										
Content standards		No. of performance standards	No. of outcomes	Achievement level of learning outcomes				Means	Achievement level	Achievement feature
				Total	Partial	Low	Unachieved			
1.6.34.	Identifying some tools and means of exploring the solar system and the universe, their dominant circumstances, and locations of some celestial bodies	4	8	5	3	0	0	2.63	High	
1.7.34.	Understanding some types, characteristics, and uses of stones and metals	4	8	4	3	0	1	2.25	High	
3.5.34.	Identifying some components of the universe and their formation	2	4		1	2	1	1	Low	
4.5.34.	Identifying some methods, techniques, and tools to explore the universe	2	4	1	2	1	0	2	Moderate	
5.5.34.	Inferring the width of the universe and the greatness and magnificence of Allah's creation.	2	4	4	0	0	0	3	High	
4.7.34.	Describing the structure, layers, and operations affecting the earth's structure and	3	6	3	3	0	0	2.5	High	

5.7.3 4.	Understanding some natural cycles, their causes, and benefits.	2	4	0	0	0	4	0	Unachieved
6.7.3 4.	Understanding operations accompanying some natural cycles, energy transformations, and change in materials and environment	2	4	0	0	0	4	0	Unachieved
7.7.3 4.	Understanding the formation and movement of stone via tectonic plates	2	4	2	1	1	0	2.25	High
8.7.3 4.	Identifying potential dangers to the earth and their prediction mechanism	2	4	2	1	1	0	2.25	High
9.7.3 4.	Illustrating some earth's changes due to human activity	2	4		4	0	0	2	Moderate
10.7. 3.4	Identifying natural resources, their management method, maintenance, and development	4	8	5	1	2	0	2.38	High
2.5.3 4.	Understanding the carbon cycle via earth atmosphere and its importance	3	6	0	0	0	6	0	Unachieved
2.7.3 4.	Grasping the features, classification, and change cycle of stones	4	8	4	2	2	0	2.25	High
3.7.3 4.	Grasping greater information about the theory of continental drift and expecting its results and benefits	4	8	3	3	0	2	1.88	Moderate
1.5.3 4.	Concluding the causes, effects, and relevant phenomena of climate changes	2	4	1	3	0	0	2.25	High

Achievement level of learning outcomes	Total	Frequency	34	27	9	18	1.67	Moderate
	88	%	38.63 %	30.68 %	10.2 %2	20.45 %		
Achievement level of performance standards	Total	Frequency	22	12	1	9	2.06	Moderate
	44	%	50 %	27.27 %	2.27 %	20.45 %		
Achievement level of content standards	Total	Frequency	9	3	1	3	2.125	Moderate
	16	%	56.25 %	18.75 %	6.25 %	18.75 %		

Table (5) shows that the content standards at the expansion level were moderate with an arithmetic mean of (2.125). Total, partial, low, and unachieved levels were rated (56.2%), (18.75%), (6.25%), and (18.75%), respectively. The results show that science textbooks treated key ideas related to space and its components and land system with a moderate degree. Content standards of the textbook for grade (7) (3.5.3.4) were low because the textbook did not introduce the Big Bang Theory, number of galaxies, comparing scientific theories about the formation of the universe. The analysis showed severe shortcomings in treating key ideas included in the performance standards of (5.7.3.4), (6.7.3.4), and (2.5.3.4). The textbook for grade eight did not cover many key ideas and concepts for achieving the performance standards, such as the changing earth surface, describing the changes of natural cycles, their uses and economic benefits, as well as the environmental changes and their negative effects qualitatively and quantitatively. Some key ideas included in (3.7.3.4) were not treated adequately. The low level of achievement is due to the lack of the textbooks' interest in some learning outcomes targeted by the national standards and relevant to the Saudi national trends, such as introducing the sources, importance, and benefits of renewable energy, causes of contemporary climate changes, old geology of the Arabian Peninsula, and climate changes of the Arabian Peninsula overtime. This finding agrees with Alabdalia (2016), Alkhalaf (2015), and Saeed (2011).

Concerning concentration, table (6) shows the alignment level of science textbooks for (10-12) grades with the national standards for earth and space sciences.

Table (6): The achievement of content and performance standards for earth and space sciences concerning the concentration level of science textbooks for (10-12) grades

Achievement of content and performance standards for concentration level										
Content standards		No. of performance standards	No. of outcomes	Achievement of learning outcomes				Means	Achievement level	Achievement feature
				Total	Partial	Low	Unachieved			
1.7.1.44.	Understanding the bases of estimating the ages of layers, fossils, event order, and reading geological history	4	8	7	0	0	1	2.63	High	
2.7.1.44.	Understanding the structure of fossil registry and relationship to geological events and history	3	6	6	0	0	0	3	High	
3.7.1.44.	Illustrating the relationship between earth crusts and the causes and multiplicity of earthquakes and volcanos in certain areas of the world	3	6	6	0	0	0	3	High	
4.7.1.44.	Identifying the types and importance of earthquake waves to analyze the earth components and characteristics of layers.	2	4	4	0	0	0	3	High	
1.7.3.44.	Understanding the geology of the Arabian Peninsula and illustrating the factors that change to the earth surface's characteristics.	3	6	0	0	4	2	0.66	Very Low	
2.7.3.44.	Identifying the natural and economic resources of Saudi	4	8	1	0	5	2	1	Low	

	Arabia and the methods of discovery and extraction								
3.7.3.4 4.	Identifying the locations of excavation of oil and concluding their features in Saudi Arabia	2	4	0	0	1	3	0.25	Very Low
4.7.3.4 4.	Estimating the importance, benefits, effects, and future of alternative energy resources	2	4	0	0	0	4	0	Unachieved
5.7.3.4 4.	Perceiving changes and natural potential dangers of geological events and the methods of treatment and prevention	3	6	6	0	0	0	3	High
6.7.3.4 4.	Discovering the most significant geological features and defining the features and locations	3	6	3	1	2	0	2.16	Moderate
Achievement level of learning outcomes		Total	Frequency	33	1	12	12	1.94	Moderate
		58	%	56.8 %9	1.7 %2	20.68 %	20.6 %		
Achievement level of performance standards		Total	Frequency	15	4	4	6	1.96	Moderate
		29	%	51.7 %2	13.79 %	13.79 %	20.6 %8		
Achievement level of content standards		Total	Frequency	5	1	0	3	1.88	Moderate
		10	%	55.5 %5	11.11 %	0	33.3 %3		

Table (6) illustrates that the content standards for earth and space science at the concentration level were achieved totally (55.5%) and partially (11.1%) or unachieved (33.3%). The results show a partial shortcoming in the treatment of some key ideas in the performance standards. Content standards (2.7.3.4.4), (1.7.3.4.4), (3.7.3.4.4), and (4.7.3.4.4) were achieved low. The textbooks for (11-12) grades did not represent many key ideas related to learning outcomes, including the geological history of the Arabian peninsula, introduction to natural resources; the emergence, features, and characteristics of oil; linking the alternative energy resources to economic features. These results agree with the findings of Cahyati and Liliawati (2019). The low level of achieving these standards relates to the lack of alignment of McGraw Hill. This finding was stressed by Excellence Research Center of Science and Mathematics (2015) that the alignment of earth science textbook with the community culture, national identity, legislation, and local laws was not rated (50%). Including evidence and statistics of the local environment, such as economic raw materials, fossils, and stone components was moderate.

Answer to the Second Question

To answer the second question concerning defining the proposed treatment aspects, the achievement level of the indicators of the knowledge content related to the learning outcomes of the standards for earth and space science and the required treatment at all levels should be determined (Table 7).

Table (7): Learning outcomes of the low and unachieved content and performance standards in the four levels

Level	No. of Learning outcomes	Frequency	Achievement Level of Learning Outcomes		Percentage of the Proposed Treatment	Rank
		Percentage	Low	Unachieved		
Foundation	47	Frequency	5	5	21%	4
		Percentage	10%	11%		
Reinforcement	85	Frequency	19	7	30%	3
		Percentage	22%	8%		
Expansion	88	Frequency	9	18	30,67%	2
		Percentage	10,22%	20,45%		
	58	Frequency	12	12	42%	1

Concentration		Percentage	21%	21%		
Total	278	Frequency	45	42	21.62%	
		Percentage	16,2%	15,1%		

Table (7) shows that the total required treatment rated (21.62%). The lowest level was concentration that rated (42%). The authors argue that shortcomings of science textbooks should be handled to align with the domain of (knowledge and understanding) of the standards for earth and science content, which included (42) unachieved learning outcomes. Moreover, the content of science textbooks should be addressed to enhance their achievement to (45) learning outcomes that were rated low. Such treatments can be achieved by including learning outcomes of the unachieved content and performance standards in the current science textbooks, reorganizing the learning outcomes across levels and grades, and treating some learning outcomes to enhance their alignment with national standards by addressing key ideas, content, and evaluation activities.

Recommendations

The study recommends defining the requirements of applying the national standards for earth and space science and preparing educators for implementing these standards ultimately. The proposed treatment aspects should be investigated, implemented, reconsidered for shortcomings, and developed to align with the national standards for earth and space science. Additionally, research projects of the national standards should be implemented in collaboration with experts of science teaching at Saudi universities and education to explore the alignment between the national standards and science curricula, in general, and earth science, in particular (teacher's manual, teacher's resources for extracurricular activities, and evaluation manual). Programs of professional development and science teacher preparation should be developed to understand the new perspective of the national standards for teaching, learning, and adopting earth science.

Conclusion

The knowledge, value, and skill requirements of the fourth industrial revolution, the requirements of comprehensive transformation by the Saudi Vision 2030, and the adoption of national standards for science curricula, application, and evaluation motivate conducting the present study. The authors aim to provide a real image of the alignment of the content of earth and space science textbooks to guide decision-makers and developers of science curricula to translate these standards into various educational materials. They recommend revising and developing current science curricula in the light of national standards for science curricula. They also recommend benefiting

from the results in developing the knowledge structure of earth and space science to ensure comprehensive alignment with the requirements of the national standards.

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References

Alabdalia, S. (2016). *Including NGSS in the content of science textbooks for (6-8) grades in Oman* (M.A. thesis). Sultan Qaboos University, Oman.

Alkasey, A. and Hekmy, F. (2018). Evaluation of the content of science curriculum for the primary stage in the light of NGSS. *University of Bisha Journal for Humanities and Education*, 2, 295-326.

Alkhalaf, T. (2015). Evaluating the content of science textbooks for (6-8) basic grades in Jordan in the light of international standards. *Journal of Education- Al-Azhar University*, 2(165), 523-551.

Anderson, L. (2002). Curricular alignment: A re-examination. *Theory Into Practice*,41(4), 255-260.

Apthorp, H., Bodrova, E., Dean, C. & Florian, J. (2001). *Noteworthy perspectives: Teaching to the core-reading, writing, and mathematics*. USA: Office of Educational Research and Improvement.

Assadouy, A. and Ashamrany, S. (2016). *Standard-based education: Basics and theoretical concepts*. Riyadh: Arab Bureau of Education for the Gulf States.

Asshaee, F. & Aloqeel, M. (2006). Achievement of the content standards for K-4 of the NSES in science textbooks in Saudi Arabia. Paper presented in the *the Tenth Conference of Scientific Education "Present Challenges and Future Perspectives"*, Ain Shams University, Egypt.

Asshaee, F. & Shanyan, A. (2006). Achievement of the content standards (5-8) of the NSES in science textbooks in Saudi Arabia. *Journal of Studies of Curriculum and Instruction*, 117, 161-188.

Awad, A. (2017). *Impact of teaching earth and environment science using project-based learning on the achievement and visual-spatial thinking of the third high school science students* (M.A. thesis). Middle East University, Jordan.

Bhatti, A. (2015). *Curriculum audit: An analysis of curriculum alignment at secondry Levein Punjab*. International Islamic Unversity, Islamabad.

Bhola, D., Impara, J. & Buckendahl, C. (2003). Aligning tests with content standards: Methods and issues. *Educational Measurement,Issues and Practice*,22, 21-29.

Cahyati, I. & Liliawati, W. (2019). Analysis of earth and space science curriculum at senior high school. *Journal of Physics*,1280, 1-8.

Center for Geoscience Education and Public Understanding. (2013). *Education in the earth and space sciences in U.S.secondary schools: Key indicators and trends*. USA: Center for Geoscience Education and Public Understanding.

Center on Standards and Assessment Implementation (CSIA) (2018). *Standards alignment to curriculum and assessment*. USA: CSIA.

Çepni, S. & Kara, Y. (2011). Investigation of the alignment between school learning and entrance examinations thorough item analysis. *Journal of Baltic Science Education*,10(2), 73-86.

ÇİL, E. (2015). Alignment between Turkish middle school science curriculum standards and high school entrance examination. *Journal of Turkish Science Education*, 12 (2), 33-48.

Council of Chief State School Officers (CCSSO).(2002). *Models for alignment analysis and assistance to states*.Washington,DC: Council of Chief State School Officers.

Darweesh, A. and Enseaw, A. (2012). Achievement of the quality standards for curriculum (CFBT) in science textbooks for the lower basic stage in Palestine. *Palestinian Humanitarian Researches and Studies Journal*, 18, 168-206.

English, F. (2000). *Millennium edition: Deciding what to teach and test*. California: Corwin Press,Inc.

ETEC (2018). *Document of the National Framework of the Standards of Public Education*. Riyadh: Education and Training Evaluation Commission.

ETEC (2019a). *Document of the Specialized Framework of Science*. Riyadh: Education and Training Evaluation Commission.

ETEC (2019b). *Document of Science Learning Standards*. Riyadh: Education and Training Evaluation Commission.

Excellence Research Center of Science and Mathematics (2015). *Report of the third stage: An evaluation study of the project of developing mathematics and science in Saudi higher education*. Riyadh: King Saud University.

Fan, L. & Zhu,Y. (2007). Representation of problem-solving procedures: A comparative look at China, Singapore and US mathematics textbooks. *Educational Studies in Mathematics*,66, 61-75.doi:10.1007/s10649-006-9069-6.

Feteha, I. (2017). Analysis of developed science textbooks for (4-6) basic grades in Jordan in the light of the international standards for science education. *Journal of Education-Sohag University*, 49, 424-447.

George, A. (2009). Quantitative and qualitative approaches to content analysis. In K. Krippendorff and A. Bock (Eds.), *The content analysis reader* (pp. 144-155). California: Sage.

Kaira, L. (2010). *Using item maping to evaluate alignment between curriculum and assessment*. USA: University of Massachusetts. Retrieved from:http://www.dpi.state.wi.us/oea/pdf/mathsummary06.pdf

Kristen, C. (2016). *Evaluating curriculum materials for alignment with the new vision for K-12Science Education. STEM Teaching Tools content: UW Institute for Science + Math Education*. United States: National Science Foundation.

Kulm, G., Morris, K. & Grier, L. (2000). *Project2061: Appendix C -Methodology*. Retrieved from http://www.project2061.org/publications/textbook.

La Marca, P., Redfield, D., Winter, P., Bailey, A. & Despriet, L. (2000). *State standards and state assessment systems: A guide to alignment*. Washington, DC: Council of Chief State School Officers.

Leitzel, T. & Vogler, D. (1994). *Curriculum alignment: Theory and practice*. Retrieved from http://www.eric.ed.gov/PDFS/ED371812.pdf.

Next Generation Science Standards (NGSS) (2018). *NGSS alignment claims how publishers talk about the Next Generation Science Standards*. Retrieved from https://www.nextgenscience.org/sites/default/files/NGSS%20Alignment%20Claims_0.pdf.

Porter, A., Smithson, J., Blank, R. & Zeidner, T. (2007). Alignment as a teacher variable. *Applied Measurement in Education*,20(1),27-51.

Project of Developing Mathematics and Science (2009). *Introduction to the project*. Saudi Arabia: Secretariat of the Project of Developing Mathematics and Science.

Saeed, T. (2011). *Analysis of Palestinian science curricula content for the higher basic stage in the light of international standards* (M.A. thesis). Al-Azhar University, Gaza.

Shield, M. (2005). Building a methodology for the comparison and evaluation of middle- years mathematics textbooks. In Clarkson et al. [Eds], *Proceedings building Connections: Research, Theory and Practice*. Melbourn: Mathematics Education Research Group of Australasia.

Webb, N., Herman, J. &Webb, N. (2007). Alignment of mathematics state-level standards and assessments: The role of reviewer agreement. *Educational Measurement Issues and Practice*, 26(2),17 – 29. doi:10.1111/j.1745-3992.2007.00091.x.

Webb, N., Horton, M. & O'Neal, S. (2002). An analysis of the alignment between language arts standards and assessments for four states. A paper presented at *the American Educational Research Association Annual Meeting*, New Orleans, Louisiana.