How Curriculum Developers' Pedagogical Beliefs Shape the Implementation of the Reform-Oriented Curriculum

Oman engaged in a major educational reform in 1998, introducing a Basic Education System (BES, grades 1–10) and Post-Basic Education System (Post-BES, grades 11–12) with the aim of enhancing students' learning outcomes. Both the BES and Post-BES emphasize a constructivist approach to learning and in particular a shift from teacher-centered learning to student-centered learning, inquiry-based learning, and continuous assessment. However, the implementation of the new curriculum has posed various obstacles related to the mismatch between the planned reform-oriented curriculum and the implemented curriculum. Teachers consistently report that the curriculum lacks consistency. They also note that despite the curriculum developers' stated emphasis on student-centered learning, the curriculum encourages a teacher-centered approach to learning. In this study, we focus on the Post-BES biology curriculum, investigating the extent to which the biology curriculum and curriculum developers' pedagogical beliefs align with the constructivist perspective. To investigate our research questions, we employed document analysis and semi-structured interviews with biology curriculum developers and twelfth-grade biology teachers. We also developed a Criteria for the Constructivist Curriculum (CCC) model to assess the reform-oriented curriculum. Our ethnographic analysis indicated that the reform-oriented curriculum represents various perspectives, including the constructivist, structure of the disciplines, and behavioral perspectives. Moreover, the pedagogical assumptions of the curriculum are grounded in both student-centered and teacher-centered approaches to learning. The curriculum developers held mixed pedagogical beliefs that are reflected in the curriculum design. The Omani biology curriculum thus does not appear to align with the CCC. The results of this study indicate that Omani policymakers and curriculum developers should reflect on their pedagogical beliefs as a crucial element of the reform process. They also suggest that the Omani Ministry of Education should adopt a theoretically and empirically driven approach to curriculum development and implementation. The study's implications for curriculum development, curriculum evaluation, factors influencing curriculum implementation, policy, and future research are provided.

Keywords: constructivism, curriculum developers, curriculum implementation, pedagogical beliefs, reform-oriented curriculum.

Introduction

The recent global reform of science education, which is rooted in constructivism, has introduced assumptions about learning and approaches to teaching that are together known as reform-oriented instruction (Le, Lockwood, Stecher, Hamilton, & Matinz, 2009). Despite focused efforts to implement reform-oriented teaching practices, current science curricula and instructional practices have remained traditional (Banilower, Smith, Weiss, Malzahn, Campbell, & Weis, 2013).

1   In traditional teacher-centered learning, which is grounded on
2   behaviorism, the focus is on the curriculum and the knowledge that is required
3   to be taught to students. The textbook is considered the curriculum as it offers a
4   common body of facts equally accessible to all students (Posner, 2004). The
5   role of the teacher is to determine what students should learn and how.
6   Examinations are employed as a form of assessment to monitor and classify
7   students as they progress through a graded educational system (Posner, 2004).
8   In this teacher-centered approach, teachers do not participate in the design or
9   development of the curriculum; rather, the content and methods are handed
10   down to the teachers (Brown, 2003). Usually, the teachers receive directions
11   from curriculum developers who typically have never known (or have
12   somehow lost sight of) the classroom dynamics that a diverse student body
13   creates and how these dynamics affect pedagogy (Brown, 2003).

14   Unlike teacher-centered learning, student-centered learning, which is
15   grounded in constructivism, prioritizes individual students' learning. The role
16   of the teacher is to facilitate learning by designing different activities to meet
17   students' level of development and interests. Evaluation is ongoing and takes
18   place mostly in the context of students' learning. The curricula are adapted to
19   address students' needs, interests, and suppositions.

20   Every educator, from a teacher to a curriculum developer, has a tacit, often
21   unarticulated, set of values and beliefs that should be explored (Sergiovanni &
22   Starratt, 2001). Therefore, when implementing a curriculum reform, teachers'
23   beliefs about teaching (as student- or teacher-centered) will either support or
24   undermine the implementation of the new initiative (Fives & Buehl, 2016).
25   Moreover, during the process of curriculum development, it is necessary to
26   make beliefs and assumptions transparent (Badiali, 2005). Therefore,
27   curriculum analysis is imperative to unpack a curriculum into its component
28   parts; evaluates how the parts fit together; checks underlying beliefs and
29   assumptions; and seeks justification for curriculum assumptions (Jansen &
30   Reddy, 1998). The purpose of this study was to examine to what extent
31   curriculum developers' beliefs influence the design and the implementation of
32   the reformed curriculum.
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35   **Science Education in Oman**
36
37   In 1998 Oman launched the Basic Education System (BES, grades 1-10)
38   and a Post-Basic Education System (Post-BES, grades 11-12) (Al Balushi, &
39   Griffiths, 2013). The reform of curriculum content and teaching strategies is
40   among the most important aspects of the BES (Issan & Gomaa, 2010). The
41   new curriculum is characterized by two key aspects: (a) it is learner-centered
42   and (b) it is comprehensive in nature, moves beyond textbook content (MOE,
43   2008; UNESCO, 2011). Furthermore, the teachers are expected to implement
44   various student-centered instructional strategies to foster autonomous and
45   cooperative learning, critical thinking, problem-solving, research and
46   investigation, creativity, and innovation (MOE, 2008).
47   Science is considered one of the core subjects in the BES and Post-BES

1 and is taught in all grades (grades 1–12). The separation of scientific
2 disciplines into three subjects (biology, chemistry, and physics) starts in grade
3 11. The MOE outsourced the development of the curriculum framework to the
4 Canadian company Educational Consultancy Services; the curriculum
5 framework was then revised by university instructors. Science teaching
6 strategies were reformed with an emphasis on student-centered instruction and
7 inquiry-based learning. The assessment of science learning shifted from merely
8 summative assessment to a blend of formative and summative assessments
9 (Ambusaidi & Al-Balushi, 2015).

10 Almost two decades after the implementation of the reform-oriented
11 curriculum, teachers report that there is a mismatch between the planned
12 curriculum and the curriculum implements in schools. Therefore, it is crucial to
13 examine to what extent the reform-oriented curriculum aligns with the
14 constructivist perspective. It is also imperative to understand curriculum
15 developers' perceptions' in terms of the factors that are affecting the
16 implementation of the reform-oriented curriculum.

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18
19 **Research Questions**
20
21 The study addresses the following research questions:
22
23 1. How do curriculum developers' beliefs about the reform-oriented
24 biology curriculum align with the designed curriculum and the
25 constructivist perspective?
26 2. How have biology curriculum developers' pedagogical beliefs shaped
27 the implementation of the reform-oriented curriculum in Oman?
28
29
30 **Literature Review**
31
32 **Theoretical Framework: Socio-Constructivism**
33
34 The theory of constructivism guided this study because constructivism is
35 considered the philosophical and theoretical rationale underlying the reform-
36 oriented curriculum. According to constructivism, knowledge is not transmitted
37 but constructed by learners based on developmentally and socially mediated
38 experiences (Fosnot, 1996). Socio-constructivism aligns with Vygotsky's
39 (1978) view of the development of scientific concepts and puts special
40 emphasis on the role of the interaction of the learner with her/his social
41 environment by means of language.
42
43 Epistemological Assumptions of Socio-Constructivism. Constructivism
44 sees learning as an adaptive activity dependent on the creation of conceptual
45 structures and self-regulation through reflection and abstraction (Yilmaz,
46 2008). From a constructivist perspective, learning science is an active, social
47 process of making sense of experiences and is something students do, not

1 something that is done to them (National Research Council [NRC], 1996).

2

3   <u>Pedagogical Implications of Socio-Constructivism</u>. From the socio-
4 constructivist perspective, the role of the learner is one of selecting and
5 transforming information, constructing knowledge, and making decisions,
6 rather than relying on the teacher's knowledge and textbooks to solve
7 problems. The role of the teacher is to recognize students' prior conceptions
8 and to design activities that build upon the students' knowledge, using
9 strategies such as experimentation, problem-solving, reflection, concept-
10 mapping, and dialogue to create deep knowledge and understanding (Brandon
11 & All, 2010).
12   In this context, the teacher is no longer seen as an authority figure or a
13 dispenser of knowledge. Rather, the teacher becomes a facilitator who focuses
14 not on her/his preferences, but on students' learning needs (Sandrin, 2010).
15 Constructivist teachers ask thoughtful and open-ended questions and provide
16 students with opportunities to engage in interactive activities such as
17 discussion, debate, and dialogue, in which the students are encouraged to
18 elaborate on their initial responses (Yilmaz, 2008). This necessitates focusing
19 on deep learning rather than content coverage.

20

Characterizing the Reform-Oriented Curriculum

22

23   Curriculum design based on a postmodern constructivist approach departs
24 significantly from the traditional conception of the curriculum as providing a
25 monolithic perspective of knowledge to learners (Cullen, Hill, & Reinhold,
26 2012). It focuses on the learners' construction of knowledge and the transfer of
27 that knowledge within different contexts (Cullen et al., 2012). Below we
28 describe two prominent constructivist and student-centered curriculum models
29 that better reflect constructivist theory.

30

31   <u>Doll's Curriculum Model</u>. Doll's (1993) postmodern constructive and
32 nonlinear model of a postmodern curriculum is based on the actions and
33 interactions of teachers and learners. Doll emphasized that a curriculum should
34 be self-organized, open-ended, and transformational. Doll's model (1993)
35 fosters a learner-centered curriculum design based on "the four R criteria":
36 richness, recursion, relations, and rigor.
37   <u>Richness</u> refers to a curriculum's depth and its layers of meaning,
38 including its multiple possibilities or interpretations of experience. Doll
39 suggested that curriculum richness can be developed through dialogue,
40 interpretations, hypothesis generation, and pattern playing. In this regard,
41 Wiggins and McTighe (2005) encouraged curriculum designers to focus on
42 students' developing deeper rather than broader understandings of the covered
43 content.
44   <u>Recursion</u> refers to a nonlinear approach to a curriculum. The nonlinear
45 curriculum has been described as a matrix or a spiral through which students
46 continue to revisit and reconsider what they have learned (Cullen et al., 2012).
47 Accordingly, the nonlinear curriculum is designed around essential questions,

1 big ideas, key performance tasks, and rubrics. It does not have a definite
2 beginning or ending.
3   <u>Relations</u> include both pedagogical relations and cultural relations.
4 Pedagogical relations refer to relations within the curriculum, which include
5 interactions between the teacher and learners and between the teachers and the
6 curriculum. Cultural relations capture the link between the historical and
7 cultural contexts and the ways relations are perceived. Cullen et al. (2012)
8 explained that relations in the learner-centered curriculum refer to the
9 importance of understanding the impact of different contexts and learners'
10 multiple perspectives.
11   <u>Rigor</u> in curriculum design refers to elements that provide learners
12 opportunities for integrative learning or learning that is organized around
13 problems or issues rather than strictly disciplinary content. A rigorous
14 curriculum allows students and teachers to become deep thinkers and reflective
15 learners who are continuously exploring, looking for new combinations,
16 interpretations, or patterns.
17
18   <u>Harris and Cullen's Curriculum Model</u>. Harris and Cullen (2010)
19 developed a matrix for assessing learning-centered qualities in course syllabi.
20 The matrix is divided into three categories and sub-categories: community
21 (accessibility of teacher, learning rationale, and collaboration); power and
22 control (teachers' role, outside resources, and syllabus focus); and evaluation
23 and assessment (grades, feedback mechanisms, evaluation, and learning
24 outcomes). This syllabus assessment matrix (SAM) allows curriculum
25 developers to review the policies and language used in a curriculum syllabus to
26 identify the extent to which it aims to build community, foster independent
27 learning, and employ assessment and evaluation strategies to help students
28 meet the learning outcomes (Harris & Cullen, 2010).
29   In a later publication, Cullen et al. (2012) merged the SAM with Doll's
30 four R criteria to provide a more comprehensive analysis of a curriculum and
31 the extent to which it incorporates learner-centered design elements.
32
33
34   **Methods**
35
36 **Participants**
37
38   <u>Curriculum Developers</u>. All current and former (those whose job titles had
39 changed recently) biology curriculum developers at the Ministry of Education
40 were invited to participate. Four curriculum developers (two of whom were
41 involved in writing the biology curriculum for grade 12) and one supervisor
42 who was involved in writing the curriculum participated. Table 1 shows the
43 demographic data of the curriculum developers involved in the study. When
44 asked about professional development (PD) programs that they had completed
45 to prepare them for the task of curriculum-writing, they all indicated that they
46 had not received any specific PD training related to curriculum development.
47 They indicated that they had instead gained knowledge by participating in

1 curriculum-writing over time. Three of them indicated that they had had the
2 opportunity to participate in one Ministry of Education-organized PD program
3 on how to design a curriculum; however, they claimed the content of the
4 training was theoretical and not practical.
5
6 *Table 1*. Demographic data of the curriculum developers involved in the study

Interviewee	HR	AB	SD	AH	BH
Years in current job	11	Few months	16	14	8
Age	50	44	45	54	42
Other previously held jobs	Teacher and supervisor	Teacher, senior teacher, and curriculum developer	Teacher and curriculum developer	Supervisor and curriculum developer	Teacher and senior teacher

7
8 Biology Teachers. Fourteen twelfth-grade biology teachers from the
9 province of Muscat were included in this study: five males and nine females.
10 Purposeful sampling was employed to select biology teachers based on their
11 gender and their students' achievement level on national tests. Teachers were
12 between 25 and 48 years old, and their teaching experience was between 3 and
13 27 years. Pseudonyms were used to represent all participants.
14
15 **Data Collection**
16
17 In order to address the study's research questions, we used documents in
18 conjunction with semi-structured interviews with biology curriculum
19 developers and biology teachers. The triangulation of data sources was
20 imperative to obtain rich and in-depth insight into the participants' perceptions
21 in relation to the official reform curriculum. We followed a certain
22 chronological order for data collection and analysis. We started by analyzing
23 the curriculum. The curriculum analysis helped us to shape the interview
24 questions and ask more effective follow-up questions. It also aided us in
25 making comparisons between our findings from the curriculum analysis and
26 the developers' perceptions and beliefs about the curriculum.
27 After completing the curriculum analysis, we interviewed the curriculum
28 developers who had designed the curriculum. After we had finished collecting
29 data from the developers, we conducted interviews with the teachers.
30
31 Document Analysis. For this study, we analyzed documents including
32 national textbooks, reports, and policy reports. The first document we analyzed
33 was the national official biology curriculum for grade 12, which included the
34 student textbook, teacher's guide, and student laboratory manual. The aim of
35 analyzing the twelfth-grade biology curriculum was to unearth the pedagogical
36 and epistemological assumptions that underlie the curriculum and to
37 investigate how they align with the constructivist perspective. The analysis also
38 sought to examine to what extent the beliefs of the developers align with the

1 planned curriculum. We also sought to develop a model that would be useful
2 for future analysis of curricula (Appendix A). Hence, we focused on
3 identifying clear and explicit criteria that an analyst could use while leading the
4 appraisal process. To do so, we looked at different models that can be found in
5 the literature and align with constructivist learning theory. Although the
6 analysis was particular to this specific curriculum, the outcomes of this study
7 may be pertinent to other curricula and may provide a baseline for curriculum
8 designers and practitioners.

9 To analyze the Omani twelfth-grade biology curriculum, we began by
10 using Posner's (2004) curriculum analysis framework. This framework is
11 widely used because it is comprehensive and aligned with constructivist theory.
12 Posner's framework allows researchers to compare the official curriculum with
13 the implemented curriculum. However, it does not present the criteria of the
14 constructivist curriculum directly; rather, it depends on the sets of questions to
15 help the researchers align their answers with constructivist theory. Then, we
16 employed Doll's (1993) model of a constructivist student-centered curriculum.
17 We used Doll's criteria in an attempt to determine what improvements and
18 changes needed to be made to have a flexible self-organizing curriculum that
19 promotes interactive and motivated learning. Finally, we utilized Harris and
20 Cullen's (2010) matrix for assessing learning-centered qualities in the
21 curriculum. In our estimation, the matrix focuses on the process of teaching
22 and learning rather than the curriculum itself.

23 Due to the limitations of the aforementioned models in terms of their foci
24 and purposes, as well as our desire to construct a more comprehensive model,
25 we developed a new model that we anticipated would allow us to better answer
26 the research questions about the curriculum under study. Our model is a blend
27 of the three aforementioned models and represents a set of criteria that align
28 with the socio-constructivist curriculum and student-centered approach to
29 learning. We also took into consideration the criteria that were deemed
30 essential elements of the curriculum by the curriculum developers and teachers,
31 as emphasized in the interviews. The model, which we named the Criteria for
32 the Constructivist Curriculum (CCC) model (Appendix A), helped us to
33 examine the extent to which the curriculum reflects certain constructivist
34 curriculum features in terms of learning, teaching, communication, explicit and
35 implicit assumptions, and assessment of learning.

36 In addition, we reviewed the BES and Post-BES structure on the Ministry
37 of Education portal (http://home.moe.gov.om/english) to identify the
38 curriculum philosophy. Finally, we reviewed published official studies and
39 reports addressing Post-BES curricula. The documents included a report titled
40 *From Access to Success: Education for All (EFA) in the Sultanate of Oman,*
41 *1970–2005*, which had been published by the Ministry of Education in 2006, as
42 well as a report titled *Education in Oman: The Drive for Quality*, a report
43 published by the Ministry of Education, Oman, and the World Bank in 2012.

44

45 Semi-Structured Interviews. After analyzing the curriculum, we conducted
46 semi-structured interviews with the curriculum developers in an attempt to
47 make connections between the curriculum and their beliefs. Three interviews

1 were conducted face to face during the summer of 2017. The remaining two
2 interviews were conducted by phone and email. Each interview took between
3 45 and 72 minutes. All the teachers were interviewed in their schools in the
4 spring of 2018.

5   In order to explore the developers' personal educational philosophies as
6 they related to the curriculum, we used the Curriculum Platform Q-sort
7 (Badiali, 2005; Appendix B). The Curriculum Platform Q-sort asked the
8 developers to order various statements in four groups (aims of education,
9 nature of knowledge, teacher's role, and curriculum purpose). Then we asked
10 them questions to allow them to elaborate further and justify the order they had
11 chosen for each group of statements based on their beliefs. All participants
12 were asked some demographic questions and other open-ended questions
13 focused on their perceptions and justifications of their perceptions regarding
14 the reform-based biology curriculum.

15   All interviews were conducted in the interviewees' first language, which is
16 Arabic. The interviews were audio-recorded after obtaining the participants'
17 permission. The audio recordings were then transcribed using the 1:09:02.2
18 version of Express Scribe Transcription Software. We then translated all the
19 transcribed interviews from Arabic into English.

20

21 **Data Analysis**

22

23   We employed Braun and Clarke's (2006) thematic analysis approach to
24 identify themes within all data sets. We presented the findings and emerging
25 themes and subthemes using evidence from multiple data sources (Creswell &
26 Plano Clark, 2011). We attempted to identify curriculum developers'
27 pedagogical beliefs in terms of knowledge, student learning, the role of the
28 teacher, and the purpose of the curriculum as the developers had articulated
29 them in their responses to the Curriculum Platform Q-sort. Thus, we coded the
30 data with "theory-driven" themes in mind (Braun & Clarke, 2006).
31 Furthermore, we compared the developers' espoused beliefs with their
32 perceptions and views, as expressed in the interviews and reflected in the
33 curriculum that they had developed.

34   Additionally, we read the entire data set to find "data-driven" codes and
35 themes. For instance, we focused on how the developers defined "curriculum"
36 and "student-centered curriculum." Our plan for the study was to compare
37 curriculum developers' views with teachers' views about the implementation
38 of the curriculum, so we intentionally scanned the data set from interviews to
39 code for this and to see how the developers' perceptions align or fail to align
40 with the teachers' perceptions.

41

42 **Trustworthiness and Ethical Considerations**

43

44   We adopted Lincoln and Guba's (1985) trustworthiness criteria—
45 *credibility, transferability, dependability,* and *confirmability*—to establish the
46 study's research validity and reliability. Moreover, to help ensure honesty in
47 responses, we targeted only those who were genuinely willing to participate.

1 We conducted member checks to ensure the accuracy of the data collected
2 from the interviews. Most importantly, the study adhered to the ethical
3 requirements of The Pennsylvania State University's Institutional Review
4 Board (IRB) and the Omani Ministry of Education's research regulations.
5
6
7 **Results**
8
9 **An Overview of the Biology Curriculum**
10
11 Within the Omani Ministry of Education, curriculum development is the
12 responsibility of the Directorate General of Curriculum Development. The
13 Directorate is also responsible for producing and evaluating instructional
14 materials and carrying out curriculum implementation training programs. The
15 Directorate forms curriculum subject committees to write, review, and amend
16 curriculum objectives and the teaching and learning material for the various
17 subjects. The final version is submitted to the Supreme Committee (chaired by
18 the Minister of Education), which makes the final decision on whether to
19 implement the curriculum. Two committees developed the biology curriculum
20 analyzed for this study. The first committee was responsible for writing the
21 curriculum and consisted of three curriculum developers and one supervisor for
22 biology. The second committee was the review committee and it included
23 university instructors, supervisors, and teachers. However, neither the writing
24 nor the review committee included any sociologists, psychologists, or
25 assessment specialists.
26 Each member of the writing team was assigned a unit to write. The team
27 then revised all units. Both committees subsequently came together to share
28 feedback and make amendments. The entire process took less than a year. The
29 textbook was developed in 2008 and has been in use since then with no major
30 changes or revisions to the original edition. The developers all agreed that the
31 foundation upon which they developed the curriculum was the scope and
32 sequence document, which included the knowledge and skills learning
33 outcomes for grades 1 to 12. They indicated that the scope and sequence
34 document was developed by the Canadian experts. AB said:
35
36 "The Canadian house of expertise hired by the Ministry in 1998 developed
37 the scope and sequence for grades 1 to 12…We revise the scope and
38 sequence every year before starting to write the curriculum to see to what
39 extent it is consistent and coherent between grades and how can we change
40 it. I mean the author could delete or add learning outcomes to ensure
41 coherence"
42
43 The curriculum developers defined and referred to the curriculum as the
44 school textbook, the teacher's guide, and the student laboratory manual. The
45 textbook is divided into four units (cell division and respiration, nervous and
46 endocrine control, reproduction and development of the human embryo, and
47 heredity). Each unit includes two chapters, and over the course of a semester,

1 two units and four chapters are taught. The developers indicated that they
2 attempted to select the content and present the information in a format suitable
3 to the grade.
4

Curriculum Analysis Using the Criteria for the Constructivist Curriculum
(CCC) Model

7

8   Epistemological assumptions. The Omani curriculum and curriculum
9 developers emphasized that students would acquire the necessary knowledge
10 and skills related to biology by studying a set of knowledge and skills that
11 includes scientific concepts, facts, principles, and theories. They focused on
12 helping students gain this predetermined set of knowledge and scientific skills
13 through explorations and scientific experimentation. From a constructivist
14 perspective, the Omani curriculum and developers' beliefs show a
15 misalignment between knowledge and understanding. However, the supervisor
16 who participated in writing the curriculum believed that students construct their
17 knowledge by building on pre-existing constructs and engaging in social
18 interactions with teachers and peers.
19

20   Pedagogical assumptions. The textbook emphasizes student-centered and
21 teacher-centered approaches to learning. It presents the teacher as a transmitter
22 of content knowledge and subject-specific skills to students. On the other hand,
23 it encourages teachers to employ different instructional strategies to address a
24 variety of learners' needs and differences; these include student-centered
25 learning, brainstorming, concept-mapping, V-shape, inquiry, questioning,
26 teamwork, cooperative learning, individual learning, problem-solving,
27 explorations and scientific experiments, the transmission of knowledge and
28 skills from teacher to student, and formative and summative assessment.
29   In a departure from constructivist pedagogical assumptions, the curriculum
30 does not emphasize the necessity of identifying students' prior conceptions to
31 help them construct new knowledge based on existing knowledge. Moreover,
32 the role of the teacher seems to be that of a knowledge dispenser rather than a
33 facilitator who actively engages students in conversations.
34

35   Goals and learning outcomes. The scope and sequence document includes
36 many very detailed learning outcomes regarding students' grasp of knowledge
37 and development of scientific skills (Appendix C). It makes a superficial
38 attempt to cover all basic and essential topics and issues related to the subject.
39 The learning outcomes are expressed in behavioral terms and describe
40 behaviors and performance. They focus on changes in students that are easily
41 observed or can be directly measured using assessment methods. It does not
42 appear that the outcomes are tied to specific assessment methods. Instead,
43 assessment is tied to the content in the textbook. The learning outcomes also
44 emphasize the aspects of the content that students will be tested on and are
45 included in the knowledge and application questions at the end of each unit.
46 This indicates that the curriculum also represents the behavioral perspective.

Constructivist goals and learning outcomes are designed to represent big questions, ideas, and problems. The Omani biology curriculum learning outcomes are detailed and focus on basic content knowledge. In addition, unlike constructivist goals that reflect internal thoughts and cognitive structures, these curriculum outcomes describe performance and behaviors.

Content. The content is aligned with a set of behavioral objectives (knowledge and skills) that constitute the scope and sequence of the subject. The structure is linear and hierarchical and organized following a top-down approach, which aligns with the behavioral approach. It is built around abstract concepts, theories, overarching themes, and fundamental ideas that the student should learn. It is centered on the subject matter. The curriculum content mainly emphasizes teacher-centered instruction, as seen in its explicit description of the teacher as the performer of major tasks such as explaining content and facilitating class discussions. Students are not encouraged to design experiments or to explore different procedures and approaches, but to carefully follow the directions written in the textbook. There is a lot of content knowledge for students to learn and not as much focus on inquiry-based learning.

In contrast, constructivist content addresses current societal issues and focuses on developing forms of thinking and problem-solving. The tasks are authentic and linked to meaningful tasks that aim to connect learning with real-world applications and personal experiences. Although this curriculum has a massive number of learning outcomes when considering the time allotted to accomplish them, it is obvious that the content presentation lacks depth and coherence.

Richness. The amount of content covered in the curriculum is massive compared to the amount of time allotted to it; thus, teachers do not have time to teach concepts in depth. The curriculum does not give the teacher a chance to design classroom activities and tasks or to differentiate among learning opportunities based on students' learning interests. The curriculum stresses one narrative, which consists of the scientific facts that are in the textbook and transmitted from the teacher to the students.

Moreover, the curriculum does not attend to students' different learning styles, needs, and multiple intelligences. It does not give students the chance to design their own scientific investigations or to conduct long-term projects; rather, the students are expected to comply with the procedures in the textbook. The textbook mainly focuses on encouraging students to understand and memorize the facts and concepts.

Unlike a constructivist curriculum, this curriculum lacks dialogue, depth, and multiple interpretations of the learning experience. It does not offer students the opportunity to transfer knowledge to new contexts or to apply knowledge to different situations. Furthermore, it does not emphasize personal importance and relevance to motivate students to find answers to the questions.

1   <u>Relations.</u> The curriculum was developed at the central level without
2 teachers' participation; there was no dialogue between the teachers and the
3 curriculum developers during the writing process or the implementation. In
4 terms of pedagogical relations, there are no clues suggesting that the
5 curriculum encourages dialogic interaction between the teacher and the
6 students to enrich learning experiences or targeted teaching strategies
7 addressing students' learning difficulties. There is no indication that teachers
8 should strive to motivate students to learn by reflecting on their experiences,
9 perspectives, and social context.

10   In terms of cultural and social relations, the curriculum does not clearly
11 reflect the social and cultural context or allow the students to reflect on their
12 learning based on its meaning to them personally and socially. Thus, the
13 curriculum does not represent relations, an important criterion for the
14 constructivist curriculum to fulfill. The curriculum should allow students to
15 provide different views and perspectives, not just the views and perspectives
16 reflected in the curriculum.

17

18   <u>Rigor.</u> The curriculum development process lacked flexibility and the
19 active involvement of teachers and students in the design of goals, content, and
20 activities. In addition, the curriculum lacks opportunities to facilitate
21 interaction between the teachers and their students and among the students
22 themselves. There are some tasks that allow for group work, but they seldom
23 shape the curriculum design or what, when, or how the students learn. The
24 curriculum tells the teachers what and how to teach. The curriculum requires
25 fidelity of implementation to ensure that all students are learning the same
26 content that they will be tested on. According to AB:

27

28   "No. Not possible (to omit, delete, or change the order of the textbook
29   content) because the curriculum developers tried to include the content
30   that aligns with the learning outcomes so if he/she deletes something this
31   will affect the learning outcomes"

32

33   The curriculum was not developed with an open-ended goal. The
34 curriculum is not generative; instead, it was set and predetermined by the
35 developers. Learning focuses on content knowledge rather than central ideas
36 and problems, suggesting a lack of rigor. This shows that the curriculum
37 encourages the teacher to engage in teacher-centered learning rather than to
38 work as a facilitator by creating an encouraging environment for students.

39

40   <u>Recursion.</u> The curriculum is connected vertically with the biology
41 curriculum that is taught in grade 11. A set of basic concepts, theories, and
42 fundamental themes are divided between the two grade levels. The concepts
43 that are covered in grade 11 include respiration, the circulatory system, the
44 excretion system, and nutrition. Building on these concepts, in grade 12, the
45 content covered includes cell division and cellular respiration, nervous and
46 endocrine control, reproduction, and heredity. It is a top-down, linear, and
47 hierarchical curriculum in its structure, both as a whole and in its individual

units. The units are organized similarly such that they all include basic concepts, explorations, and assessment questions. Hence, the units' structure is also linear and hierarchical. This has led to the creation of discrete units that lack coherence and depth.

Although a team of four curriculum developers wrote this curriculum, each developer was responsible for writing one unit. A common consequence of this division of responsibility is that the units that are presented in different styles and levels of content depth and quality. The units lack coherence and logical transitions from one concept to another. The developers believed that the curriculum is organized in a spiral structure to achieve integration and a logical sequence in content across all grade levels. According to AH:

> "We developed all the science curricula (general science, chemistry, biology, and physics) based on the spiral model. The experiences are built in a cumulative manner; so, each concept is being taught in more than one grade level in more depth. There is also horizontal and vertical integration in the curricula"

However, supervisor HR had a different view. He explained that they had developed the curriculum based on the scope and sequence so that the textbooks for grades 11 and 12 are independent of each other and not integrated. The content and units are different and not linked.

> "Assigning units to different authors is definitely a major reason
> for inconsistency due to differences among authors based on each
> one's background and expertise. However, to ensure coherence, the
> team discussed all the units together to minimize such variations
> and to bridge the gaps"

Instructional/learning methods. The student textbook and the teacher's guide include recommended instruction methods for each topic, including lecturing, experiments, hands-on activities, group work, and investigations. The role of the teacher is to transmit the knowledge in the textbook to the students and facilitate students' investigations by helping them to follow the instructions to complete the experiments and inquiries. The teacher should also prepare the students to grasp and memorize knowledge for the final test. The students need to master the content knowledge to receive high scores on the national test. The curriculum also encourages cooperative learning and teamwork for some of the tasks and experiments. However, because final grades depend mainly on students' scores on the final test, collaboration is encouraged and incorporated into the curriculum but is not considered a requirement in this particular grade.

Constructivist instructional methods foster student-centered and inquiry-based learning in which the student is an active learner and the teacher is a facilitator. This curriculum appears to emphasize teacher-centered instructional methods, however. Even though it encourages the implementation of inquiry-based learning, cooperative learning, and hands-on activities, in all such

activities the students are supposed to follow instructions given by the teacher.

Learning assessment. This curriculum focuses on making decisions about the learners. The purpose is mainly for diagnosis, instructional feedback, and credentialing (Posner, 2004). The students' performances are compared to a predetermined set of knowledge and skills outcomes included in the scope and sequence document. The evaluation instruments used are summative tests and formative assessments including laboratory work, classroom participation, homework, and quizzes. The focus is on grades, which are often not associated with learning outcomes. The students have to sit for the national test at the end of each semester. The scores a student earns on the two end-of-semester tests constitute 70% of the student's final grade. The remaining 30% is based on prescribed formative assessment tools, and the scores are determined by the teacher.

Furthermore, the teachers are encouraged by Ministry personnel to focus on test preparation during the few weeks before the final tests. The Ministry of Education sets high standards for teachers and demands school accountability by publishing students' test score reports for each school at the end of each semester. This suggests that the learning assessment methods employed do not align with constructivist principles.

Learning resources. The curriculum suggests some outside resources for enriching learning, but students are not required to use them. There is a great emphasis on the necessity of adhering to the curriculum and in particular the textbook. Again, this does not reflect alignment with the constructivist perspective.

Students' Engagement and Communication. Teacher-student interactions are limited to questions and discussions. The opportunities for students to interact with other students are restricted to cooperative learning and teamwork. The quality of communication and students' engagement levels are insufficient for creating a safe environment for sharing opinions, debating ideas, and challenging findings and perceptions.

Curriculum Change/Review. The approaches that characterize the curriculum change efforts are aligned with the research, development, and diffusion (RD&D) model, which is based on the behavioral perspective. The curriculum review process is informed by measurement-based evaluation that focuses on the learners' performance on norms-based assessments. Students' test scores are utilized to assess the achievement of learning objectives and curriculum implementation in terms of "degrees of adoption/fidelity." The teachers are expected to adopt the curriculum as designed with very little adaptation allowed.

It appears that curriculum developers do not take teachers' beliefs and feedback are not taken into consideration when the curriculum is reviewed or changed. The curriculum developers do not assign teachers any role in developing or reviewing the curriculum. In addition, changes are made based

on students' test scores rather than classroom observations and interviews with teachers that would allow developers to gain a clearer sense of the actual implementation of the curriculum. There is a need to reconsider the plans for curriculum reform to make it a collaborative process and adopt a more constructivist approach.

There is a specialized department that carries out the process of curriculum assessment, however, the curriculum developers seemed dissatisfied with the quality of feedback they received from this department. SD explained:

"Although there is a department responsible for curriculum assessment in terms of its strengths and weaknesses, they don't send the report to us unless we ask for it. Maybe they have so much to do, but they should initiate the communication with us and send us the analysis report"

Curriculum Developers' Pedagogical Beliefs

Theme 1. Curriculum developers who had been engaged in student-centered teaching experiences held pedagogical beliefs that aligned with constructivism.

Table (2) below shows the curriculum developers' orientations based on the Curriculum Platform Q-sort. HR and BH held beliefs that were equally aligned with progressivism and social reconstructionism; thus, their philosophical base was determined to be pragmatism. It is worth noting that HR is a supervisor who had been involved in writing the curriculum and BH is a curriculum developer who had had the opportunity to teach this curriculum. AS and SD held beliefs that aligned best with progressivism but were very closely aligned with critical theory. Finally, AH held beliefs that were equally aligned with essentialism, reconstructionism, and perennialism.

Table 2. Curriculum developers' Philosophical Orientations Based on Curriculum Platform Q-sort

Participant	Orientations	Curriculum Writing Role
HR	Progressivism & Reconstructionism	Involved
BH	Progressivism & Reconstructionism	Not involved
AB	Progressivism & Critical Theory	Involved
SD	Progressivism & Critical Theory	Not involved
AH	Essentialism & Reconstructionism & Perennialism	Involved

Both HR and BH believed that knowledge is constructed by students and should lead to growth and development. HR considered knowledge to consist of all the experiences a student has to construct new knowledge based on previous knowledge; the student has these experiences under the guidance of the teacher, but the knowledge gleaned from them is not transmitted from the teacher to the student. BH thought that knowledge is acquired through investigation and scientific inquiry. Both believed that students learn best

through active learning, investigation, and when they see that the concepts are meaningful and connected to their lives and real-world applications. They both believed that the role of the teacher should be to guide students' learning and help them become active learners who engage in research, scientific inquiry, and cooperative learning. They also believed that the curriculum should be based on students' interests and involve applications to social problems.

Unlike HR and BH, curriculum developers AB, AH, and SD had no experience teaching the reform-oriented curriculum or observing its implementation in classrooms. The three developers had an eclectic mix of orientations. They believed that knowledge is a set of facts, skills, and experiences provided by a curriculum, including scientific concepts, principles, and scientific laws and theories. They believed that knowledge is acquired and gained through exploration and scientific experimentation. However, they indicated that students learn biology better when teachers incorporate theoretical and practical aspects into their teaching than in traditional methods. They added that students' learning depends on the nature of the topic, the learning environment, and the available aids and resources. They viewed the role of the teacher as a guide who helps students to be active learners by engaging research, inquiry, and cooperative learning. On the other hand, they insisted that the teacher is responsible for delivering the content and the essential knowledge to the students and preparing them to pass the test. AH and SD explained respectively:

"It is best to use a variety of instructional strategies based on the topic and the level of the learners and the availability of learning resources. Therefore, the teacher should employ strategies such as explanation, discussion, and ask different questions short and open-ended. The teacher should also use scientific inquiry because it is the focal of science learning. Also, the teacher should use V-shape, problem solving, brainstorming, and learning cycle. However, it depends on the topic taught"

"The teacher has the authority in the classroom and should prepare the students for the test."

Given the above, it could be inferred that individuals' pedagogical beliefs become deeply entrenched but develop when they opportunities to interact with and implement the reform-oriented curriculum. Teaching the curriculum helps shape and develop individuals' beliefs. Indeed, our findings indicate that the supervisor and curriculum developer who had taught the curriculum better understood how learning occurs when students construct knowledge based on pre-existing knowledge. They appreciated the role of the teacher as a guide and facilitator of learning, whereas the other developers insisted that the teacher is a knowledge dispenser.

Theme 2: Curriculum developers believed that the curriculum provides learners with a set of knowledge and skills.

Four of the curriculum developers (AB, AH, BH, and SD) defined the school curriculum as inclusive of the student's textbook, teacher's guide, and all the books that the teacher uses to teach the subject content. Furthermore, they said that the curriculum provides students with a good foundation of knowledge and skills related to the subject so that they are college-ready. AH and SD defined the curriculum and its purpose by saying, respectively:

"The curriculum is the student textbook, teacher guide, and lab manual. The curriculum is a set of planned knowledge, skills, and experiences that the teacher provides to the students in order to achieve the learning outcomes and goals to prepare a productive and good citizen"

"It is the school textbooks and learning aids and everything related to the textbook"

Supervisor HR believed that "the curriculum should address students' interests and focus on the application of problem-solving." He defined the curriculum as "all the experiences that should be presented to the learner." In other respects, he seemed to agree with other developers that all experiences should be in the textbook or teacher's guide and approved by the Ministry. Additionally, all of the participants confirmed that the teacher should teach based on the learning outcomes rather than the textbook content. This means that the teacher should be able to add to and enrich but not eliminate or change the order of the content. AB, SD, and HR rationalized the necessity of having a national textbook for all schools and students by saying, respectively:

AB: "it is because the Ministry wants to guarantee the minimum level of knowledge that each student gain or the big ideas or main issues that the teacher should teach to achieve the outcomes"

SD: "to unify what the students receive, so no school or province could delete because of the national final test that is developed based on the outcomes"

As the above discussion suggests, the developers defined the curriculum as a set of behavioral outcomes and prescribed content included in the textbook. Furthermore, regardless of their personal beliefs, all stressed that teachers should adhere to the national prescribed curriculum and ensure the delivery of the same set of knowledge and skills to all students. Teachers are expected to adhere in all ways and implement the curriculum as designed. This indicates that the developers lack of a specific and clearly formulated definition of curriculum to guide practice.

Importantly, there was no agreement on the definition of a student-centered curriculum among curriculum developers. The developers maintained that a student-centered curriculum focuses on "providing the learner with essential knowledge and skills." Supervisor HR defined a student-centered curriculum as follows:

1

2   "It focuses on self-directed learning and the effective role of the student in
3   an effective learning environment. The student is active learner and the
4   teacher is a guide or facilitator. The student is provided a supporting
5   learning environment to investigate so that he could construct new
6   knowledge on pre-existing knowledge. The student becomes a young
7   scientist who do inquiries and interpret results based on evidence from his
8   investigations. The teacher does not provide the information and facts or
9   results but allows the student to find it"

10

11   *Theme 3: Curriculum developers' pedagogical beliefs aligned with the*
12   *curriculum's pedagogical assumptions.*

13

14   With respect to knowledge, the textbook emphasizes that knowledge and
15   skills are acquired by learning an essential set of scientific concepts, facts,
16   principles, and theories. This indicates that the curriculum's epistemological
17   assumptions align with the curriculum developers' beliefs about knowledge. In
18   terms of student learning, all seemed to agree that students learn when they are
19   actively engaged in meaningful learning experiences. Nevertheless, the
20   developers who held mixed beliefs emphasized that passive learning and active
21   learning are equally important. In contrast, those who held beliefs that aligned
22   with constructivism believed that a learner should be actively engaged in
23   hands-on and inquiry-based learning. This is further evidence that the
24   curriculum developers' beliefs shaped the curriculum they developed and that
25   reflects mixed perspectives on pedagogical assumptions.
26   Although the developers indicated a belief that the teacher's role is to
27   guide and facilitate students' learning, they stressed that the teacher must
28   deliver curriculum content and prepare students for the test. This was clearly
29   reflected in the curriculum, which emphasizes student-centered and teacher-
30   centered approaches to learning at the same time. The curriculum presents a
31   mixed set of perspectives and emphasizes both teacher-centered and student-
32   centered approaches to learning. This is in alignment with curriculum
33   developers who held different beliefs or mixed sets of beliefs.
34   In terms of the curriculum's alignment with constructivism, AB and AH
35   seemingly considered the curriculum to be in complete alignment with
36   constructivism. They justified their argument that the curriculum was
37   developed based on the constructivist perspective by noting that the content is
38   both theoretical and practical. Comments made by AB include:

39

40   AB: "I am not biased but I think the recent school textbooks reflect this
41   theory (constructivism) because they combine skills with knowledge. If the
42   curriculum is implemented as it is planned for then we will have student-
43   centered learning taking place in classrooms"

44

45   However, supervisor HR thought that the curriculum is only slightly
46   aligned with the constructivist perspective due to some Ministerial policies and
47   the resources and technology that had been available at the time the curriculum

was developed. He further asserted that assigning units to different developers might have resulted in the units' varying levels of compatibility with constructivist theory. HR said:

> "The current curriculum took some aspects of the constructivism theory but not everything. Some of the topics were presented theoretically so the teacher has to provide the information directly to the student. The textbook was developed in 2008, when not as many and as different resources were available like today. Even teachers and students are different compared to 2008. Technology use and availability at the time was limited…"

Theme 4: Curriculum developers believed that the reform policies and the curriculum implementation procedures influenced the implementation of the reform-oriented curriculum.

<u>Teachers Resist Change.</u> All of the curriculum developers indicated that teachers resist change and innovation if it is imposed by the Ministry. AB explained that teachers' resistance was expected in the first year as the teachers were familiarizing themselves with the new system and curriculum. She described teachers' resistance as a typical response to changes. Teachers' resistance was further triggered because the teachers are usually held responsible for the success of a new reform and they are held accountable by principals, supervisors, and parents. HR exclaimed that teachers resist change because they are not convinced of the change's value or do not believe in the new teaching methods and their effectiveness:

> "Teachers resist change, they are not convinced or don't believe in new teaching methods and their effectiveness. They have excuses such as time constraint and the massive content that needs to be covered"

Except for BH, all of the developers agreed that the teachers are not complying with the guidelines provided by the curriculum developers and are not implementing the curriculum as planned. They all confirmed that teachers are still using traditional teaching methods and encourage memorization. According to AH:

> "The students are taught using the traditional methods like dialogue and discussion and it is not common to employ problem-solving methods"

Furthermore, HR reported that based on his supervision experience, about 95% of the teachers are still relying on traditional teaching methods. He noted that since the Basic Education System (BES) was introduced, the Ministry of Education (MOE) has partially succeeded in reforming assessment and curricula but not in reforming teaching methods:

> "Regrettably, I would say, and this is a fact that a high percentage of teachers do not comply with what is planned and approved. I don't

exaggerate if I say 95% of the teachers are still following the traditional style"

In contrast, the teachers indicated that they have to comply with the curriculum in terms of the content; however, they openly described how they do not adhere to the curriculum in terms of the teaching methods. The teachers attributed their adherence to the textbook content to the strict guidelines issued by the Ministry that prohibit any changes to the curriculum. Below are some excerpts from my interviews with the teachers:

LS: "We are required to deliver the curriculum exactly as it is planned for, but I change the order of the topics based on students' needs"

AR: "No we can't omit any topic we should implement the curriculum as it is designed because the test is on the textbook's content. But we can add and enrich it or ask students to do research by themselves. I explain to them any discrepancy and emphasize that they should focus on what is in the textbook"

Teachers' Beliefs. The curriculum developers recognized teachers' beliefs as an important influence on the implementation of the curriculum. They all pointed out that teachers still hold traditional beliefs which do not align with the student-centered philosophy of the curriculum. They attributed the mismatch between teachers' beliefs and the curriculum philosophy to teachers' prior experiences as students and teachers in the old system where the focus was on teacher-centered teaching.

The curriculum developers indicated that they are aware of the incompatibility between teachers' beliefs and the student-centered approach taken by the reform curriculum. They said that they expected that teachers' beliefs would impact curriculum implementation. They all asserted that they had discussed this issue during the process of curriculum development and decided not to take teachers' beliefs into consideration. Rather, they decided to develop the teacher's guide to include a holistic view of each unit and some suggested teaching strategies. According to AB and HR, respectively:

"The teachers are qualified especially grade 11 and 12 teachers they have college degree and bachelor in the subject and in education. It is impossible that a person with this qualification would be unable to teach in a good or acceptable way…Our goal was not the experienced teacher because he needs some boosting, but the teacher who teaches the curriculum for the first time…Of course, teachers learn from their experience and mistakes, so if he teaches the curriculum this year he will recall his mistakes in teaching and try to avoid them"

"As authors we should not take teachers' beliefs into consideration much. I mean as authors we should expect more of our teachers and not go down to

the teachers' level. If we lower our level of expectations, then teachers'
level also will go down"

Teachers' Knowledge. The curriculum developers affirmed that teachers
possess well-developed content knowledge (CK) but lacked pedagogical
content knowledge (PCK), which is crucial for proper implementation of the
curriculum. The teachers emphasized that they lacked the necessary PCK for
the implementation of the reform-oriented curriculum. Some of them had not
experienced any planned professional development activities related to the
implementation of the curriculum. Others indicated that the training on
curriculum implementation they had received was theoretical and ineffective.
For instance, QF said:

"My preparation in college was in the traditional style lectures,
memorization, and recitation. I was a passive recipient of knowledge and
the teacher was always the dispenser of knowledge. I keep researching,
inquiring for knowledge so I don't face challenges in terms of my level of
confidence about myself, the curriculum, or how to deal with knowledge
to make it easy to understand and accessible to students"

Reform Policies and Implementation Procedures. Curriculum developers
emphasized that some of the Ministry's policies had interfered with the
implementation of the reform curriculum. In particular, they mentioned the
procedures followed in developing and implementing the curriculum and the
assessment system. They maintained that they had been rushed to write and
implement the curriculum without first piloting it. They were not given the
time they needed to write and revise the curriculum. The entire process took
less than six months. On the other hand, the curriculum developers
acknowledged weaknesses in the scope and sequence and the learning
outcomes. They agreed that some of the outcomes were vague and unhelpful in
writing the curriculum; however, these outcomes remained unchanged. AB
described the outcomes, saying:

"We confess that some of the learning outcomes are vague and did not
help when writing the curriculum. We received some feedback that some
outcomes are very general and vague, so they open the door for many
aspects when writing the test. The scope and sequence had undergone
minor revisions and now it's been 10 to 12 years. There is no document
that should last for this time without revision"

The curriculum developers indicated that the assessment system and the
national test encourage teaching to the test and memorization of content. AB
and SD indicated that due to the national testing policy, teachers feel it is easier
to help their students memorize facts to obtain high test scores. According to
AB:

1 "100% there was a great influence (of the test). The common view is that
2 the teacher should teach to the test. The test itself reflects an idea that the
3 teacher should teach everything according to the textbook. They (tests
4 writers) say that the test aligns with the outcomes, but it focuses on very
5 minor details and minor concepts but not the general outcomes"
6
7 Likewise, all the teachers confirmed that the national testing policy has a
8 negative impact on students' learning. The students' goal and focus are on
9 earning high test scores rather than understanding and applying knowledge.
10 Teachers said that their students think about the test almost all the time.
11
12 RH: "Yes, 90% of the time the students' study for the test not for learning"
13 KM: "Yes of-course students focus on learning for the test. They always
14 focus on their desire to get the full mark and not the application"
15
16
17 **Discussion and Conclusions**
18
19 This study aimed to examine how curriculum developers' pedagogical
20 beliefs shape the implementation of the reform-oriented curriculum. Methods
21 of data collection included document analysis and semi-structured interviews
22 with biology curriculum developers and biology teachers. An ethnographic
23 approach to data analysis was employed. Two assertions emerged from this
24 study in response to the research questions. They are as follows:
25
26 1. Curriculum developers' pedagogical beliefs are reflected in the
27   curriculum design as represented by the epistemological assumptions,
28   the pedagogical implications, the forms of learning assessment, and the
29   teacher's role.
30 2. Reform-oriented curriculum implementation procedures contribute to
31   the misalignment between the planned curriculum and the implemented
32   curriculum.
33
34 A discussion of the assertions with supporting evidence from the literature and
35 study data follows.
36
37 **Assertion 1:** Curriculum developers' pedagogical beliefs are reflected in the
38 curriculum design as represented by the epistemological assumptions, the
39 pedagogical implications, the learning assessment, and the teacher's role.
40
41 The biology curriculum developers involved in this study held mixed sets
42 of beliefs. As a consequence, the textbook reflected a mixed set of perspectives
43 that positioned both teacher-centered and student-centered approaches to
44 learning as equally important. The developers defined the curriculum as the
45 textbook and asserted that teachers are expected to fully adhere to the
46 curriculum to prepare their students for the national test.
47 Curriculum development should be a flexible, generative, and active

1 process that involves teachers and students in the creation of goals, plans, and
2 activities. A curriculum should be designed to allow interaction between
3 teachers and students. A constructivist and reflective curriculum should be a
4 multilayered, undefined, and open structure to facilitate the creation of
5 knowledge interactively, dialogically, and conversationally (Gang, 2015).
6 Curriculum development should be an interrelated, semi-autonomous, and
7 heterarchical process rather than a hierarchical one (Hunkins & Hammill, 1994,
8 as cited in Mansour, 2010). Therefore, the dialogue between teachers and
9 curriculum developers should be improved.

10 In the case of the Omani biology curriculum and in light of the CCC
11 model we designed, this means that the curriculum should include the major
12 essential topics related to biology, but it should also allow for interaction
13 between the teacher and the students so that they can freely design the
14 activities and learning materials. Furthermore, in line with constructivist
15 instruction, emphasis should be placed on learning by understanding how
16 students construct knowledge based on existing knowledge. Thus, teachers
17 should be able to elicit students' prior knowledge and misconceptions and then
18 design engaging learning situations to help the students elaborate on and
19 structure new knowledge. Teachers should be given the freedom and flexibility
20 to provide their students with opportunities to work collaboratively on
21 complex, meaningful problem-based activities.

22 However, in order to improve the critical dialogue between teachers and
23 the curriculum, teachers must have the required knowledge (CK and PCK) to
24 master the curriculum, so they can present effective learning experiences to
25 students. In addition to improving teachers' relation with the curriculum,
26 curriculum developers should define the expected role of teachers to be that of
27 facilitators who create an encouraging environment for students' autonomous
28 learning. The curriculum needs to allow teachers to focus on facilitating
29 interaction between them and their students and among the students
30 themselves. It should also encourage teachers to motivate students' learning
31 through reflecting on their experiences, perspectives, and the social context.

32 Failure in curriculum innovation has been associated with developers'
33 neglect of teachers' beliefs and perceptions (Sutherland, 1981, as cited in
34 Mansour, 2010). Teachers' own interests and concerns are rarely taken into
35 consideration when developers make decisions (Ben-Peretz, 1980). Hence, it is
36 essential to take teachers' pedagogical beliefs into consideration and plan for
37 PD programs as a core component in the curriculum development process.

38 **Assertion 2:** Reform-oriented curriculum implementation procedures
39 contribute to the misalignment between the planned curriculum and the
40 implemented curriculum.
41
42 Curriculum Development and Implementation Plan. Although the
43 curriculum developers perceived the curriculum to be aligned with the
44 constructivist perspective, the supervisor and the teachers seemed to disagree,
45 believing that it included only some aspects of constructivism and a student-
46 centered approach to learning. A few teachers indicated that the curriculum has
47 helped them to implement student-centered learning. The majority of the

1 teachers believed that the curriculum did not stress student-centered learning
2 because it focused on CK and lacked opportunities for students to practice
3 research, active learning, and inquiry-based learning.

4   The development and implementation plan seemed to be limited to the
5 phase of writing and distributing the curriculum to schools for implementation.
6 The plan lacked phases for data gathering and analysis, a pilot study,
7 professional development, and evaluation. The development of the curriculum
8 should not cease once a development committee finishes creating a curriculum.
9 Nicholls and Nicholls (2018) argued that curriculum development is not an
10 activity that is performed once and then is finished. Rather, they asserted that
11 viewing curriculum development as a dynamic, never-ending process helps
12 teachers to cope with rapidly changing societies, schools, and students. Hence,
13 the curriculum should be regarded as dynamic rather than static.

14

15   Concepts' Definitions and Reform Ideologies. There was an evident lack
16 of consensus on curriculum conceptualization in general among curriculum
17 developers and teachers. The participants also embraced different definitions of
18 a student-centered curriculum and active learning, which seemed to be
19 informed by their beliefs. The curriculum developers agreed that the
20 curriculum included the student textbook, teacher's guide, and students'
21 laboratory manual. However, the supervisor and the teachers defined the
22 curriculum as all learning experiences in which a student is actively engaged.
23 The majority of the teachers believed the curriculum should address students'
24 interests.

25   Furthermore, the curriculum did not stress specific definitions or strategies
26 for student-centered learning, inquiry-based learning, problem-solving,
27 formative assessments, active learning, project-based learning, or hands-on
28 activities. It was expected that teachers would be able to figure out the meaning
29 and be able to implement such strategies as required. The assumption that there
30 is general agreement on definitions of terms such as a curriculum, student-
31 centered learning, active learning, and inquiry-based learning has made the
32 implementation process more challenging. Therefore, reform-related
33 documents including the reform-oriented curriculum should include agreed-
34 upon conceptualizations of the terms and strategies that are crucial to the
35 process of the implementation.

36

37   Considerations for Curriculum Developers. This study's findings show
38 that curriculum developers' pedagogical beliefs are reflected in the curriculum
39 design, and in particular, in the curriculum's epistemological assumptions,
40 pedagogical implications, the teacher's role, forms of learning assessments, and
41 instructional strategies. The curriculum developers did not have the opportunity
42 to interact with the curriculum material or oversee the implementation process,
43 however. This lack of interaction with the curriculum material and students in
44 the classroom deprived the curriculum developers of the opportunity to
45 understand how students interact with the curriculum and how learning
46 happens. The supervisor who oversees teachers' instruction and the curriculum
47 developer who had experience teaching this curriculum held beliefs that

aligned with progressivism and reconstructionism. This suggests that curriculum developers' beliefs should be taken into consideration when assigning them the responsibility of curriculum writing and revision.

The official procedure for approving a new curriculum in Oman does not follow a research-based curriculum analysis framework. This has led to a mismatch between the approved and the implemented curriculum. It seems that there is no official framework or process for curriculum review and analysis, which supports our finding that there is no systematic plan for curriculum development.

PD Programs for Teachers. The curriculum developers indicated that teachers resisted the reform and leaned toward traditional teacher-centered learning strategies. Our findings highlight the importance of curriculum developers taking into consideration teachers' beliefs as early as the curriculum planning and writing phase. These findings correspond with those of multiple studies that have called for curriculum developers to investigate and address teachers' beliefs as part of the process of curriculum development. For instance, Mansour (2010) asserted that unless curriculum developers take into account science teachers' beliefs and knowledge and the sociocultural factors that shape those beliefs in designing and planning a new curriculum, the curriculum implementation is unlikely to match the planned curriculum.

The curriculum developers realized that the teachers lacked the CK and PCK to master the curriculum, so they can present effective learning experiences to students. The teachers explained that college had not prepared them to engage in reform-oriented instruction and to adopt a student-centered approach to learning. As students, they had experienced a teacher-centered approach to learning and traditional teaching methods such as lectures, memorization, and tests. Accordingly, they attempted to update their PCK through self-directed learning, research, and PLCs. Research has shown that when teachers lack the PCK necessary for reform-oriented instruction, the implementation of a reform-based curriculum is hindered (Park & Chen, 2012).

Curriculum developers should take teachers' beliefs and PCK into account when creating the curriculum, making sure to clearly define the expected role of the teacher as a facilitator. They need also to plan for PD programs as part of the curriculum development process.

References

Al Balushi, S., and Griffiths, D. 2013. The school education system in the Sultanate of Oman. *In Donn, G., & Al Manthri, Y. (2013): Education in the broader Middle East: Borrowing a baroque arsenal*. Symposium books Ltd, Oxford.

Ambusaidi, A., and Al-Balushi, S. 2015. Science education in the Sultanate of Oman. In: Mansour, N., & Al-Shamrani, S. (2015). *Science education in the Arab Gulf States: Visions, sociocultural contexts and challenges*. Sense Publishers.

Badiali, B. 2005. Standards for supervision of curriculum development. In: S, Gordon (Ed). *Standards for instructional supervision, enhancing teaching and learning*. Larchmont, NY: Eye On Education.

Banilower, E. R., Smith, P. S., Weiss, I. R., Malzahn, K. A., Campbell, K. M., and Weis, A. M. 2013. *Report of the 2012 National Survey of Science and Mathematics Education*. Chapel Hill, NC: Horizon Research.

Ben-Peretz, M. (1980). Teachers' role in curriculum development: An alternative approach. Canadian. Journal of Education. 5. 52–62.

Brandon, A., and All, A. 2010. Constructivism theory analysis and application to curricula. *Nursing Education Perspectives. 31(2):* 89-92.

Braun, V., and Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology, 3:* 77-101.

Brown, K. 2003. From teacher-centered to learner-centered curriculum: Improving learning in diverse classrooms. *Education. 124(1):* 49-54.

Creswell, J., and Plano Clark, V. 2011. *Designing and conducting mixed methods research (2nd Edition)*. Thousand Oaks: Sage.

Cullen, R., Hill, M., and Reinhold, R. 2012. The learner-centered curriculum: Design and implementation. Wiley, Hoboken NJ: John Wiley & Sons.

Doll, W. 1993. *A post-modern perspective on curriculum*. Teachers college press.

Fives, H., and Buehl, M. 2016. Teachers' beliefs, in the context of policy reform. *Policy Insights from the Behavioral and Brain Sciences. 3(1):* 114-121.

Fosnot, C. 1996. Constructivism: A Psychological Theory of Learning. In *Constructivism: Theory, Perspectives and Practice,* ed. C. T. Fosnot, 8–33. New York: Teachers College Press.

Harris, M., and Cullen, R. 2010. *Leading the learner-centered campus: an administrator's framework for improving student learning outcomes*. Jossey-Bass higher and adult education series (1st ed.). San Francisco.

Issan, S; and Gomaa, N. 2010. Post basic education reform in Oman: A case study. *Literacy information and computer education journal. 1(1):* 19-27.

Jansen, J., & Reddy, V. 1998. Curriculum analysis, a reference manual. Unpublished document. South Africa: Centre for Educational Research and Policy, University of Durban-Westville.

Le, V. N., Lockwood, J., Stecher, B., Hamilton, L., and Martinez, J. 2009. A longitudinal investigation of the relationship between teachers' self-reports of reform-oriented instruction and mathematics and science achievement. *Educational Evaluation and Policy Analysis. 31(3)*: 200–220.

Lincoln, Y., and Guba, E. 1985. *Naturalistic inquiry*. Beverly Hills: Sage.

Mansour, N. 2010. Impact of knowledge and beliefs of Egyptian science teachers in integrating a STS based curriculum: A sociocultural perspective. *Journal of Science Teacher Education. 21.* 513-534.

Ministry of Education, Oman and the World Bank. 2012. Education in Oman: The drive for Quality. MOE, Oman.

Ministry of Education. *Inclusive education in the Sultanate of Oman. National report*. Presented at the 48th session of the International Conference of Education, Geneva, 2008.

Ministry of Education. From Access to success. *Education for All (EFA) in the Sultanate of Oman, 1970-2005*. Sultanate of Oman, 2006.

Ministry of Education (Oman): http://home.moe.gov.om/english/

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academy Press.

Nicholls, A., and Nicholls, S. H. 2018. *Developing a curriculum: A practical guide*. Routledge.

Park, S., and Chen, Y. 2012. Mapping out the integration of the components of pedagogical content knowledge (PCK): Examples from high school biology classrooms. *Journal of research in Science Teaching. 49(7)*: 922-941.

Posner, N. 2004. *Analyzing the Curriculum* (3rd edition). New York, NY: McGraw Hill.

Sandrin, A. 2010. An analysis of the Primary Years Program as a socio-constructivist curriculum model. A thesis submitted for the degree of Master of Arts, Concordia University, Montreal, Canada.

Sergiovanni, T., and Starratt, R. 2001. *Supervision: A redefinition* (7th ed). New York: McGraw-Hill.

United Nations Education, Scientific, and Cultural Organization (UNESCO). 2011. World data on Education (Oman). VII ED. 2010/2011. UNESCO-IBE (http:///www.ibe.unesco.org/).

Vygotsky, L. 1978. *Mind in society: The development of higher psychological processes*. Harvard: Harvard University Press.

Wiggins, G., and McTighe, J. 2005. *Understanding by design* (2nd ed). Alexandria, VA: Association for Supervision and Curriculum Development.

Yilmaz, K. 2008. Constructivism: Its theoretical underpinnings, variations, and implications for classroom instruction. *Educational Horizons. 86(3):* 161-172.

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2 **Appendix (A)**
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4 **Criteria for the Constructivist Curriculum (CCC) Model**
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Criteria	Socio-constructivism
Epistemological assumptions	Learners actively construct their own interpretation of knowledge by linking it to prior knowledge constructs. Meaningful learning is socially mediated, and it is affected by the learner's reflection on his personal experiences as an active member of society.
Pedagogical assumptions	The role of the learner is one of selecting and transforming information, constructing knowledge, and making decisions, rather than using the teacher's knowledge and their textbooks to solve problems. The student and the teacher engage in an active conversation. The role of the teacher is to engage students by asking open-ended questions and uses students' questions and experiences to direct the learning and guide selection of teaching strategies. The teacher is a facilitator who focuses on what students need to learn rather than what he or she wants to teach. Furthermore, the teacher works to recognize students' prior conceptions and to design activities that build upon students' knowledge, using strategies such as experiments, problem-solving, reflective tasks, concept-mapping, and dialogue to create deep knowledge and understanding.
Goals/Learning outcomes	The objectives focus on big questions and internal thought processes and cognitive structures, rather than on performance. They refer to changes in students that are not directly observable. These internal changes are described using devices such as "schematic diagrams depicting the interrelationships of acquired concepts, called "concept maps" or "semantic networks"; flowcharts of cognitive processes; and lists of cognitive operations or concepts. Objectives are framed in these ways rather than using lists of behavioral objectives. They are tied to specific assessment.
Content	The content focuses on current societal issues. It is a form of thinking, reasoning, or problem solving. It constitutes the tools of thought by providing authentic tasks that require extended purposeful problem-solving activity (e.g. writing for a real purpose not as an exercise). It provides social interaction and support that encourage students to stretch beyond current capacity as peers help each other build on another's ideas. It aligns with the standards/outcomes and facilitates student understanding of the content and processes espoused in the standards. The balances of depth and breadth of the curriculum and the standards/outcomes are congruent.
Instructional/Learning methods	Student-centered learning approach and inquiry-based activities to enhance the development of complex cognitive skills and processes. Teachers should work as facilitators to help their students construct their knowledge and understanding through inquiry-based activities.
Learning Assessment	The assessment tasks are integrated into learning tasks and are designed to facilitate further learning as well as to develop deep understanding rather than to produce reliable data on surface features of learning. Tied to learning outcomes; students have options for achieving points; not all work is graded. Feedback includes grades and other feedback in the form

	of non-graded assignments, activities, and opportunities to conference with teacher. Periodic feedback mechanisms employed for the purpose of monitoring learning. Multiple means of demonstration outcomes; self-evaluation and peer evaluation.
Learning Resources	Outside resources encouraged; students responsible for their own learning. Learning beyond classroom.
Richness	Richness refers to the curriculum's depth and its incorporation of multiple interpretations of experience. Deep learning is characterized as a student's ability to transfer knowledge into new contexts and to apply knowledge to different situations. The pedagogical strategies that facilitate deep learning include discussion with peers, reflective writing, practical application, and reading. Emphasize personal importance and relevance to motivate students to find answers to the questions.
Relations	Relations refer to wholeness. It takes into account the complex, idiosyncratic, and personal nature of learning. It builds opportunities for reflection to address the personal nature of learning. Relations include both pedagogical relations and cultural relations. Pedagogical relations refer to the relations within the curriculum, which involve the interactions between teachers and learners and also between the participants and the curriculum. Cultural relations underscore the relation between the historical and cultural context and the ways relations are perceived, which convey we should not just confine to our own perspectives, instead we should integrate our own perspectives into a larger social and cultural context.
Rigor	Flexibility in the curriculum to be to some degree self-organizing. Integrative design and involve students in the choice and selection of content. Integrative learning includes intentional focus on critical thinking, communication, and problem solving. Teachers have freedom to select or rearrange the curriculum and what and when to teach it. Learning that is organized around problems or issues rather than strictly discipline content.
Recursion	Refers to the spiraling nature of design. The curriculum is nonlinear, one that offers students' opportunities to repeat, review, and reconsider their understanding of concepts and ideas. A recursive curriculum by design builds the opportunities for revisiting and reassessing one's understanding into the academic plan rather than leaving it up to chance.
Student Engagement and Communication	The curriculum encourages teacher interaction with students and allows the teacher to provide multiple means of access. Rationale is provided for investigations and activities and also tied to learning outcomes. Collaboration, use of groups for class work, and team projects are required and essential. The curriculum provides opportunities for active participation of students by asking questions, arguments and debate among all students.
Curriculum Review/ Curriculum Change	A collaborative approach to curriculum change. Teachers are viewed as active shapers of curriculum change to meet local needs. The developers believe that a set of beliefs about teaching and learning, the subject matter, and the relation of schooling to broader social and political forces guide curriculum change rather than a set of pre-specified objectives. Evaluation methods tend to be less standardized, systemic, and formal. It

	is derived more from classroom observations, semi-structured interviews, and examination of student classwork. Rather than relying on psychometric methods, the evaluators tend to employ more ethnographic methods, yielding intensive, naturalistic descriptions of the classroom.

Appendix (B)

Personal Curriculum Q-Sort (Adapted from Badiali, 2005)

Below you will find 20 statements that characterize our public system of education. These statements are arranged in four categories; they address 1) the aims of education; 2) the nature of knowledge; 3) the role of the teacher; and 4) the purpose of the curriculum. These are foundational considerations for curriculum. Your task is to prioritize these statements by numbering them one to five in each category. Assign the number 5 to the statement you believe best represent your beliefs, 4 to the statement you believe represents your beliefs next best, and so on until you have numbered all 5 statements in each section. At the end of the Q-sort there is a scoring rubric.

Aims of Education

A. --- To improve and reconstruct society; education for change

B. --- To promote democratic, social living, to foster creative self-learning

C. --- To educate the rational person; to cultivate the intellect through transmitting worthwhile knowledge that has been gathered, organized, and systematized

D. --- To provide for the construction of active citizens; to nourish civic literacy, citizen participation, and political responsibility

E. --- To promote the intellectual growth of the individual; to educate the competent person for the benefit of humanity

Nature of Knowledge

A. --- Focus on skills and subjects needed to identify and ameliorate problems of society; active concern with contemporary and future society

B. --- Focus on past and permanent studies, mastery of facts and universal truths

C. --- Focus on reconstructing a visionary language and public philosophy that puts equality, liberty, and human life at the center of the notions of democracy and citizenship

D. --- Focus on growth and development; a living-learning process; active and relevant learning

E. --- Focus on essential skills and academic subjects; mastery of concepts and principles of subject matter

Role of the Teacher

A. --- Teachers are critical intellectuals who create democratic sites for social transformation. They empower students to question how knowledge is produced and distributed

B. --- Teachers serve as change agents for reform; they help students become aware of problems confronting humanity

C. --- Teachers should help students think rationally; teach based on Socratic method, oral exposition, relaying explicit traditional values

D. --- Teachers are guides for problem solving and scientific inquiry

E. --- teachers should act as authority figures who have expertise in subject areas

Curriculum purposes

A. --- Curriculum centers on classical subjects, literacy analysis. It is constant

B. --- Curriculum centers on social critique and social change dedicated to self and social-empowerment

C. --- Curriculum centers around essential skills in the 3 R's (readin`, `ritin`, `rithmetic) and major content areas (English, science, math, history, foreign language)

D. --- Curriculum centers on examining social, economic, and political problems, from present/ future, national/international perspectives

E. --- Curriculum centers on student interests; involves the application of human problems; subject matter is interdisciplinary

Scoring guide for curriculum philosophy Q-sort (Badiali, 2005)

When you have completed the Q-sort exercise, go back and look at each category. Place the number that you assigned to each statement in the space provided in the following rubric. Add the columns to determine the educational/curricular philosophy with which you most agree. Grouped together, these statements represent major tenets of five educational/curricular philosophies.

	Perennialism	Essentialism	Progressivism	Social Reconstructionism	Critical Theory
Aims	C	E	B	A	D
Knowledge	B	E	D	A	C
Teacher's Role	C	E	D	B	A
Curriculum	A	C	E	D	B
Totals					

The taxonomy below is adapted from Badiali (2005)

	Philosophi	Instructiona	Knowledge	Role of Teacher	Curriculum	Related

	cal Base	l Objectives			Focus Trends	Curriculum
Perennialism	Realism	To educate the rational person; to cultivate intellect	Focus on past & permanent studies; mastery of facts and timeless knowledge	Teacher helps students think rationally; based on the Socratic method and oral exposition; explicit teaching of traditional values	Classical subject; literary analysis; constant curriculum	Great books Paideia proposal (Hutchins, Adler)
Essentialism	Idealism; Realism	To promote the intellectual growth of the individual; to educate the competent person	Essential skills and academic subjects; mastery of concepts and principles of subject matter	Teacher is authority in his or her field; explicit teaching of traditional values	Essential skills (the three r's) and essential subjects (Eng, math, science, history, for. language)	Back to basics; excellence in education (Bagley, Bestor, Bennett)
Progressivism	Pragmatism	To promote democratic, social living	Knowledge lends to growth and development; a living-learning process; focus on active and interesting learning	Teacher is a guide for problem solving and scientific inquiry	Based on student's interests; involves the application of human problems and affairs; interdisciplinary subject matter; activities and projects	Relevant curriculum; humanistic education; alternative and free schooling (Dewey, Beane)
Social Recon-structionism	Pragmatism	To improve and reconstruct society; education for change and social reform	Skills and subjects needed to identify and ameliorate problems of society; learning is active, concerned with contemporary and future society	Teacher serves as an agent of change and reform; acts as a project director and research leader, helps students become aware of problems confronting humanity	Emphasis on social sciences and social research; examining social, economic, and political problems; focus on present and future trends	Equality of education; cultural pluralism; international education; futurism (Counts, Grant & Sleeter)
Critical Theory	Marxism	To challenge and deconstruct society, the status quo, powerful oppressors; to teach citizens to act politically	Focus on how the world works to privilege some and not others; awareness of race, class, gender, sexuality, and (dis)ability politics	Teacher acts with conscience and resolve as a social agent of change in the world with students	Teacher opens up societal norms to criticism and action	Some forms of service learning socially active, alternative education programs (Freire, Apple,

		for social justice				Giroux)

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Appendix (C)

Examples of knowledge and skills outcomes from the Omani scope and sequence for the grade 12 biology curriculum

Knowledge outcomes	
General learning outcome	Sub-learning outcomes
12.1 Describe goals and processes of cell division (mitosis & meiosis)	a. Describe the structure of the cell organelles and their roles. b. Explain the cell cycle. c. Describe the process of mitosis d. Describe the process of meiosis and the importance of reducing the number of chromosomes e. Compare the stages of mitosis and meiosis f. Describe the process of crossing over and lack of segregation and evaluate its importance in inheritance and evolution of the living organism. g. Compare the process of production of identical and non-identical twins h. Explain how the understanding and technology of cell division has developed to meet social needs and has enabled people. i. List some examples on cell divisions disorders

Skills outcomes		
Item	General outcome	Sub-outcomes
1. Initiative and Planning	1.12.2 Design an experiment and determine the variables	a. Design an experiment to show that temperature is a biproduct of cellular respiration b. Design an experiment and practical activities to examine some vital processes in the human body c. Define changes in levels of the hormones such as estrogen, progesterone, FSH, and LH in the blood of the female during the menstrual cycle. d. Design an experiment and practical activities to examine some vital processes such as growth. e. Design a model to simulate

		replication of DNA f. Design a model to show the processes of transcription and translation during protein synthesis in the cell g. Design a model to simulate function of helicase enzymes

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