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Teachers' Perceptions on the Changes in the Curriculum and Exit Examinations for Biology and Human Biology

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Abstract: In the age of educational accountability, national and state-wide measures are assumed to secure and improve the educational quality. However, educators often wonder how much a new accountability measure may improve the actual teaching and learning practices when the agents of change (teachers) are not active participants of such educational reform. Nevertheless, in Australia, the National Curriculum is rolling in for the first time for K-10 school education in 2012-13. In Western Australia, the new Western Australian Certificate of Education (WACE) system with new compulsory exit examination requirements has been implemented recently for Years 11-12. In this study, using the contextual curriculum theory (Cornbleth, 1990) and the levels of curriculum (van den Akker, 1998, 2003) as our theoretical framework, we investigated how experienced Biology teachers are making sense of the recent changes in the curriculum and the exit examination requirements: what they perceive as the major changes in the new WACE system; and how they implement the changes in their teaching practice. We discuss how the teachers' teaching philosophy, their school environments, and the new curriculum interact to create a spectrum of the implemented curriculum.

Measures of Educational Accountability and Teachers' Perceptions

In the age of educational accountability, more and more policy makers put forth bold measures to secure and improve educational quality, such as introducing a national curriculum for the first time, making public the results of national numeracy and literacy assessments, and administering compulsory high school graduation examinations (Dietz, 2010; Holme, Richards, Jimerson, & Cohen, 2010). The graduation examination system, for example, requires students to show their academic competences in a state-wide test and achieve a certain score in order to graduate from high school. By requiring students to take such tests, educational policy makers claim that they are making students themselves accountable for their learning (Dee & Jacob, 2007) and standardizing students' achievement within subjects (Broatfoot, 2010). In addition to this "traditional" function of the examinations, the policy makers use them as a tool to effect changes in teaching and learning practices in secondary schools, and make sure that new syllabi and innovative instructional methods are implemented quickly and comprehensively (Bishop, 1998; Dierick & Dochy, 2001; Frederiksen, 1984; Osborne & Dillon, 2008).

Despite the public (or politicians') call for more measures for educational accountability, the actual effects are mainly discussed normatively rather than reviewed empirically in educational discourse (Maag Merki 2010; Reardon, Arshan, Atteberry, & Kurlaender, 2010). For example, after conducting a meta-analysis, Holme and her colleagues (2010) concluded that a limited number of existing empirical studies show the inconsistent or inconclusive effects of exit examinations on teaching and learning. Some studies have found that the introduction of exit examinations was associated with higher performance gains (Jurges, Schneider, Senkbeil, & Carstensen, 2009) and the countries with exit examinations achieved higher scores on TIMSS (Woessmann, 2003). Other researchers claim that the exit examinations increase the consistency in curriculum and instruction, but teachers often focus on test preparation too much and reduce time for class discussions or creative activities (Gayler, 2005; Zabala & Minnici, 2007). Yet other researchers claim that an exit examination exacerbates education inequality and increases the dropout rate of low-income minority students (Dee & Jacob, 2007) while others say it has no effect (Reardon et al., 2010). Overall, research studies have found that the positive effects of compulsory graduation examinations on instructional practices are either inconclusive (Holme et al., 2010) or largely dependent on schools, individuals, subjects and states rather than the existence of the exit examination itself (Baumert & Watermann, 2000; Maag Merki, 2010; Vogler & Carnes, 2009).

These mixed results may not be a big surprise to many educators. The actual implementation of a new education policy or curriculum at the classroom level is "never simply a matter of executing prescriptions and procedures (März & Kelchtermans, 2013, p. 13)." As Cornbleth (1990) observed, curriculum is a contextualized, dynamic social process. It includes not only the curriculum materials and the activities and methods by which the curriculum is taught and learned, but also the sociocultural context that includes the developers and the implementers, all of whom have their own traditions and ideologies. Indeed it is well known (see, for example, Prawat, 1992) that teachers interpret a new curriculum in terms of their own epistemologies and that the enacted curriculum can be a variation of that intended. After the government or the education board determines and approves a new curriculum, teachers need to interpret and implement the given document based on their own perception of the curriculum (Goodlad, 1979). Due to the differences in their experiences and values, one teacher's interpretation may reflect his or her own view of the curriculum and what happens in the classroom may be quite different from other teachers' classes or from the one the educational policy makers had in mind (Remillard, 2005). On top of that, there are the diverse experiences of the students who are learning the curriculum (van den Akker, 1998). In other words, the curriculum designers, teachers, students, and parents could interpret the same curriculum quite differently due to their individual and collective experiences and value systems (Clandinin & Connelley, 1992). The relationship between the intended, implemented, perceived and achieved curriculum has been investigated over a number of years in international comparative studies (Rosier & Keeves, 1992) as well as classroom studies (Treagust, 1987). van den Akker (1998, 2003) has reviewed these different aspects of curriculum. Previous studies illustrate how significant the difference is between the intended, perceived, and implemented curriculum even in the subject area of primary and secondary science (Levitt, 2001; Smith & Southerland, 2007) as well as other areas such as a science and mathematics outreach program (Hartley, Treagust, & Ogunniyi, 2008), a bioscience curriculum for nurse practitioners (Friedel & Treagust, 2005) and project-based instruction in engineering (Mills & Treagust, 2003).

This framework of different interpretations of curriculum, which forms the theoretical framework for this study, implies that the way teachers perceive the curriculum has a profound impact on the implemented curriculum and the educational change (Duffee & Aikenhead, 1992; Lee, 1998; NRC, 1996; Waugh & Punch, 1987). Teachers' knowledge,

experiences and beliefs greatly impact the way they teach in the classroom (Anderson et al., 1994; Connelly & Clandinin, 1988) and the way they adopt educational reform efforts (Tobin, Tippins, & Gallard, 1994; Van Driel, Beijaard, & Verloop, 2001). When teachers' pedagogical beliefs and experiences are in conflict with the intended educational reform, one cannot expect successful implementation of it (Haney, Czerniak, & Lumpe, 1996; Levitt, 2001). As Clark and Peterson (1986) note in their influential review of research on teachers' cognition, "Teachers' belief systems can be ignored only at the innovators' peril" (p. 291). Therefore, for any educational reform effort, it is necessary to carefully analyze teachers' beliefs and their practical knowledge (Duffee & Aikenhead, 1992; Tobin & McRobbie, 1996).

Most Australian states developed a range of courses and external examinations since the early 1990s (Brew & Leder, 2000). In Western Australia, the Curriculum Council recently implemented a new set of courses and mandatory external examinations for high school graduation with the Western Australian Certificate of Education (WACE) in 2010, replacing the elective Tertiary Entrance Examination (TEE) system (the details of the change will be discussed in the later part of this paper). In the view of the curriculum designers, it represents a significant shift regarding the course structure, course content and design brief for senior high school education (Years 11 and 12), compared to the previous curriculum and statewide exit examination. However, neither evaluative reports of the changes nor the perspectives of teachers in implementing the changes are publically available. This study is a response to this concern. It investigates how experienced biology teachers interpret the new WACE system and implement the changes in their teaching practice. In Western Australia, Human Biology is separately offered from Biology in upper secondary schools. It is a very popular subject, even more so than Biology. Thus, we included both Biology and Human Biology teachers for this study. Consequently, two research questions guided the study:

- What do biology teachers perceive as the major changes in the new WACE system?
- How do biology teachers implement the changes in their teaching practice?

Overall Summary of the Recent Changes in WACE

Before commenting on the teachers' interpretation of the curriculum change, it is necessary to lay out the scope of changes in the official documents. As none of the authors are members of the Curriculum Council, we accessed the documents that are publically available. They included the public introductory documents of the new WACE system by the Curriculum Council of Western Australia (such as *Our Youth, Our Future: Post-compulsory Education Review* (2002), and *WACE Manual: General Information for Senior Secondary Schooling* (2011)), statistical reports, and the new course outlines and learning outcomes documents. From the archives of the Curriculum Council, we accessed consultation reports, curriculum developer meeting notes, and teacher workshop feedback reports.

The Curriculum Council (2002, pp.2-3) stated that the existing secondary education system did not adequately accommodate diverse students' interests and needs. This was revealed in poor education outcomes and a high dropout rate (about a third) after compulsory education. The Curriculum Council then suggested that the issue was exacerbated due to (1) early streaming; (2) absence of explicit education standards; and (3) inadequate assessment and reporting methods. In order to address the issues, the Curriculum Council introduced a new set of measures in 2003 and completed trialing in 2009. Below, we discuss the major changes in more detail from an analysis of the available documentation (changes 1-3).

Change 1: Flexibility to Pursue Higher Education

Previously, the WA schools operated in a three-tier system (Curriculum Council of Western Australia, 2002). One was for university-bound students (TEE track), another one was for students pursuing vocational tertiary education (TAFE track) and the last one was for students who did not plan to pursue any tertiary education (VET track). Students in each track took a different set of subjects or vocational training programs. This was quite a complex system with a great number of courses available for students. However, students usually set their career paths early (depending on their academic achievement at the end of Year 10) and it was very difficult for them to change their decision later. Once in a TAFE track or VET track, students could not sit for the university entrance examination because they had not taken the TEE subjects at school.

To provide students with the flexibility to pursue further education, the Curriculum Council decided to integrate three different tracks and create 50 new courses that resemble TEE-style subjects (Curriculum Council of Western Australia, 2002). These new courses include university-oriented courses (e.g., Literature, Physics, and Chemistry) but they also include the vocation-oriented courses (e.g., Automotive, Construction, and Workplace Learning) as well. Most of them have 3 stages (Introductory, Intermediate, and Advanced). Instead of requiring students to take Stage 2 courses in Year 11 and Stage 3 courses in Year 12, the Curriculum Council allowed students to mix and match the stages and the subjects depending on their background knowledge. When they get through a certain number of studies and with high enough scores from the external examination at the end of Year 12, they are awarded the Western Australia Certificate of Education and become eligible to apply for further education.

The change in the course structure and the exit examination requirement signals more equitable access to higher education (Curriculum Council of Western Australia, 2002). However, the simple equality principle was met with the teachers' practical concerns. How can we teach the same content to students with greatly different background knowledge and orientation? Wouldn't vocation-oriented students feel discouraged or inadequate by difficult content? If less academically challenging subjects can be counted toward university entrance the same as more challenging subjects, wouldn't all students want to take less challenging ones and get higher scores (Phillips, 2009)? To address these issues, the Curriculum Council adjusted the students' scores based on the difficulty of subjects through complicated calculations of students' performances (Curriculum Council of Western Australia, 2011).

Change 2: Alignment of Learning Outcomes, School Assessments, and Exit Examinations

One of the main goals of this reform was the increase in the alignment between state education standards, external examinations, and school practices. To this end, the Curriculum Council (1998) put forward the curriculum framework, assessment guidelines, and workshops for teacher training.

For the curriculum framework, the Curriculum Council (1998) focused on the learning outcomes, and invited a board of teachers, academics, and representatives of the Department of Education to create new course outlines that integrate the curriculum framework with specific learning outcomes. The changes in course structures were accompanied by the changes in assessment practices. The new certificate of secondary school education (WACE) took 50 percent of school mark and 50 percent of the external examination mark to calculate the total mark. To make students' marks comparable across different secondary schools, the Curriculum Council moderated the school assessment more

strongly. The Curriculum Council held multiple workshops and moderation meetings for teachers to learn how to change assessment of the courses. In addition, the Council put the sample questions, answers, and markings online so that teachers can refer to them as a guide for school assessment and exit examination preparation.

Change 3: Content Updates and Focus on Learning Outcomes

There are three noticeable changes in the new WACE syllabi of the Biological Sciences and Human Biological Sciences with regard to the course content, learning outcomes and assessment guidelines.

Reduced and updated content: The most visible change is the introduction of biotechnology-related topics. The Human Biological Science syllabus includes reproductive and medical procedures, techniques, issues of genetic testing, and the Human Genome Project. To make room for the new content, some topics were removed, such as the theories concerning Aboriginal settlement of Australia. Likewise, the Biological Science syllabus includes several DNA technologies, and their applications. Other than those topics, the majority of the previous content is still included in the new syllabi but is now organized according to the stage system. Later in the amendment for teaching in 2012, some minor contents were added, removed, or rephrased without changing the overall scheme.

Learning outcomes instead of learning objectives: One of the main arguments for the new curriculum was moving away from focusing on what has been taught towards focusing on what students have learnt. The WACE syllabus for 2011 contains learning outcomes and outcome progressions. These attainment levels are described in detail, and the performance outcomes are aligned with the science learning framework in WA. Later in amendments for teaching in 2012, the Curriculum Council replaced the outcome progressions with the grade descriptions due to teachers' confusion about the attainment levels.

Changes in assessment guidelines: The TEE syllabus provided detailed instructions on assessment, which specify the content components and learning outcomes (cognitive and sensorimotor), the types of assessment and the weightings. In contrast, the WACE syllabus provides different weighting for different stages of the course, and contains slightly different assessment categories: a) investigation; b) extended response; and 3) test and examinations. The extended response is introduced as a more contextualized assessment type, but there are still investigations, assessments of practical skills, tests and examinations.

Research Methods

Following the interpretivist tradition (Cohen, Manion, & Morrison, 2011), we conducted interviews to gauge WA teachers' perspectives on the curriculum change as they were the actual implementers of the curriculum. We did not intend to observe their teaching practice to evaluate the alignment of their comments to their teaching of the new state curriculum. The data in this article arises from the interviews.

From the pool of biology (both Biology and Human Biology) teachers in Perth metropolitan area, we wanted to include teachers with well-established teaching experiences in the Western Australian school system. We screened teachers with at least 10 years of teaching experience in WA schools and with some type of recognition and commitment in science teaching, such as national and state teacher's award or prior experience in state curriculum writing or active participation in science teachers' association. To address different school environments, we endeavored to include teachers from independent schools

as well as government schools with diverse socio-economic backgrounds of student populations. In the end, we chose six teachers and provided a pseudonym for each teacher to protect their identity (Aaron, Bob, Charles, Devin, Evan, and Frank).

All six teachers were recognized as excellent teachers among students and teachers, with teacher's awards from various organizations. Several also had participated in educational research projects with the authors prior to this study. Each of the teachers had been actively involved in the activities of the Science Teachers Association of Western Australia (STAWA). Some of the teachers had been previously involved in the state's syllabus redesigning, examination reviewing, or examination marking. One teacher was teaching at an independent school, and the others were teaching at government schools in different Perth suburbs. In Table 1, we summarized each teacher's profile.

Teacher	Teaching Experience *	Teaching Recognition & Commitment	School Information	
			Type	ICSEA **
Aaron	24 (13) years	Head of science department for 7 years	Independent	Above average
Bob	42 (14) years	National teacher award, Higher degree in education, State external examination marker	Government	Above average
Charles	42 (42) years	Head of science department for 37 years	Government	Above average
Devin	36 (36) years	Head of science department for 31 years, State syllabus writing committee member, State external examination reviewer and marker, Higher degree in education	Government	At average
Evan	24 (24) years	State science teacher award and nominations, State external examination marker, Curriculum advisory committee member, Committed STAWA member	Government	At average
Frank	17 (17) years	Active STAWA member, Biology textbook working group	Government	At average

Table 1. Participating Teachers' Demographic Profiles

* Years of overall teaching and the numbers in parenthesis indicate the years of teaching of Biology and Human Biology in Western Australian schools.

** ICSEA: Index of Community Socio-Educational Advantage, calculated by Australian Curriculum Assessment and Reporting Authority (ACARA).

Before conducting the interviews, we developed an interview protocol based on our research questions (Cohen et al., 2011). It consisted of three main categories: influence of the WACE system on teaching (and assessment) practices; influence of the WACE system on students' learning; and the main differences between previous TEE and current WACE syllabus and examinations. Although we had a set of questions for 30-45 minutes, the interview sessions were semi-structured and conversational. If the participating teachers prepared their teaching materials and school records in advance to share with us, we extended the interview sessions up to 2 hours. Each teacher was interviewed individually by the authors.

At each interview, the researchers took interview notes in addition to the audio recording. Right after each interview session, the authors discussed salient features of the interview together. This initial discussion helped the subsequent interviews with refined interview questions to confirm or contrast the views of the participating teachers. For

example, the first two teachers' (Aaron and Bob) accounts of the influence of the new exit examination system on their teaching were quite different. In subsequent interviews, we attempted to highlight the difference in teachers and to ask some questions regarding why such differences occur in relation to the school environments and pedagogical beliefs. If there was any doubt on the meaning of what the interviewee said, we contacted the teacher through email to verify our interpretation.

After all interview sessions were conducted, the first author transcribed the audio recordings. Based on the interview notes, transcripts, and discussion notes, the authors of this paper individually coded the data independently. We first categorized data into three aspects of research questions and then coded them into open, emerging themes. If we found a salient theme in an interview that we missed from initial interview meetings, we combed through the rest of the data (other interviews) to support or contrast the findings. After individual deliberation, the authors got together to discuss the findings and resolved any differences in interpretations. We kept records of the meeting results with date stamps to track the changes of the interpretation. After writing the initial manuscript, the authors sent the document to the participating teachers for verification.

Perceived Changes in the Curriculum and Exit Examinations by Biology and Human Biology Teachers

Change 1: Change in Course Structure and Graduation Requirement

When asked about the new WACE system as a whole, the teachers explained that the changes were to attract more students by offering relevant, diverse courses. The teachers' explanations were quite similar to the rationales provided by the Curriculum Council. Frank explained that the change was intended to make the courses more relevant to students. He said, "There was a report about senior secondary education [*Our Youth, Our Future*], and the conclusion was that we needed to rewrite the courses because they weren't relevant to modern kids." Carl mentioned a greater number of courses. "What they [the Curriculum Council] tried to do was to create a greater range of courses so we could keep more adolescent students at school. [...] So they structured courses in different stages (Stage 1, 2, 3) with different difficulty levels. [...] The idea was that those courses would appeal to the whole body of students [rather than the university-bound students only]." Because Biology and Human Biology were not the courses newly created or totally revamped for the new WACE system, the teachers did not talk about first-hand experience of offering a greater range of courses.

However, they did express some concerns about the actual implementation of the flexible stage system in terms of attracting more students to remain in school. Maybe because it is still early in the implementation of the new system, the schools do not offer very flexible course choices to students. Schools offer only a subset of the 50 courses due to the limitation of available teachers and facilities. In addition, because of scheduling issues, students cannot freely choose a variety of courses. Aaron, Bob, and Carl, all of whom teach at more academically-oriented schools, pointed out that the stage system at their schools is not flexible: rather, it almost always goes along with the students' year level. "In our school, we still see most departments offering Stage 2 at Year 11 and Stage 3 as Year 12 courses and most kids would follow through that way." Carl added, "I'm not sure how well Stage 1 courses appeal to students—because a lot of the kids who don't end up in Stage 2 or 3 are often rather disaffected by their studies at all."

Another criticism on the new system was about the mandatory exit examinations for Stage 2 and Stage 3 courses. With the required end-of-year standardized assessment for any

university-worthy courses, the Curriculum Council intended to provide every student with a fair chance to enter higher education. However, giving a fair chance for higher education does seem to deter, in a way, some students from studying some subject matters for their own curiosity, especially the students who are not applying for university entrance. Devin, who has been teaching students with less academically-oriented career goals, complained that because students are required to sit the exit examination at the end of Stage 2 or 3 courses, they are either hesitant to take the course or are enjoying it less. Devin fondly remembered the time when the students still wanted to take the Human Biology course to learn about how the human body functions even though they were not planning to go to university after graduation. While students were supposed to take school-based examinations, the pressure was not as great as the current requirement, and they could veer off to study their own research projects. On the other hand, the teachers from strong academic schools did not mention this change because most of their students took the external examination (TEE) at the end of Year 12 anyway and they did not see much change at all. It seems obvious that this requirement caused some change only in schools with a low population of university aspirers. If this change is implemented to encourage students to go to university, how has it really impacted them -- as added pressure to take away students' intrinsic motivation to study science or as an eye-opener for possible university entrance? Fundamentally, this change has been implemented with the assumption that every student would want to go to university when given a chance and it is desirable to have more people with a university degree. However, from the interview with the teachers, this assumption seemed just that—an assumption, rather than a consensus among the people concerned.

Another point that the teachers discussed was about making the courses be at the same difficulty level. Frank said, “They [Curriculum Council] tried to make the courses much at the same difficulty level and value.” However, he thought it did not make any sense due to the nature of each subject matter. For example, physics or biology has inherently different characters than media studies, and you cannot just use one model to revamp the other. Carl also said, “I do read in the newspaper that so many kids are dropping out of the challenging courses [like physics] to choose something light.” It is always contentious to compare and adjust the examination scores across different subjects, even when statisticians assure you that they scaled the students' scores through complicated Rasch analysis. Yet, scaling and adjusting the examination scores is not a newly introduced practice to WACE. A similar practice existed in the TEE system anyway. Then why do teachers express sudden doubts on the comparable difficulty levels across subject areas? Biology has been regarded as one of academic school subjects along with other science courses. Under the new WACE system, though, biology is counted as having a similar value as any other non-academic subjects for graduation and university entrance. The biology teachers might have felt that their subject was depreciated somewhat in the new system.

Change 2: Content Update and Reorganization for Students' Motivation

The teachers agreed that the most salient feature in the new syllabus was the more updated content, especially for biotechnology area. They full-heartedly supported the change because it provided a context to show the relevance of biological knowledge in everyday life. Evan thought that teaching biotechnology helps students to make connections between what they are learning in school and what they are experiencing outside school. He elaborated, “There is lot more biotech than there used to be. [...] I think that's a really good thing to include—because that's the stuff [students] hear about in the news. [...] You can use the biotechnology to engage them, keeping them motivated. [...] You can also use it as a good

background to teach the other stuff, [such as when you] introduce the stuff on cells and body systems. [You can] even bring [biotechnology] back in when they are looking in genetics. You can use all of those sorts of things to keep students' interest going." Bob spoke about his interaction with students before and after the introduction of biotechnology. "I remember a student a few years ago saying, 'I loved the human biology, but I don't know if I will ever find a use for my knowledge, but I did like it.' But now, [...] students do a project on bio genes, polymerase chain reactions, and the stem cell research. [The topics are] becoming much more relevant to students and to me. It's a shiny example of how to make classroom learning relevant to life outside school." Frank regretted that the introduction of biotechnology had not come earlier. He said, "We really needed that years and years ago," not just to show the relevance of biology learning to students' life, but to provide updated information on the field of biology to students as well.

The teachers acknowledged that other than the introduction of biotechnology, the syllabus has not changed much for Biology and Human Biology, but there were some rearrangements of content between Year 11 and 12 courses. Carl said, "The changes in content have been few; there has been a transplant of materials—[some topics are] used to be covered in the Year 12 course [but they] have been put in the Year 11 course and vice versa." For example, Frank listed, "There is some stuff in Year 11 which is used to be in Year 12. Kidney physiology is in Year 11 now, but it used to be in Year 12. Most of the genetics is in Year 11 now, but it used to be in Year 12." Evan was most positive about the rearrangement of content. "They've taken more out, leaving the good stuff in, in most cases. And over time we are getting better stuff to teach and more interesting stuff to teach which means that we can engage our kids a lot better."

Change 3: Continued Emphasis on Reading and Writing in the Examination

The teachers did not see much change in the assessment guidelines. All teachers agree that the WACE examinations are quite similar to the TEE examinations, except the weighting of the test items. Comparing the past WACE papers and TEE papers for the interview, Carl concluded, "I don't really think there is much difference in the level of difficulty. The number of questions and weightings have changed, and the content might have changed as well, because of the structure of the course though." Bob agreed, "I think the changes are rather more in the syllabus content rather than in the assessment."

However, the teachers felt that the emphasis on reading and writing for the examination continued or is gradually increasing. The examination questions are getting longer, and the portion of the extended essay answers is increased in the WACE examinations. Frank said that the long questions are often confusing to many students. "[The exam questions] tend to have a lot more words now. It's sort of putting the question in context. They give you three quarters of a page of stuff and then a question—which is good, except the kids often grab the stuff in and write what isn't necessarily what they are supposed to do. They just pick up a couple of words and put off what they're actually supposed to be answering. [The exam writers] try to contextualize [the questions], but often don't do a good job of it. That makes it more confusing for the kids." The contextualization of science questions and the integration of reading and writing into science are frequently emphasized in recent science education documents. Yet, the contextualization and the integration often add an additional layer of difficulty, especially to the students whose first language is not English or those who are not confident to draw out the relevant components from the questions. To help students address this issue, the participating teachers stated they train their students how to decipher long questions and write extended answers in the examination.

Implementation of Changes in Year 12 Classes

Practice 1: Organizing the Lessons with the High Content Load

All teachers we interviewed conceded that the Curriculum Council's syllabus is the "backbone" of their teaching and learning program. Devin believed that the syllabus provides a worthwhile context to teach biology and human biology. The teachers organize their lessons, class activities, and assessments—all based on the syllabus. The teachers are used to the system and did not seem to question why they need to follow the syllabus. In addition, organizing their lessons based on the WACE syllabus is very much expected by the parent body, especially at higher education-oriented schools. Aaron said, "Students and parents demand the WACE syllabus from Day One." Many parents call for strictly following the WACE syllabus to achieve excellence in the WACE examination results.

Following the WACE syllabus does not seem to cause many problems in its implementation, considering that these teachers have been implementing the statewide syllabus over many years. However, the teachers fear that the amount of content in the syllabus leads to the lack of flexibility to engage students in more student-centered activities or to follow up the students' interest areas. Carl, for example, likes to teach biology through a constructivist approach. He very much appreciates the value of student-oriented work, and believes that students need to have opportunities to get engaged in hands-on laboratory work, discuss their own ideas, and apply their knowledge. He often tries to follow up on students' questions/interests and incorporates various research-oriented projects in lower secondary science classes. However, he limits such activities in Year 11 and 12 classes and teaches more in a lecture style to meet the high content load. Carl said, "The model of teaching I use in Year 12 is very didactic. It's of necessity, really." He limits the research opportunities where students get engaged in their own projects and present their own work to the class, "simply because the time commitment it takes." He continued, "You are actually forced to do things certain ways to get through the curriculum in the time available. So with the Year 12, it tends to be pretty much teacher-centered model." Aaron, on the other hand, mentioned that he felt obliged to teach the upper secondary schools in a didactic way, not only because of the amount of content, but also because of the parents' and students' demands. Parents often regard student-centered activities not rigorous enough, and "If we [teachers at the school] were to adopt a more student-centred approach to learning biology, we would have complaints from the students and parents that the rigor is not there." Even though the teachers at school are encouraged to develop less teacher-centred teaching strategies by the school administrators, Aaron feels compelled to teach didactically at the upper secondary school to satisfy the students and parents.

When asked if the WACE system encourages change in their teaching approach to more investigative ones, the teachers all responded negatively. Evan said, "I don't think that WACE demands [change in the teaching approach] as long as you deliver the content [and] you fit all of the assessment items in it..." Carl added, "In many cases, I am continuing to use the resources that I created for the TEE-course." The teachers said that the main reason why they are putting investigation-oriented activities into teaching from time to time is because they believe such activities would help develop students' interest in learning biology. Aaron explicitly declared the impracticality of the recommendation for an investigative teaching approach in the current examination system. "I'm willing to change to teaching for higher order thinking skills [through engaging students in their own research], but unless the examination changes, I'm not going to change my teaching."

Practice 2: Preparing Students for the High Pressure External Examination

The teachers admitted that teaching Year 12 students involves high pressure on the students as well as on the teachers themselves due to the external examination. They adopt a series of strategies to assist students to get ready for the external examination at the end of Year 12. One of the common strategies is having frequent tests—about 12 to 15—throughout the year. This means students would need to sit a test every two or three weeks, because, as Aaron said, “They [students] want constant feedback about how they’re doing.” Many teachers believed that frequent tests would help students to study the subject steadily to demonstrate their understanding, and monitor exactly which topic they would need improvement. Carl said, “I try to make fairly short-term foci so that students can endure a major test later on... so the kids have an opportunity to review a small chunk of work and do in-depth learning of it, rather than attend to a major learning task after a couple of months.” Also, the teachers believed that frequent testing would help the students get used to sitting a WACE-type test and it would reduce their anxiety of taking the real thing at the end of the year.

Because the school assessments are recognized as a good preparation for the external assessment, the test items are carefully constructed to simulate the WACE examination—in terms of the test format and the difficulty level. Carl mentioned that “We will have a similar sort of arrangement [as WACE format] of multiple choice questions followed by extended answer-questions. [We also have] the short-answer section where they are required to draw graphs or whatever... And so, in a way, it follows the model established by the TEE and also WACE.” To construct assessment items, Aaron, in particular, was very methodical in analyzing the past WACE examination items. “I go through each year’s WACE examination, and answer the questions myself and reflect on what’s being asked. I take note of what is being asked, what level of questions they are [in terms of Bloom’s taxonomy], and which chapter they are from. I then [feed the data into] the database I’m building year by year.” This type of thorough analysis not only helps the teachers to build the assessment items, but to provide feedback on students’ progress. Aaron said, “[I say to the students], well, if you found that test difficult, you need to know that those are, a good proportion of those questions are, WACE level questions. So you know where you’re at a certain difficulty level. If you coped okay with that, then, okay, [you] can say to [yourselves], at this stage, [you] can feel confident that [you] should be able to cope with the difficulty level in the WACE examination, broadly speaking.”

Another popular strategy to help students prepare for the WACE examination is analysing the past examination questions and sample answers together with students in class. Bob assigns one of previous extended essay questions from WACE, TEE, or other state’s exit examinations as homework, and guides students on how to read and answer essay questions in class. In some schools, students are allowed to check out the booklets of the past examinations from the school science department and review the questions outside school. Other teachers use the Curriculum Council’s sample answers from the previous years to build students’ test taking strategies. Evan said, “I use those [prior questions and sample answers from the Curriculum Council intranet] extensively with my students. I tell my students, ‘This is a question you might see in the exam, and how would you answer that? Well, here is somebody who answered this very well. Here is somebody who didn’t. Let’s have a look at those two and see. They gave this [answer] three marks. Why did this kid get three marks and this kid only two? Can you see the difference? I use that as a guide how to answer exams and tests.’” He continued, “[Putting the sample answers] is one of the things the Curriculum Council does well.” Aaron and Evan mentioned that the Curriculum Council recently increased teachers’ online access to the previous examination questions and answers and it

was quite helpful for them. It was one of the positive changes of the new WACE system for them.

In addition to analysing the prior examination questions, the teachers analyse the school reports carefully to improve their teaching. Aaron analyses the school report item by item to check if there is any content area students are missing more than the state average. Based on the analysis, Aaron examines his teaching methods and reorganizes the following year's lessons. "We get a printout of our [students' responses] with areas of relative weakness and also areas of relative strength. So if our [students] didn't perform well on, say Question number three, I might go back to my teaching notes and just make a comment to myself for next year that might need clarification. Or it might be a question where the [students] are required to make a small interpretation of some data or graph. I try and use that to inform how I teach in the next time along." Aaron added, "I am actually required by the [school] to go through it quite carefully. I don't have a problem with that because it's useful feedback [to my teaching]." However, not all teachers were performing a thorough analysis like Aaron. Carl did not believe in the school report because it changes every year and it does not give enough information to analyse his teaching practice due to various factors influencing the examination results, such as students' physical conditions and examination stress.

Overall Practice: Transforming the ideal curriculum

Although the teachers all seem to align their teaching practice to the WACE syllabus and examinations, we found distinct differences in the teachers. Aaron, for example, is deeply test-oriented, like his students and parents. The students and parents are important actors in the micro-culture of his school, and the school administration desires to deliver satisfaction to them in terms of test performance. Consequently, he is oriented toward high WACE test results. He diligently goes over the syllabus word by word, makes careful notes of every examination question, and critically analyzes the examination report item by item. He tries to pick up the trends of the WACE examination, direct students to focus on important concepts in the subject, and reorganizes his teaching to maximize students' performance in the examination. Although he sometimes feels that the test anxiety of students and parents is above the healthy level for productive learning, he is 'pragmatic' to accommodate their needs and tries to deliver the content effectively. He knows the educational benefits of helping students build critical thinking skills through investigating their own research questions. Yet, the current WACE system does not demand such student-centered teaching, so he would not change his teaching approach unless the current examination system changes.

On the other hand, Carl does not think he is teaching to the test. Although he thinks the WACE syllabus is the backbone of his teaching, he believes his teaching is to improve students' understanding of biology rather than to improve students' test scores. Of course, his school assessments are aligned with the WACE examination format and he does the examination preparatory work for his students, including 15 tests a year and reviewing previous examination questions. However, he does not feel obligated to analyze the school test reports item by item in order to maximize the students' test scores. He has built his own teaching style and resources over the many years of his teaching career and he uses those materials to help students understand and appreciate biology. His students study hard and generally perform very well in the WACE examination. The supportive and somewhat relaxed school environment enables Carl to teach in a way he did not feel inhibited by the external examination.

The main focus of teaching for Evan is connecting students' interests in learning human biology rather than helping students get high scores on the WACE examination. He

believes students develop understanding through investigating their own questions. He always seeks to incorporate real life examples and encourage students to discuss their ideas in class. He is knowledgeable about finding relevant learning resources through Internet and from other teachers, and he finds joy in helping students answer their questions. He also does a lot of formative assessment to evaluate what students really know and how they are progressing in the course. However, he fears that the WACE system is too restrictive and it does not really help to teach in a constructivist way. The system dictates that he has to cover only a set of topics, give certain types of assessment items, and mark them in a certain way. He can neither veer off to investigate other topics even if students show immense interest in the topic nor use students' discussion as their assessment. The majority of his students are not highly academically oriented students, and they are not overly concerned about going to university. Yet, he has to prepare all his students to write better answers in the examination. He does not like the current system because it is not really flexible, but he does follow the guidelines anyway because he has to. In short, Evan wants his students to learn biology following a constructivist model of learning, but he finds the current WACE system is working as a roadblock for his desired teaching practice.

While the difference in the individual teachers' teaching practice is great as shown above, the spectrum should not be understood solely by their individual preferences or attitudes. Rather, it should be understood in regard to the context of the dynamic interplay between the curriculum, the teachers' teaching philosophies, the student population, and the school environment as discussed above and as described by Cornbleth (1990).

Discussion and Conclusion

The aim of this study was to investigate how teachers perceive and implement the newly implemented curriculum and external examination system (WACE). From the official documents of the Curriculum Council, it appears that the main purpose of the reform was to widen the path to higher education for students. Yet, the Biology and Human Biology teachers did not feel much change in 'how business is done.' The schools do not really offer 'flexible choices of subject.' The syllabus has not changed much except for the introduction of biotechnology content. The only systematic change the teachers felt was the requirement for the exit examination for every student as Devin and Evan mentioned. Those teachers felt the exit examination requirements took away students' motivation to learn biology or human biology for its own merits. Maybe it is too early to tell the actual impact of the reform in terms of higher education aspirers.

From the interviews with these six experienced teachers of Biology and Human Biology, we have found that the teachers all believe the WACE curriculum is the backbone of their upper senior high school teaching. They organize their teaching following the content list and the assessment guidelines. Accordingly, the teachers were knowledgeable in terms of the changes in the syllabus. They could pinpoint which topics were added, moved, or deleted from the syllabus without referring to their notes. They thought the changes are mostly minor reorganizations of contents except one aspect—the inclusion of biotechnology topics in the syllabus. The teachers most welcomed the addition because such topics give students an opportunity to learn about how the biology they are studying at school applies to their daily lives. The teachers also put effort into preparing students for the WACE examination at the end of the year by adopting frequent tests, assigning similar test items to the WACE examination, going over previous test items and model answers, and analyzing school reports. From the teachers' account, we could assume that they all endeavor to align their

teaching and assessment with the state curriculum and the external exit examination as the Curriculum Council envisioned.

Despite the teachers' obvious effort, we were able to notice the differences in the implementation of the curriculum due to the interaction between the curriculum, teacher's pedagogy, and the school environment. As many educational researchers already have identified, the contextual aspects in and around teachers' workplaces—such as students' expectations, available resources, and school culture—along with their pedagogical beliefs affect the way teachers interpret and implement the curriculum (Ben-Peretz, 1990; Holliday, 1994; Owston, 2007). For Aaron, the school administration's consumer-oriented approach largely shapes his teaching practice. He focuses on the effective delivery of the content for his students' best performance in the examination. Unless the curriculum changes to encourage student-centered teaching, he is not going to change his teaching style. On the other hand, Evan wants his students to ask relevant questions and really learn biology following a constructivist approach. His students are not overly concerned about going to university or getting high test scores, and he finds that the compulsory examination at the end of Year 12 is limiting students from enjoying biology. In contrast to Aaron and Evan, Carl does not feel much pressure to change his teaching due to the new curriculum and exit examination system. He regrets that, in order to cover the content within the time limit, he has to adopt a more teacher-centered teaching approach for upper senior high school classes. Yet, he doesn't feel it was forced on him. His students and parents are very supportive, and there is no immediate need to modify his teaching. The diversity in curriculum interpretation and implementation shows how a curriculum intricately interacts with teachers' knowledge, beliefs, experience, and contextual aspects (Tobin, Tippins, & Gallard, 1994; Van Driel et al., 2001).

It is worthwhile to note that the participating teachers were all respected by their colleagues as highly effective, engaging, and committed teachers. Nevertheless, the compulsory statewide exit examination seems to lead those teachers to adopt a more teacher-centered, delivery-oriented approach to prepare students for the examinations. The teachers felt the need to go through the amount of content before the examination, and they recognized that the WACE examination does not particularly assess high order thinking skills. Teachers often change their teaching approach to match the way instruction is assessed (Baartman, Bastiaens, Kirschner & Van der Vleuten, 2006; Cheng & Watanabe, 2004). Often in large scale summative assessments, however, high-order thinking skills are less emphasized (Andrews, 2004) and the WACE examinations are not an exception. As research on high-stakes testing and effects of teaching to the test has shown, centralized summative assessment structures tend to counteract policy makers' intention of implementing curriculum innovations, such as a student-centered teaching approach, because teachers and students are under pressure to prepare for statewide exit exams (Au, 2007). The new high-stake test requirement for WACE in this study seems to have a similar effect on teaching, and the teachers feel obligated to teach biology in didactic manner despite the explicit emphasis in the curriculum for investigative, context-based teaching approach.

One of the issues of implementing any change is the degree of professional development that is available. From the document analyses, it is obvious that the Curriculum Council did put a lot of effort into the planning and moderation of the new syllabus including several stages of development and interaction. There have been several periods of face-to-face consultation with teachers, feedback on the new course outlines and rewritings. Once finalized, the new courses were published and distributed to every school and the teachers had 18 month to prepare for teaching the new curriculum. Additionally, the Curriculum Council did a lot of teacher development during this time inviting teachers to participate on workshops about the new courses and assessment plans. The Curriculum Council also offered

teacher support materials in order to communicate how best to put the new syllabus into practice. In doing this, the Curriculum Council followed some of the characteristics of successful implementation of new curriculum (e.g., O'Day, 2004). Despite the Curriculum Council's best effort and the participating teachers' various levels of involvement in the state curriculum writing and examination marking, our research has shown, consistent with the literature, that the curriculum is interpreted in diverse ways, though the reasons are unclear without more research. Is it because the Curriculum Council did not have enough authority or resources to ensure that the new curriculum is interpreted and implemented by all teachers in a uniform way? Or, is the diversity in interpretation just the nature of implementing any educational innovation as many curriculum theorists assert? Or is there something missing in this equation of curriculum design and implementation, such as consideration of the diversity in school environments (government and independent schools, highly academic and VET-oriented schools, etc.), the diversity in teachers' pedagogical and practical knowledge (constructivist-oriented and teacher-oriented teachers, novice and experienced teachers, etc.), the autonomy of teachers (experimental and passive teachers), and the actual and perceived needs of students and parents (aspiration for higher education)? As we finalize this article, we ask ourselves how the diversity in teaching and learning could be best accommodated by a new curriculum or by a new educational policy.

References

- Anderson, R. D., Anderson, B. L., Varanka-Martin, M. A., Romagnano, L., Bielenberg, J., Flory, M., Mieras, B., & Whitworth, J. (1994). *Issues of curriculum reform in science, mathematics and higher order thinking across the disciplines*. The Curriculum Reform Project, University of Colorado. U.S. Department of Education, Office of Educational Research and Improvement.
- Andrews, S. (2004). Washback and curriculum innovation. In Cheng, L., & Watanabe, Y. (Eds.), *Washback in Language Testing* (pp. 37-50). Lawrence Erlbaum Associates, London.
- Au, W. (2007). High-stakes testing and curricular control: a qualitative metasynthesis, *Educational Researcher*, 36 (5), 258–267.
- Baartman, L. K. J., Bastiaens, T. J., Kirschner, P. A., & Van der Vleuten, C. P. M. (2006). The wheel of competency assessment: Presenting quality criteria for Competency Assessment Programmes. *Studies in Educational Evaluation*, 32, 153-170.
- Baumert, J., & Watermann, R. (2000). Standardisierung durch die Abiturprüfung: Zentralabitur oder dezentrale Prüfungsorganisation? (Standardisation through upper secondary exit examinations: Centralised school exams or decentralised examination system?) In J. Baumert, W. Bos & R. Lehmann (Eds.), *TIMSS/III. Dritte internationale Mathematik- und Naturwissenschaftsstudie-mathematische und naturwissenschaftliche Bildung am Ende der Schullaufbahn. Bd. 2* (pp. 341-351). Opladen: Leske + Budrich.
- Ben-Peretz, M. (1990). *The teacher-curriculum encounter: Freeing teachers from the tyranny of texts*. Albany: State University of New York Press.
- Bishop, J. H. (1998). The effect of curriculum-based external exit exams on student achievement. *Journal of Economic Education*, 29, 172-182.
- Brew, C. R., & Leder, G. C. (2000). Curriculum and assessment: A question of politics? *Australian Journal of Teacher Education*, 25(2), 1-9.

- Broadfoot, R. (2010). Records of achievement: Beyond traditional tests. In P. Peterson, E. Baker, & B. McGaw (Eds.), *International Encyclopedia of Education* (pp. 243-248). Oxford: Elsevier.
- Cheng, L., & Watanabe, Y. (2004). *Washback in Language Testing: Research Contexts and Methods*. Lawrence Erlbaum Associates, London.
- Clandinin, D. J., & Connelly, F. M. (1992). Teacher as curriculum maker. In P. W. Jackson (Ed.), *Handbook of research in curriculum: A project of the American Educational Research Association* (pp. 369-401). New York: Macmillan.
- Clark, C. M., & Peterson, P. L. (1986). Teachers' thought processes. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed.) (pp. 255-296). New York: Macmillan.
- Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (4th ed.). London: Routledge.
- Connelly, F. M., & Clandinin, D. J. (1988). *Teachers as curriculum planners*. New York: Teachers College Press.
- Cornbleth, C. (1990). *Curriculum in context*. London: Falmer.
- Curriculum Council of Western Australia. (1998). *Curriculum framework for Kindergarten to Year 12 Education in Western Australia*. Curriculum Council. Osborne Park, WA: Government of Western Australia Curriculum Council.
- Curriculum Council of Western Australia. (2002). *Our youth, our future: Post-compulsory education review--summary of the directions endorsed by the Western Australian Government*. Osborne Park, WA: Government of Western Australia Curriculum Council.
- Curriculum Council of Western Australia. (2011). *Western Australian certificate of education WACE manual: General information for senior secondary schooling 2011*. Osborne Park, WA: Government of Western Australia Curriculum Council.
- Dee, T. S., & Jacob, B. A. (2007). Do high school exit examinations influence educational attainment or labor market performance? In A. Gamoran (Ed.), *Will No Child Left Behind help close the poverty gap?* (pp. 154-197). Washington, D.C.: Brookings University Press.
- Dierick, S., & Dochy, F. (2001). New lines in edometrics: new forms of assessment lead to new assessment criteria. *Studies in Educational Evaluation*, 27(4), 307-331.
- Dietz, S. (2010). *State high school tests: Exit exams and other assessments*. Washington, D.C.: Center on Education Policy.
- Duffee, L., & Aikenhead, G. (1992). Curriculum change, student evaluation, and teacher practical knowledge. *Science Education*, 76(5), 493-506.
- Erickson, F. (2012). Qualitative research methods for science education. In B. F. Fraser, K. Tobin, & C. McRobbie. *Second international handbook of science education* (pp.1451-1469). Springer.
- Frederiksen, N. (1984), The real test bias: Influences of testing on teaching and learning, *American Psychologist*, 39, 193-202.
- Friedel, J. M., & Treagust, D.F. (2005). Learning bioscience in nursing education: perceptions of the intended and prescribed curriculum. *Learning in Health and Social Care*, 4(4), 203-216.
- Gayler, K. (2005). *How have high school exit exams changed our schools?* Washington, D.C.: Center on Education Policy.
- Goodlad, J. I. (1979). *Curriculum inquiry: The study of curriculum practice*. New York: McGraw-Hill.
- Haney, J. J., Czerniak, C. M., & Lumpe, A. T. (1996). Teacher beliefs and intentions regarding the implementation of science education reform strands. *Journal of Research in Science Teaching*, 33(9), 971-993.

- Hartley, M. S., D.F. Treagust, D.F., & Ogunniyi, M. B. (2008). The application of a CAL strategy in science and mathematics for disadvantaged Grade 12 learners in South Africa. *International Journal of Educational Development*, 28, 596-611.
- Hiatt, B. (2011, October 31). Exam change makes study harder: MP, *West Australian*. Retrieved from <http://au.news.yahoo.com/thewest>
- Holliday, A. (1994). *Appropriate methodology and social context*. Cambridge University Press, Cambridge.
- Holme, J. J., Richards, M. P., Jimerson, J. B., & Cohen, R. W. (2010). Assessing the effects of high school exit examinations. *Review of Educational Research*, 80(4), 476-526. doi: 10.3102/0034654310383147.
- Jurges, H., Schneider, K., Senkbeil, M., & Carstensen, C. H. (2009). *Assessment drives learning: The effect of central exams on curricular knowledge and mathematical literacy* (CESifo Working Paper 2666). Munich, Germany: Ifo Institute for Economic Research.
- Lee, C. K. J. (1998). Primary teachers' receptivity to curriculum reform in Hong Kong: The comparison between target-oriented curriculum and general studies. *Curriculum Forum*, 7(2), 71-83.
- Levitt, K. (2001). An analysis of elementary teachers' beliefs regarding the teaching and learning of science. *Science Education*, 86(1), 1-22.
- Maag Merki, K. (2010). Theoretische und empirische Analysen der Effektivität von Bildungsstandards, standardbezogenen Lernstandserhebungen und zentralen Abschlussprüfungen (Theoretical and empirical analyses on the effectiveness of education standards, comparative testing and central exit exams). In H. Altrichter & K. Maag Merki (eds.), *Handbuch neue Steuerung im Schulsystem* (pp. 145-169). Wiesbaden: VS Verl. für Sozialwissenschaften.
- März, V., & Kelchtermans, G. (2013). Sense-making and structure in teachers' reception of educational reform: A case study on statistics in the mathematics curriculum. *Teaching and Teacher Education*, 29(1), 13-24.
- Mills, J., & Treagust, D.F. (2003). Using projects to teach structural engineering. *Australian Journal of Structural Engineering*, 4(3), 211-220.
- National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.
- O'Day, J. A. (2004). Complexity, Accountability, and School Improvement. In Fuhrman, S. H., & Elmore, R. F. (Eds.), *Redesigning Accountability Systems for Education* (p. 15-43). New York/London: Teachers College Press.
- Osborne, J., & Dillon, J. (2008). *Science education in Europe: Critical reflections*. London (A report to the Nuffield Foundation).
- Owston, R. (2007). Contextual factors that sustain innovative pedagogical practice using technology: an international study. *Journal of Educational Change*, 8(1), 61-77.
- Phillips, Y. (2009, December 22). Year 12 students dumbing down to get into TAFE, *Perth Now*. Retrieved from <http://www.perthnow.com.au/news/western-australia/year-12-students-dumbing-down-to-get-into-tafe/story-e6frg13u-1225812770359>
- Prawat, R. S. (1992). Teachers' beliefs about teaching and learning: A constructivist perspective. *American Journal of Education*, 100, 354-395.
- Reardon, S. F., Arshan, N., Atteberry, A., & Kurlaender, M. (2010). Effects of failing a high school exit exam on course taking, achievement, persistence, and graduation. *Educational Evaluation and Policy Analysis*, 32(4), 498-520. doi: 10.3102/0162373710382655
- Remillard, J. T. (2005). Examining Key Concepts in Research on Teachers' Use of Mathematics Curricula. *Review of Educational Research*, 75(2), 211-246.

- Rosier, M. J., & Keeves, J. P. (Eds.). (1991). *The IEA study of science I: Science education and curricula in twenty-three countries*. Oxford: Pergamon Press.
- Slavin, R.E. (1998). Sand, bricks and seeds: school change strategies and readiness for reform. In Hargreaves, A., Lieberman, A., Fullan, M. & Hopkins, D. (Eds), *International Handbook of Educational Change* (Part one) (pp. 1299-1313), Kluwer Academic Publishers, Dordrecht.
- Smith, L., & Southerland, S., (2007). Reforming practice or modifying reforms? Elementary teachers' response to the tools of reform. *Journal of Research in Science Teaching*, 44(3), 396–423.
- Tobin, K., Tippins, D. J., & Gallard, A. J. (1994). Research on instructional strategies for teaching science. In D. L. Gabel (Ed.), *Handbook of research on science teaching and learning*. New York: National Science Teachers Association.
- Tobin, K., & McRobbie, C. J. (1996). Cultural myths as constraints to the enacted science curriculum. *Science Education*, 80(2), 223-241.
- Treagust, D. F. (1991). A case study of two exemplary biology teachers. *Journal of Research in Science Teaching*, 28, 329-342.
- Van den Akker, J. (1998). The science curriculum: between ideals and outcomes. In B. J. Fraser & K. G. Tobin (Eds.), *International handbook of science education* (Vol. 1, pp. 421-447). London: Kluwer Academic Publishers.
- van den Akker, J. (2003). Curriculum perspective: An introduction. In J. van den Akker, W. Kuiper & U. Hameyer (Eds.), *Curriculum landscape and trends* (pp. 1-10). Dordrecht, The Netherlands: Kluwer Academic Publisher.
- Van Driel, J. H., Beijaard, D., & Verloop, N. (2001). Professional development and reform in science education: The role of teachers' practical knowledge. *Journal of Research in Science Teaching*, 38(2), 137–158.
- Vogler, K. E., & Carnes, G. N. (2009). Comparing the impact of a high school exit examination in science teachers' instructional practice. Paper presented at the annual meeting of the American Educational Research Association, San Diego, California.
- Waugh, R. F., & Punch, K. F. (1987). Teacher receptivity to systemwide change in the implementation stage. *Review of Educational Research*, 57(3), 237–254.
- Wallace, J., & Louden, W. (1992). Science teaching and teachers' knowledge: Prospects for reform of elementary classrooms. *Science Education*, 76(5), 507-521.
- Woessmann, L. (2003). Central exit examinations and student achievement: International evidence. In P. E. Peterson & M. R. West (Eds.), *No Child Left Behind? The politics and practice of school accountability* (pp. 292–323). Washington, DC: Brookings Institution.
- Zabala, D., & Minnici, A. (2007). *"It's different now": How exit exams are affecting teaching and learning in Jackson and Austin*. Washington, D.C.: Center on Education Policy.

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