

2013

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

Mirko Krüger

University of Duisburg-Essen, Germany, mirko.krueger@uni-due.de

Mihye Won

Curtin University, mihye.won@curtin.edu.au

David F. Treagust

Curtin University, d.treagust@curtin.edu.au

Recommended Citation

Krüger, Mirko; Won, Mihye; and Treagust, David F. (2013) "Teachers' Perceptions on the Changes in the Curriculum and Exit Examinations for Biology and Human Biology," *Australian Journal of Teacher Education*: Vol. 38: Iss. 3, Article 3.
Available at: <http://ro.ecu.edu.au/ajte/vol38/iss3/3>

This Journal Article is posted at Research Online.

<http://ro.ecu.edu.au/ajte/vol38/iss3/3>

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,

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

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

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

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."

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

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 (Bartman, 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

- Broatfoot, 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.

- 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.

Acknowledgements

Our sincere thanks to the teachers who willingly gave up their time to converse with us about the issues raised in this article, to personnel at the WA Curriculum Council who supplied relevant documents for this project, and to the reviewers of this manuscript.