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<http://dx.doi.org/10.1007/s11422-011-9352-4>

Tobin, K., Rennie, L., Venville, G., Chu, H-E, Fensham, P., Gallagher, J., Duit, R., Graeber, W., Berg, E., Hands, B., Ritchie, S. and Dillon, J. (2011) David F. Treagust: Congenial soul, science educator, and international research leader. *Cultural Studies of Science Education*, 6 (3). pp. 783-793.

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David F. Treagust: congenial soul¹, science educator, and international research leader

Kenneth Tobin with Leonie Rennie, Grady Venville, Hye-Eun Chu, Peter Fensham, James Gallagher, Reinders Duit, Ed van den Berg, Brian Hand, and Stephen Ritchie

Abstract For more than a half century David F. Treagust has been an exemplary science educator who has contributed through his dedication and commitments to students, curriculum development and collaboration with teachers, and cutting edge research in science education that has impacted the field globally, nationally and locally. A hallmark of his outstanding career is his collaborative style that inspires others to produce their best work.

Keywords conceptual change · collaboration · mentoring · scholarly productivity · science education

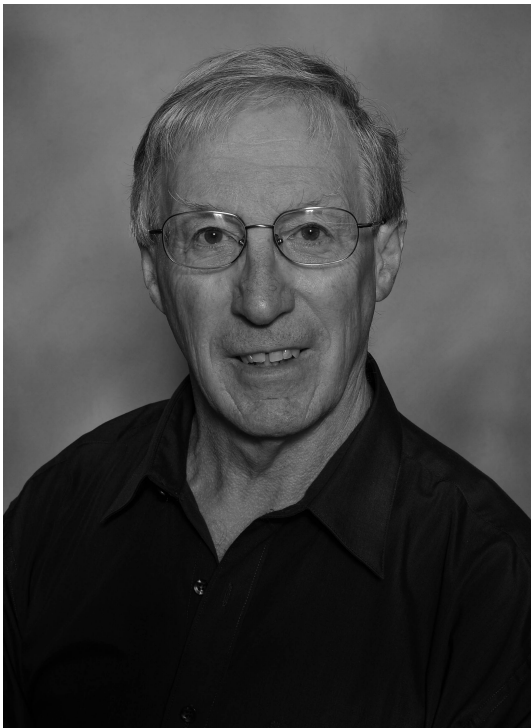


Fig. 1 David F. Treagust: a role model to emulate in science education

David is a congenial soul who is always available to offer advice if required, but more importantly, engage in conversation about what might be important to you in the moment. (Stephen Ritchie)

I was fortunate to work with David Treagust at the Western Australian Institute of Technology in the early 1980s. He was a friendly, knowledgeable, hard-working and enthusiastic colleague. He was also a can-do kind of a guy who rolled up the sleeves and volunteered to do the hard work when it needed to be done. We often talked about our good fortune to be paid so well for doing a job we enjoyed so much. Treagust was innovative and above all a very great agreeable colleague who listened attentively without interrupting to put forward his own ideas. Of course he had his own ideas and the science education community has benefited greatly from his ability to adapt his own ideas with what

¹ Steve Ritchie commented that, "congenial soul is what immediately comes to mind when I think of David; he is one of the congenial souls of science education who has influenced my disposition to research and science education. Ritchie recalled a poem by Humphry Davy in which he used the phrase "the gentle influence of congenial souls. (Davy 1799)

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he has learned from others. There are many ways to represent Treagust's outstanding contributions to science education. For example, his publication record is stellar. Software that calculates an author's impact based on citations listed in Google Scholar reports Treagust's h-index is 44. This represents 6576 citations based on 433 sources listed in the Google Scholar database. Treagust's publications have been cited more than 100 times on 10 occasions, his most cited paper (334) being co-authored with Reinders Duit (Duit and Treagust 2003). Interestingly, 9 of the 10 papers in the list are co-authored, with Treagust as a minor author. Inspection of these data suggests that many of Treagust's most successful publications have been co-authored with former students and colleagues from the international community. Obviously Treagust is a collaborative scholar who consistently produces and disseminates high quality research. Interestingly Ed van den Berg, a colleague from the *Free University of Amsterdam* noted that, "Some time in the mid 1980s David was told, and probably more than once, that working so much with and through students would inhibit his academic career." As van den Berg went on to state, "the conclusion is that it did not inhibit and in fact strongly contributed to the academic careers of his students as well." My point of view is that this is an example of well intended, one size fits all advice that is offered by administrators who have a static view of what it means to be a successful scholar. Treagust has convincingly demonstrated that in working at the elbows of his students he can bring them along and in so doing he brings himself along and also advances the field. The world's leading scientists will readily acknowledge that collaborative work within labs catalyzes and sustains the major developments in science, people working together to advance knowledge. Treagust's footprints are embedded in the collaborative products that have been so highly cited and it is clear that his work will be cited for many years to come.

Treagust's scholarship has been recognized by peers in many ways throughout his careers with numerous best paper awards and recognitions for his service to science education associations. Three of his most recent awards speak strongly to the claim that Treagust's career has indeed been stellar. In 2006 Treagust was recipient of the National Association for Research in Science Teachings' highest award: The *Distinguished Contributions to Science Education through Research Award*. In 2008 he received a *Curtin Excellence and Innovation in Teaching Award*, and in 2011 he was honored with the *American Chemical Society Award for Achievement in Research for the Teaching and Learning of Chemistry*. These three awards show both the depth and breadth of Treagust's excellence in science education and more broadly in education. In addition, David has been elected as a Fellow of the *American Educational Research Association* and England's *Society of Biology*.

The qualities that make Treagust a distinguished contributor to science education cannot be fully represented in statistical analyses. Instead, Treagust's distinction arises from the quality of his scholarly interactions with others in a long and rich career. I decided that the distinctiveness of Treagust's contributions would be best represented through the testimonials of those who have worked at his elbows in various times and places as Treagust enacted science education. Accordingly, the sections that follow build around the voices of science educators who have collaborated with Treagust at different times

and places and in varied ways. Clearly, Treagust is a Distinguished Contributor to Science Education.

Getting started

Treagust began a career as a science educator in 1964 when he began to teach high school science in Bradford England. In 1966 he came to Australia where he taught science in high schools and secondary colleges in Tasmania and Western Australia. In 1974 he commenced his postgraduate studies in science education at the University of Iowa, one of the leading science education institutions in the world. Ed van den Berg, now at the *Free University of Amsterdam* was a doctoral student at the *University of Iowa* when Treagust was there. He wrote:

In August 1975, I arrived at the *University of Iowa* from the Netherlands. During the first seminar in which I met David, I noted that he pursued exactly the kind of questioning one needs to turn a seminar into an intellectual event. We met in courses on the nature of science (George Cossman) and in the special Piaget discussion sessions at the house of Darrell Phillips. In all, we had those typical and very useful graduate student discussions, which sometimes continued during our late night office evenings. David first completed a master's thesis on mathematical models, working with Vincent Lunetta, and then his PhD focused on Piagetian work with Darrell Phillips. The Piagetian experience was to be a nice start for his alternative conception work later on.

After graduating with a doctorate in science education, Treagust joined James Gallagher at *Michigan State University* as a postdoctoral fellow. Gallagher wrote:

David's friendly demeanor and solid command of science and science education immediately impressed me. I also was pleased with his eagerness to engage with our team of scholars and students. During his two years at *MSU*, David demonstrated a keen ability to learn new research techniques, to integrate into our research and teaching community, and to distinguish himself as a scholar and a promising leader in the field. He worked well with colleagues in science and education faculties, with graduate students, undergraduate students, and teachers in local schools. Within a short time he was taking leadership roles in important aspects of our program.

Over the years, I have had many opportunities to continue to work with David, both over distance and on recurring visits to each other's campuses. It has been rewarding to maintain this professional contact and to observe his continued development as an international leader in our field. As one of my first post-doctoral fellows, I am very proud of his accomplishments and dedication to improvement of science education around the globe.

When Treagust joined the *Science and Mathematics Education Centre* at the *Western Australian Institute of Technology* (now *Curtin University*) he was a central part of the

Master's degree program that could be completed by thesis work only or by coursework plus a project. As Ed van den Berg noted "*SMEC* developed very practical diploma and master's degree programs with a high enrollment of practicing full-time teachers. Most courses had a large project component in which the teachers could work on R&D projects related to their own school environment." According to van den Berg, in the 1980s *SMEC* "knew very well how to conduct professional development: Get teachers into a Diploma program (=first year of a 2-year Masters degree), let them apply coursework to their own school problems through course projects, make sure the courses provide an attractive social environment which included course dinners once or twice a semester." During his first five years at *SMEC*, Treagust was instrumental in developing research groups in which graduate students collaborated with him on research involving conceptual change in many areas of science. Before too long Treagust was the centerpiece of a highly successful research group that contributed to knowledge locally, nationally, and internationally. He made a commitment to his students that he would work with them to publish at least one article from their thesis in an internationally renowned journal. It is evident from Treagust's vita that he successfully met this goal from the 1980s until the present time. This approach has been highly successful in connecting cutting-edge research to journals and books as vehicles for dissemination.

Research at *SMEC*

From 1987 onward, *Curtin University* was able to award doctoral degrees. A large high quality program quickly developed, mainly because of the well-established research tradition. Ed van den Berg continued:

David did all that needed to be done to keep busy teachers in the program (pushing, prodding, motivating, telephoning, being a friend, being a coach, being a demanding lecturer) and moving them to produce high quality, joint conference presentations and publications. This approach explains the wide variety of topics evident in David's publications, since the teachers did research on their own schools' problems. The approach afforded David becoming a top notch all round science educator with the ability to function well in both school and academic settings.

Peter Fensham, from *Monash University* in Australia, noted that one of Treagust's very special qualities was "his care and concern for younger scholars in our field. Their testimonies are always so positive about the time and attention to detail that David has given them, and especially in that final critical task of publishing their work." These sentiments about Treagust's supervision are evident in the following comments from Brian Hand, now a professor at the University of Iowa:

I was David's first PhD student to graduate. David had two distinctive qualities that have both pushed me and helped me build a concept of academic life and work with graduate students. First, in many conversations over about 13 years of study with him, David always managed to end the conversation with the question "what will you have for me next time"? Somehow he managed to make this

question sound encouraging, and it had the effect of making me promise to go beyond what I thought I could get done. Fortunately I always managed to get the work done, and plan what I was going to have ready for the next meeting. His constant question highlighted the need for me to constantly keep at it in order to succeed. David was able to push the right buttons to get me to think outside the box and struggle towards the finish line.

I really treasure ongoing conversations we now share as researchers, which are immensely enjoyable and rewarding. It is not because David is just an easy-going person but it is the sense of a shared endeavor. Since my graduation David consistently ends his conversations with the phrase - "I am so proud of you and your achievements." I am honored to receive such accolades from someone who I regarded in the highest esteem as my mentor. For me these two qualities highlight the strength of David - a velvet glove with an unselfish view of the world. David wants you to succeed, is prepared to push you, and is immensely proud of you as you make your way in the world.

Hand's comments highlight several strengths that characterize Treagust's mentoring of doctoral students. He is an attentive listener with an astute awareness of the importance of affording students' goals rather than supplanting them with his own. He knew how to relate with graduate students to build their sense of professional identity and induct them into social networks of colleagues. Grady Venville, now a professor of science education at the University of Western Australia, also was a doctoral student of Treagust's and provides the following insights into her collaboration with him and other graduate students from *SMEC*.

I have most fond memories of working at *SMEC* with David as my supervisor along with a number of other graduate students. It was a very thought provoking and productive time in my life. For example, my most highly cited paper is one published in *Science Education* in 1997 with David as fourth author and three of his graduate students (Louise Tyson, Allan Harrison, and me) as first, second, and third authors. The paper is titled "A multidimensional framework for interpreting conceptual change events in the classroom." As David's doctoral students we all were working on different aspects of conceptual change in different science contexts including equilibrium, atomic structure, and genetics. The paper arose from our collaborative work and resulted in a view of conceptual change theory that, for the first time, incorporated epistemological, ontological, and social/affective perspectives. It was exciting and incredibly stimulating to work with David as our mentor. He encouraged and motivated us, and in every meeting he pushed us beyond where we had ever been in our thinking previously. He'd say things like, "You have to read that 1995 paper by Metz, it has a terrific critique of Piagetian views of curriculum that will really add to your discussion here." David has an awesome knowledge of the literature and we were continually amazed that he actually knew or was friends with people like Peter Hewson and Stella Vosniadou who were simply incredibly famous authors to us at the time. With David's encouragement, we also stimulated each other by sharing ideas, debating, and discussing issues. A light smattering of healthy competitiveness also

pushed us that bit further.

David's enormous contribution to research on conceptual change over at least two decades is as deep as it is broad. The most important point to note is that David and his graduate students have contributed both to the theory underpinning conceptual change research, as well as the practical application with tools and strategies that are readily applicable in the classroom. David's work has resulted in researchers viewing conceptual change from multiple perspectives, that is, they now go beyond using one single way of thinking about the changes to using different perspectives that enrich and inform their understanding of conceptual learning. Many researchers interrogate conceptual change from an ontological perspective, that is, they investigate the change to the nature of scientific phenomena in the mind of the learner, but through the multiple perspectives approach introduced through David's research, they also consider changes that might be happening to the way the knowledge is structured in the brain, and/or how motivation and social factors may influence those knowledge changes.

David's research on the use of analogies and two tiered tests is used by teachers in Australia and worldwide, and are wonderful examples of the practical application of his theoretical work. David's work has demonstrated the power of the analogical learning tool from a number of perspectives and has resulted in simple, but effective teaching models that are accessible to teachers for improving their teaching techniques.

As I indicated at the beginning of this paper, Treagust is not only a superb graduate level teacher, but also a loyal colleague who initiates and follows through consistently. One of Treagust's colleagues at *SMEC*, Léonie Rennie, also is a renowned science educator who was featured in *CSSE* in 2009 (Venville 2009). Léonie noted that:

When I joined *SMEC* in January 1988, David and I had adjacent offices until August 2000, when *SMEC* moved to another building. *SMEC* was always a busy place, and often our meetings were conducted at the photocopier, just outside our offices. David is wholly collaborative and generously collegial and it wasn't long before we were both involved in two projects relating to technology education. Technology (as distinct from information technology) was a new subject in the Australian curriculum and there was very little research that was helpful to practitioners. We produced some field-tested curriculum materials and evaluated a statewide government program to fund technology-based initiatives in schools. I learned enormously from David's exemplary standards in research methods, and his original and creative thinking, which resulted in, what was at the time, groundbreaking research in Australia. In his role as Editor of the *Australian Science Teachers Journal*, David produced a special issue on technology education in 1990. He even managed to get an article for the special issue from the Australian Federal Minister for Science and Technology, no mean feat! During his editorial tenure, I was the editor for feature articles, a job, which allowed me to appreciate David's attention to detail and organization, which made my job very easy indeed.

A rather unique insight into David's personal approach to research and to research

students came to me during the 7+ years I was Dean of Graduate Studies at *Curtin*. In this role I read all of the research thesis examiners' reports that came into *Curtin* (Australian universities do not have oral defenses for assessing theses, but rather written reports from external examiners). It became very clear to me who were good research supervisors and who were not. David may well be the best supervisor of quality theses at *Curtin*, an assessment I do not make lightly. He expects and accepts only top quality work, and especially given that many of his students are not first language English speakers, he achieves consistently outstanding results, evaluated by examiners who are themselves leaders in the field.

David is my choice when I want someone to provide a fair and critical eye on a reference I have written, and a sounding board for ideas I am not sure about, whether it is research, relationships, policies or politics: he is just so well informed and a wonderful colleague. I was proud to be asked to be a referee when David was nominated for *NARST's Distinguished Contributions Award*. With characteristic humility he was genuinely surprised and honored at being nominated. If, at the end of his career, he were asked, what were his greatest rewards, David would refer to two things: that his research made a difference to teachers in their classrooms, and the continuing success and achievements of his past students. He would have to be reminded of his own accolades.

The encouragement that Treagust gives to his students to publish in leading journals prepares them well for careers as scholars. Accordingly, it is not surprising that many of his former students are now leading researchers, situated in universities around the world. Two former students, Grady Venville and Allan Harrison, were recipients of *NARST's* Early Career Award for Research in Science education. However, there are other indicators of broad ranging success of his graduates, such as prestigious appointments, grants from funding agencies, and high citations of publications in strong journals. There is no doubt that the ripple effects produced by Treagust's exemplary doctoral level teaching will be enduring and global in nature.

Mentoring others

Treagust has successfully mentored numerous postdoctoral scholars. One of these, Hye-Eun Chu, from Nanyang Technological University, Singapore made the following comments about Treagust's role as a mentor.

During my postdoctoral studies (2005 – 2008) with David, followed by three more years of collaboration with him, I have developed significantly as a science educator. I have developed deeper insights into international science education and I have grown professionally in a sustained working environment that takes account of me not being a native speaker of English. David provides mentoring related to: research diversity; translating research into practice; and increasing my self-confidence.

David emphasized the importance of widening my research interests to include both quantitative and qualitative research in a variety of research areas. He was aware that in my previous work I was involved in quantitative research on

environmental education in Korea. Based on his suggestion, I collaborated with him on an investigation of the naive conceptions of beginning learners in a physics bridging course and their attitudes towards learning physics. I interviewed students biweekly to elicit their conceptual understanding and their developing views on their physics lectures, tutorials, and laboratory work over a period of six months. In this way I was able to learn more about qualitative research. In addition, through David's encouragement, I was able to rewrite and publish my previous Korean project on environmental education in the *International Journal of Science Education* and coauthor a book chapter on environmental education with him.

Before I started working with David, my research focus was on constructivist theory that was not fully connected to the classroom context even though my research was on students' conceptual understandings and reasoning processes. I took up his suggestion to develop a two-tier multiple-choice diagnostic instrument in optics. This enabled me to better understand how a two-tier diagnostic instrument could be used in classroom instruction. To develop this diagnostic instrument, I had to study the research literature over the previous 20 years to identify students' conceptual understandings in optics. Having this practical view about research has been emphasized in my current work and has enabled me to secure a research grant.

David enabled me to identify my strengths in science education research and teaching. As a result, I was able to successfully complete the research related to item validation in Thermal Conceptual Evaluation (TCE) with self-confidence. Also, after my postdoctoral studies with David, he strongly encouraged me to apply for academic positions in countries outside of Korea. This led me to accept an academic position in Singapore. Despite many difficulties I have faced in my work, David's consistent encouragement inspires me to work towards achieving greater success as a science educator while at the same time helping me to refocus and work on my strengths instead of dwelling on my weaknesses. David's valuing of hard work also rubbed off onto me, inspiring me to work towards my goal of becoming a proficient science educator. Without his constant encouragement, I would not have reached this stage in my development as a science educator.

International impacts

It is clear that Treagust has been highly influential for sustained, exemplary contributions to research in science education. From 1999-2001 he was President of *NARST* and he served in a similar role for the *Australasian Science Education Research Association* from 2003 to 2010. Treagust has exercised editorial leadership for international journals such as: *International Journal of Science Education*, *International Journal of Science and Mathematics Education*, *Science Education*, *Research in Science Education*, *Journal of Biology Education*, and *Research in Science and Technological Education*.

Reinders Duit, from Germany, is perhaps Treagust's longest international collaborator. Duit argues that his close cooperation with Treagust has tremendously

contributed to the development of his own expertise in science education research:

Our initial meeting was fortuitous. Being back in Australia for three years from his post graduate studies in the USA, in 1983 David had decided to learn more firsthand about science education research in Germany and England, being the countries, respectively, where his wife Gisela and he were born and lived until their early 20s prior to their independent immigration to Australia. Gisela's brother happened to live in a place near Kiel. Hence, there was a good chance to also visit the *IPN - Leibniz Institute for Science and Mathematics Education* (hereafter *IPN*) in Kiel, a major centre for science education research in Germany. He made an appointment to meet the then Director, Karl Frey. Upon arrival and further explaining his interests, Frey immediately saw a connection with some of David's professional activities and mine – David had recently published secondary and primary school science textbooks about solar energy and I was writing my habilitation (the German second PhD) about research on the energy concept. Of course, what was more fortuitous is that we both had interests in research on students' science conceptions – then an area of research gathering much momentum – and this led to a successful collaboration between us since that time, in particular in the field of conceptual change.

This cooperation has fundamentally influenced my work in science education since then. I have been fortunate to spend three periods of sabbatical leave at *Curtin University*. David is the international colleague who most supported the development of science education in Germany. David visited the *IPN* on a number of occasions. These longer visits as well as numerous international conferences that we both have attended over the past two decades have meant a rich dialogue of exchanges about conceptual change. Through this collaboration, David and I have written several manuscripts. The two of us were not just working in the same field (like conceptual change or the role of analogies in teaching and learning science), we carried out quite different research and development studies. A particular strength of our collaboration seems to be our differences as well as our similarities in thinking about science education. I grew up in the German tradition being significantly theory oriented (that includes the danger of being “lost in deep Germany thinking”) and learned to think the more pragmatic Anglo-Saxon way. For David it was the other way round.

As Duit noted, Treagust has been a frequent visitor at the *IPN*, where he successfully collaborated with Duit and colleagues such as Wolfgang Graeber. At a recent meeting of the *American Chemical Society* Graeber stated that Treagust helped science educators throughout the world to initiate and implement projects and publish their results in journals. Graeber noted that Treagust's work in Germany had influenced science education and helped German scholars to participate in the international community. Clearly, Treagust's contributions to international science education have been extensive and substantive. Peter Fensham observed:

David Treagust has been the main link with European research for the Australian science education community. With his own initial development in research in USA, linking with that country's researchers has been natural for him and his deep

involvement with *NARST* testifies to it. His linkage with European colleagues, particularly those in Germany, stems from his genuine admiration for the rather different way in which they approach research, and his desire to ensure that others become aware of its worth.

My abiding personal memory of David throughout our long association is his very positive response to the ideas of others. I have experienced this many times in conversations but also observed it in David's response to suggestions other people are making. The great thing about this characteristic is that David then often, not only takes the ideas on board, but also develops them into research studies that go beyond the original idea. David is a doer, not a speculator.

Beyond international contributions

We conclude this paper with a note from Grady Venville, which nicely illustrates the way Treagust has consistently contributed locally, nationally and internationally. Grady noted that:

David is highly respected in the international science education scene, but what many international science educators may not realize is that David is very well known and highly respected by the local science teachers in Western Australia. He is an active member of the local science teachers' association and is on the editorial board of the local science journal. He goes to the annual general meeting of the science teachers' association meetings and regularly attends local conferences to present or watch his graduate students present papers and generally interact and network with the local teachers. I think this is an amazing feature of David's professionalism and the awesome contribution that he has made over the years to science education. From local hero to international guru – David Treagust does it all!

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Author biography

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