Discrete Mathematics Letters
www.dmlett.com

Discrete Math. Lett. **10** (2022) 115–123
DOI: 10.47443/dml.2022.i1

Interview

An interview with Ortrud Oellermann*

Akbar Ali

Department of Mathematics, Faculty of Science, University of Ha'il, Ha'il, Saudi Arabia

(Published online: 2 September 2022)

Ortrud R. Oellermann received an M.Sc. in mathematics from the University of Natal, South Africa in 1983 and a Ph.D. in mathematics from Western Michigan University, USA in 1986. She taught at several universities, but the majority of her academic career was spent at the University of Winnipeg, Canada, where she served from July 1996 until August 31, 2021, when she retired as a professor. She is currently an adjunct professor of mathematics at both the University of Winnipeg and the University of Victoria, Canada. Professor Oellermann was honoured with a Professor Emerita title from the University of Winnipeg in June 2022. Throughout her career she held research grant funding from research funding agencies such as the Office of Naval Research (USA), the National Research Foundation (South Africa) and NSERC (Canada). To date she has 85 co-authors of which 22 are former research students or post-doctoral fellows. She is currently one of four editors-in-chief of the Bulletin of the Institute of Combinatorics and its Applications. Previously she served on the editorial boards of Ars Combinatoria and Utilitas Mathematics. Professor Oellermann has received several medals, including the Hall Medal from the Institute of Combinatorics and its Applications in 1995. She was an elected member of the board of directors of the Canadian Mathematical Society (July 2001 - June 2005) and the executive committee of the Discrete Mathematics activity group of the Society for Industrial and Applied Mathematics (January 2006 - December 2007). Professor Oellermann also served as an academic consultant for the Cambridge University Press monograph "Topics in Structural Graph Theory" edited by Lowell W. Beineke and Robin J. Wilson.

1. **(Akbar)** Professor Ortrud R. Oellermann, first of all, I would like to thank you for accepting the request for conducting this interview. Would you please tell something about your (i) School life, (ii) College life, (iii) University life, (iv) education and interests before you entered college, (v) education and interests while you were an undergraduate in college, (vi) education and interests while you were a graduate student? If any stories occur to you, humorous or otherwise, that might interest the readers, please let us know.

   (Ortrud) For the first seven years of my schooling, I attended a small private school (the Michaelis Schule) in Vryheid, Natal, South Africa. The school was affiliated with the Lutheran church and offered German as a first language. For the first two years our instruction was completely in German. In Grade 3 (at the time this was referred to as Standard 1) we learned English and later Afrikaans and our course instruction subsequently transitioned to English but we continued to receive German language instruction. During my elementary school years, I also started taking music lessons - recorder, piano, violin for a couple years and I sang in the school choir. After completing Grade 7, I entered the local high school – Vryheid High School – where I completed Grades 8-12. My mathematics teacher Mrs. Abrahamson and my Physical Science teacher Mrs. Kruger inspired me to continue my education at the University level.

   After completing my Matric exams in 1977, I was admitted to the University of Natal in Durban where I pursued a BSc degree. My initial intent was to major in Chemistry and Physics, but I recognized that what appealed to me most in my Chemistry and Physics courses was the underlying mathematics.

   My first-year university studies were interrupted by the death of my father and two siblings in a fatal car accident on August 11, 1978. I returned to Vryheid to support my mother on the dairy farm which she now had to manage on her own. It was a challenging time for us and for a while I didn't think that I could even consider continuing my studies. One of my Physics professors, Professor Manfred Hellberg, however, persisted in trying to convince me to come back and complete my studies and he called me a few times to encourage me to do so. My friends were also very supportive and sent me their notes so that I could resume my studies (while being at home with my mother) about a month after my family members' deaths. The University permitted me to write some of my exams with the regular final exams in November/December and the remaining ones in February with the supplementary exams. I am thankful to everyone who encouraged and supported me during this time. For my second year I enrolled at UNISA (The University of South Africa) – a correspondence university – where I took courses in Chemistry, Mathematics, and Applied Mathematics. In February 1979 my mother decided that it was too difficult for us to continue the farming. With the help of several of my cousins she sold our farm equipment and animals in May 1979 and then rented out the land. We subsequently moved to a town near Durban, called Hillcrest, where my aunt lived.

I completed my second year with UNISA and then returned for the last year of my BSc to the University of Natal, majoring in Chemistry and Mathematics. Unsure about which direction to follow for graduate studies, I worked as lab assistant with my Organic Chemistry Professor Karl Pegel over the summer. This was an interesting experience, but I decided that lab work was not my passion and hence continued with an Honours and then a Master's degree in Mathematics at the University of Natal. My Master's thesis supervisor was Professor Henda Swart. She was a Projective Geometer by training but had gained a passion for Graph Theory when she and her husband spent a sabbatical leave at the University of Albuquerque, New Mexico, USA. She had taken a course with Professor Roger Entringer who had given the class a list of problems to solve as part of the course. She told us that these problems were incredibly difficult, but that she did succeed in solving one of them and handed it in. At the next class Professor Entringer called her aside and told her that she had solved one of his open research problems. She was delighted and excited and became an instant convert to Graph Theory. She passed on her love for the subject to many students - including myself. She also encouraged me to pursue a PhD in Mathematics. So, after completing my Master's and teaching at the University of Durban-Westville for one semester, I embarked on my journey to Kalamazoo Michigan in August 1983 to pursue a PhD in mathematics at Western Michigan University. My thesis was completed under the supervision of Professor Gary Chartrand and I graduated with a PhD in August 1986. Gary is a master problem poser who was never at a loss of finding another topic for yet another PhD student. Gary officially supervised 22 PhD students, but he continued assisting other colleagues with problems for many more. My PhD thesis dealt with generalized connectivity and planted the seed for my interest in structural Graph Theory.

Figure 1: Gary Chartrand with 11 of his PhD students.
Back: Garry Johns, Songlin Tian, John Mitchem, Don VanderJagt, Ron Gould, Grzegorz Kubicki, Hector Hevia;
Front: Linda Lesniak, Ortrud Oellermann, Gary Chartrand, Karen Novotny (Holbert), Elzbieta Jarrett.

2. **(Akbar)** What were your early experiences with mathematics? When did you think mathematics would become a major part of your life? What is it about mathematics that led you to pursue it as a career? If you had never become a mathematician, what would have liked your occupation to be?

   (Ortrud) From an early age I was fascinated by puzzle-type problem solving. I found this type of problem solving rewarding and somewhat addictive. Even though neither of my parents had a formal education beyond Grade 10, I see, upon reflection, that my father's thought process was systematic and mathematical. For example, he designed a milking parlour and then built a good share of it himself. He also designed and welded the milking stalls for the cows. In the process he'd use basic trigonometry and geometry. He also bred dairy cattle and would essentially use rooted tree structures to name his cows and to draw up their genealogical trees. For example, a cow or heifer named Mhlope 2AB1 would have been the first daughter of the second daughter of the first daughter of the second daughter of Mhlope. We went to school daily with the milk truck and on the way there he'd keep us occupied either by signing canons with us or by posing basic arithmetic problems for us to solve and we'd each try to be the first one to get the correct answer. I believe that these activities served as catalyst for my eventual passion for mathematics.

But even before this I had nightmares in which exponential growth played a role. I was petrified of the many venomous snakes that we would encounter on our farm. So, I often dreamt about being chased by snakes. In my dream the rule of the game was, if I didn't look back the number of snakes chasing me would remain constant but as soon as I looked back to determine how close they were, their number would double. Of course, in my fear I kept looking back and the number of snakes chasing me doubled each time, and eventually I was surrounded by an ocean of snakes - what a terror!

In high school I really enjoyed proving trigonometric identities, and geometric riders and I was absolutely intrigued when I first understood the proof that the square root of 2 is irrational. What I find most appealing about mathematics is its rigour. All the other sciences are based on theories which frequently get modified as scientists gain a better understanding of their problems, but in Mathematics a theorem stands as truth once it has been established.

In my primary school years, I had entertained the idea of becoming a nurse and during my high school years I had thought about choosing music as a career. I thoroughly enjoyed music theory, which is also mathematical in nature, but performance was not my forte - I would get very nervous in front of an audience.

Figure 2: Kieka Mynhardt, Henda Swart, and Ortrud Oellermann.

Professor Henda Swart played a key role in my decision to choose academic mathematics as a career. She was very enthusiastic about the subject and strongly encouraged me to consider mathematics as a career. She was incidentally the first woman in South Africa to obtain a PhD in mathematics. Professor Kieka Mynhardt, who served as external examiner for my Master's thesis, also encouraged me.

3. **(Akbar)** Many have said that in many parts of the world, students aren't as interested or as prepared in mathematics as in the past. Have you noticed this? If so, do you have any thoughts on what might be done to improve this?

   (Ortrud) Yes, I have observed this. There seems to be a fear of mathematics among many students. I believe this stems primarily from the fact that students are not adequately prepared. Mathematics is a cumulative subject. So, if there are gaps or insufficient skill levels in their prerequisite knowledge, students cannot cope with topics that assume mastery of this material. I like to compare this to the way a computer functions. If the ram (working) memory becomes overloaded, processing slows down significantly. Instead, what one wants to be able to do is to easily retrieve some of the "prerequisite" information from the hard drive rather than recreating it each time. Similarly, our working memory becomes overloaded when we have not mastered basic math skills. So, if students are trying to solve problems that require them to use prerequisite material, they get bogged down since they need to expend too much energy and focus on prerequisite material rather than focussing on the problem at hand. In short, they have ram overload. Consequently, they become overwhelmed by the process and cannot see the forest for the trees and then often just give up.

   Practice of basic math skills has become largely deemphasized and the use of calculators has been encouraged. In addition, a lot of emphasis has been placed on making students "feel good" about doing mathematics by showing them applications and asking them to come up with their own way of solving a problem – or showing them ways, other than the standard ways, of arriving at a solution that are often inefficient and frequently do not easily extend to the general case. If students are not well versed in basic math skills as, for example, their times tables, fraction arithmetic, factorization, laws of exponents and others, they will simply get stuck on problems that should be straightforward. To illustrate this point, a calculus student may have no difficulty evaluating $\int 2dx$ or $\int 3^x dx$ by applying some well-known integration techniques but if they are not well-versed in factorizing polynomials, simplifying fractions and laws of exponents, they might have considerable difficulty evaluating $\int (\frac{x^3+1}{x^2+x+1} - \frac{x^2-2x+1}{x-1})dx$ or $\int \frac{9^x}{3^x}dx$, even though each of these integrals reduces to one of the afore-mentioned integrals. I believe that if students are required to achieve mastery in prerequisite topics, using the most efficient methods and ample practice they will be far less intimidated by mathematics and in fact will enjoy doing math. Of course it is very important that the teachers themselves are competent in the subject matter, that they are enthusiastic about the subject and that they have effective ways of communicating the subject matter.

4. **(Akbar)** Would you please tell me something about your interests besides mathematics?

(Ortrud) I enjoy classical music, gardening and have recently taken up quilting. I also like reading biographical novels or short non-fictional accounts or opinion pieces. Other than that I enjoy travelling and spending time with my family, especially my first grandchild who was born in August 2020.

5. **(Akbar)** Would you please tell me something about your first job? Did you feel that being a faculty member was what you expected? Faculty members at universities primarily teach and some also do research. What other parts of being a faculty member did you do? Did you find these interesting? Did you encounter many students who had the same enthusiasm for mathematics that you possess?

   (Ortrud) My first job in mathematics was a temporary position at the University of Durban-Westville. I taught an abstract algebra course. I had almost no experience teaching, except for occasionally explaining things to fellow students. At that point I felt that if I understood the material, then I could teach it. Knowing the material is of course important but being able to explain it, so that others understand it and get excited about it is much more challenging than I initially thought. As I gained experience, I knew what common mistakes/misconceptions students had - so I could change my emphasis and warn them about these and I learned to foster enthusiasm for the subject by reminding myself and my students how enlightened I felt when I first understood certain proofs or methods. I enjoyed my teaching much more when I felt that I succeeded in making the subject come alive and when I felt that the students gained a better understanding of the material than if they had just read a textbook.

   As far as research goes, the highlight of my research career was supervising undergraduate student research projects over the summer. These students were usually bright and highly motivated. Their excitement when they managed to solve a problem was so very rewarding! If their experiences working with me motivated them to choose a career in the mathematical sciences, I was of course particularly pleased. As was the case with teaching, I learned that there is so much more to research supervision than giving students a problem to work on. Once I learned this, I was able to gauge when and how input from me was needed. It was important that students were not completely overwhelmed by the problem. So, I would usually show them how I would approach the problem, particularly if the problem appeared difficult to solve. I would try to provide some scaffolding by breaking the problem into smaller parts of which some were accessible to them or ask them to look at special cases of the problem and I would regularly meet with them to keep them motivated.

   I also did my share of administrative work by serving on a variety of committees and as department chair for a few years. Committee work was part of my job description, but it was not my favourite part.

6. **(Akbar)** What was the main thing that made you decide to work in discrete mathematics/combinatorics/graph theory? Was it a course or courses you took, was it a person who influenced you, was it something about the subject, or was it something altogether different?

   (Ortrud) In my case I would say that Professor Henda Swart played the most important role in my choosing discrete mathematics and specifically Graph Theory as my area of specialty. I also took my first Graph Theory course with her and subsequently completed a Master's degree under her supervision.

7. **(Akbar)** Would you please tell me something about some major events in your life concerning discrete mathematics/combinatorics/graph theory. Perhaps this was having your first paper accepted for publication, the first talk you gave at a major conference, or something else.

   (Ortrud) There are a couple events that I remember very well. The first of these happened when I was working on my Master's thesis that dealt with "Aspects of High Traceability in Graphs" (both vertex and edge traceability). I had worked through many papers on related topics. One result that I had studied was the characterization of graphs for which all strong orientations were Hamiltonian. I had also learned that researchers would frequently explore the edge version of the problem if something about the vertex version was known or vice versa. So I poured through hard copies of Math Reviews in our library (electronic versions did not exist at the time) to see whether the corresponding edge version problem had been studied. Since it didn't appear to have been solved, I decided to think about it. I then came up with a conjecture on the structure of those graphs for which all strong orientations are Eulerian and an argument why this conjecture is in fact a theorem. I wasn't sure though if my argument was sound, so I shared it with Professor Henda Swart. She checked it over and agreed that the result was correct. She then streamlined the proof and we submitted our first co-authored paper – which was also my very first paper – for publication in Expositiones Mathematicae. I was very excited when the paper was accepted for publication!

   The other event I distinctly remember was the "Fifth International Conference on the Theory and Applications of Graphs" which was held at Western Michigan University in 1984. I had nearly completed my first year toward my PhD when this meeting was held. It afforded me the opportunity to meet and listen to so many well-known Graph Theorists some of whose research papers I had studied for my Master's degree. I met many well-known researchers who, up to that point in my life, had only been revered authors of papers. This conference still sticks in my mind.

Figure 3: Fifth International Conference on the Theory and Applications of Graphs, 1984.

8. **(Akbar)** What would you suggest or advise for young people thinking about pursuing a research career (or for early career researchers working) in discrete mathematics? Certainly not everything always goes well even for a successful mathematician. This might be working on a problem that you just can't solve, receiving a report on a research paper where the comments aren't as complimentary as expected, or giving a talk that didn't seem to go over as well as you had hoped. What suggestions can you give to others about how to react to such situations?

   (Ortrud) My advice is always to see whether one can learn from the experience and then do things better the next time around. Whenever my students got stuck on a problem, I would always tell them that this happens even to the best researchers and that it has happened to me many times. Sometimes one can solve an interesting special case instead, which either has a nice motivation or which may give insights into the more general problem. Quite often one can learn from a referee's report, and it can be helpful for improving one's paper and even one's approach to doing research in general. Occasionally one gets reports where one can tell that the referee has missed the point of the paper or even makes incorrect claims. This is, of course, very frustrating! In that case it might help to submit the paper elsewhere and hope that the same person is not asked to referee it.

9. **(Akbar)** When you think about your career thus far as a mathematician, you have encountered many mathematicians and attended many conferences. What are some stories that occur to you that might interest the readers?

   (Ortrud) Yes, I met many mathematicians. There are two that stand out for their eccentric personalities, namely Paul Erdős and Frank Harary, and I'll share some stories about them that I found to be rather unusual.

Figure 4: Paul Erdős.

Recollections about Paul Erdős: During my PhD studies at Western Michigan University and at meetings I regularly met Paul Erdős. He did not have a home, nor did he have a fixed job and all his worldly belongings fitted into a couple of small suitcases. He travelled from place to place throughout the world inspiring mathematicians with his wealth of interesting problems that were usually easy to state but regularly confounded even the brightest minds. I was told that when his mother was still alive, she would often accompany him on his travels, and he missed her a great deal when she passed away. Whenever he was invited somewhere, it was an unwritten rule that the host institution would cover his travel and living expenses and they would usually add a small honorarium. The little money he had was managed by Ron Graham and Fan Chung. Yousef Alavi at Western Michigan University would normally ensure that his medical needs were attended to. Paul loved and lived for mathematics and when he heard of an interesting problem, he would immediately want to share it with as many people as possible who he thought would like the problem. In that sense he was a great disciple for good problems, but if you wanted a good chance at solving a problem, it was wise not to tell Paul about this until you had given it your best try. His main goal was to get problems solved. He had an amazing intuition for the difficulty of a problem and would quite often offer monetary rewards for a correct solution in accordance with his perceived level of difficulty of a problem – a higher reward meant a more difficult problem.

Figure 5: Ron Graham and Fan Chung.

I had the privilege to work with him on three different projects. One of these included Ron Graham and Fan Chung. It was a great learning experience and very inspirational to have the opportunity to work with researchers of their calibre. When Paul came to visit, he'd be ready early in the morning to get started on research work. I recall, when he came to Western Michigan University during my PhD years, that he would call around 7-8 am in the morning indicating: "I am ready". When communicating with Ron Graham, he would sometimes say in jest about Paul's visits: "We had Paul here last week for a year". I remember Paul as a gentle and humble soul who was willing to share his ideas with both experienced and inexperienced mathematicians. He also had a keen interest in world history and could talk about political issues at length.

Figure 6: Gary Chartrand and Frank Harary.

Recollections about Frank Harary: Before starting my PhD studies at Western Michigan University I was aware of Frank Harary's 'Graph Theory' textbook. Gary Chartrand had mentioned to me that he had spent some time working with Frank at the University of Michigan after completing his PhD at Michigan State University. Gary shared quite a few 'Frank stories' with his PhD students. One of the stories I remember well had taken place at a restaurant in Ann Arbor that they would frequent. In those days smoking was permitted in restaurants and Frank liked to smoke cigars. On one of their visits to this place, Frank was again smoking a cigar. The owner then came up to Frank, took the cigar out of his hand, extinguished it in a glass of water and then pulled a dollar from his pocket, gave it to Frank and said: "I have always wanted to do this". Apparently, Frank was dumbfounded, but after the owner left, he whispered to the others at the table: "it wasn't even worth a dollar!"

Frank set himself lots of unusual goals. For example, I remember that he endeavoured to publish in journals starting with every possible letter of the alphabet. In his pursuit to achieve this goal, he contacted me once when he discovered the South African journal 'Quaestiones Mathematicae'. He was delighted that he had at last found a math journal starting with the letter 'Q'. He subsequently submitted a paper to this journal. He also endeavoured to give research talks in as many countries of the world as possible and he'd organize himself an audience in different places, even if it consisted of a single person, to achieve this goal. There were many other goals that he was bent on achieving of which I don't know all the details.

Over the years, Frank posed many interesting problems, and he was an excellent writer. I too had the opportunity to work with him on several projects.

10. **(Akbar)** You have attended talks of many mathematicians. What do you think makes a good talk to an audience of mathematicians?

(Ortrud) In a good talk the speaker knows their audience well so that the material is gauged appropriately. I believe that it is very important that the speaker engages the audience in the first part of the talk. This can be accomplished by taking time to motivate the topic, to introduce the definitions and background material, and to give ample examples. In this part of the talk the speaker can engage the audience by asking lots of simple questions.

Sometimes some good humour can be very effective in engaging the audience, but it must be something that suits the speaker otherwise it can fall flat. I recall the first time I listened to a talk by Ron Graham and how he engaged his audience. In those days we prepared our talks using overhead projector slides (and not power point or beamer). On his first slide he showed several rows of figs (the fruit) and labeled them sequentially as Fig. 1, Fig. 2, etc., and he did this all with a straight face. After a good chuckle everyone was focused on what he had to tell us. I heard that on another occasion he started his talk with a slide that had some words written backwards, others up side down, and others were written in their mirror image. So when the slide didn't appear to be right side up he turned it around, and when that did not work he rotated it and so on. But each time something still did not look right. Then in his 'frustration' he simply threw the slide away. Once again after this little antic, the audience was fully engaged.

In the next part of the talk the speaker should clearly and concisely state the main problem and illustrate it with some well-chosen examples. The third part of the talk should focus on the main results and hopefully highlight some of the techniques that were used. A good talk usually concludes with a summary of the main ideas/results and some interesting open problems.

11. **(Akbar)** Being a research mathematician is a creative occupation. How do you decide on a topic for your research? How do you discover problems to work on?

(Ortrud) I think it is important to know the literature well. Past avenues of exploration of certain topics often suggest natural extensions that can be worked on. Quite often there are already results in the literature that are extensions of classical topics and this, in as of itself, gives direction to a researcher. Take for example, generalized Ramsey numbers as an extension of classical Ramsey numbers or generalized colourings as an extension of classical colouring etc. The literature abounds with examples such as these.

I will now describe a few problems that arose naturally from research that I had already worked on.

(a) I had been involved in several projects on the average distance of a graph and problems related to Steiner distances between three or more vertices in a graph. This got me thinking that the average Steiner distance is a natural way of marrying these two topics. This idea led to some fruitful investigations which were published in [8].

(b) After I gave a talk on the the average Steiner distance of trees, I was made aware of the problem of finding the average order of a subtree of a tree first introduced by Jamison in [15] - which I will call the average subtree order problem. This paper contained six interesting open problems of which four had already been solved when I first started working on the average subtree order problem. In [18], we solved one of the remaining two open problems and made progress on the last open problem, namely the problem of describing the structure of those trees of a given order with maximum average subtree order. This work prompted us to ask the question whether there is a natural extension of the average subtree order problem to all graphs. Since the subtrees of a tree are precisely the connected induced subgraphs of a tree, we felt that the problem of finding the average order of the connected induced subgraphs of a (connected) graph is a natural extension of the average subtree order problem. The extremal values and structures of this extension were studied for co-graphs in [16] and for block graphs in [1].

(c) The study of the average distance can be nicely motivated as being a much better overall measure of how far apart pairs of nodes are in a graph than its diameter - which is a worst case measure. That in turn prompts the questions whether there are other graph parameters for which there is a natural average measure that is a better indicator of the structure of a graph, than the classical worst case measure. Since I had also worked on graph connectivity, which too is a worst case measure based on the connectivities between pairs of vertices, it occurred to me that the average connectivity of a graph taken over all pairs of vertices gives a much better picture of the "connectedness of a graph" than the connectivity. This is how this area of study was conceived. Apart from the seminal paper on the topic [2], both the edge and vertex versions of this parameter were studied for graphs and digraphs in [4–7, 13, 19].

(d) I came across distance hereditary graphs when I looked at the complexity of NP-hard problems for certain graph classes, as for example in [11]. Distance hereditary graphs are those graphs G for which every connected induced subgraph has the property that the distance between every pair of vertices in the subgraph is the same as the distance between the pair in G. This class of graphs was introduced by Howorka [14]. Apart from their significance in complexity studies, distance hereditary graphs have interesting structural characterizations. My work on Steiner distances motivated me to define k-Steiner distance hereditary graphs, for some integer $k \geq 2$, as those graphs G for which every connected induced subgraph, of order at least k, preserves the Steiner distance of every k-set of vertices in the subgraph. This class was first introduced and studied in [9]. For the special case $k = 3$, a forbidden induced subgraph characterization was established in [10].

(e) I also had an interest in graph convexity since there is a natural way of defining convexity in graphs in terms of intervals (these are unions of vertices on shortest paths) between pairs of points in much the same way as Euclidean convexity is defined in terms of intervals between pairs of points. I became aware of several other definitions of graph convexity that had been defined in terms of some type of interval notion between pairs of points. Since I had already worked on problems related to Steiner intervals (between three or more vertices), see [17], I realized that this type of interval notion led to yet other ways of defining graph convexities, see [3]. This too resulted in several interesting new graph structure problems and related results, see [12,20–23], previously investigated for graph convexities defined in terms of intervals between pairs of vertices.

12. **(Akbar)** Do you have any suggestions on how women can become more involved in mathematics?

(Ortrud) I think women need to have enough support and encouragement to get them more involved in mathematics research. Often, they assume the primary care-giver role for their families and consequently their research development is placed on the back burner. As a result, they frequently hold teaching positions with heavy loads that rob them of even more time to work on research.

In 2019 I was involved in a mentor role at a research workshop for Women in Graph Theory and Applications (WIGA) at the Institute of Mathematics and its Applications in Minneapolis. I spoke with several women at the workshop who either were (i) recently on maternity leave or (ii) spent several years focusing on the adoption and nurturing of young children or (iii) cared for ill family members, for whom this workshop was particularly beneficial. The workshop gave them the opportunity to reconnect/network with other researchers in their field in a non-threatening environment and also affirmed that they were capable of doing research. This workshop was a source of encouragement for many women who wanted to get ahead in their careers. For mentors it was also a rewarding experience to see how women from varying backgrounds and with a variety of challenges found safe spaces to interact, ask questions, grow and express their creativity. The work that was started at WIGA was continued through online zoom meetings and resulted in several publications. The organizers also encouraged participants to present their work and suggested various venues where this could be done. These opportunities provided valuable experiences and allowed these women to regain their confidence in participating in research activities after periods where this was very difficult or even impossible.

13. **(Akbar)** When you read someone else's research paper, what is it that catches your attention that makes you read on?

(Ortrud) A well-written and motivated introduction will usually catch my attention. If the paper relates to something I have studied in the past and offers progress, new insights, or a neat technique for tackling a longstanding open problem this will also catch my attention and motivates me to read on.

14. **(Akbar)** You have done research with many mathematicians. What do you think makes a good research team? How is the work on a research paper divided after the research has been completed?

(Ortrud) To form a good research team, it is important that all team members are invested in the project and motivated to do their share of work and that they have sufficient background for the project. It is important that the team has a good leader – especially when the team has members from different backgrounds. The leader should be willing to spend some time explaining concepts to members that are less experienced to give them a chance to grow and participate. Some team members might think more clearly/creatively in a private setting. I think this should be recognized and supported by the leader. After the work has been completed, it is best to divide the writing up as equally as possible and preferably in such a way that each member writes up a portion that they contributed to most. Then the team should discuss how the results/sections should be assembled and someone should take on the task of putting the various parts together. In the end each member should read the entire paper to ensure it is well-written and accurate.

If team members are on par, in terms of experience, it also works quite well to collaboratively/organically prove results using a board.

References

[1] K. J. Balodis, M. E. Kroeker, L. Mol, O. R. Oellermann, On the mean order of the connected induced subgraphs of block graphs, *Australas. J. Combin.* **76** (2020) 128–148.

[2] L. W. Beineke, O. R. Oellermann, R. E. Pippert, The average connectivity of a graph, *Discrete Math.* **252** (2002) 31–45.

[3] J. Caceres, O. R. Oellermann, On 3-Steiner simplicial orderings of graphs, *Discrete Math.* **309** (2009) 5828–5883.

[4] R. Casablanca, P. Dankelmann, W. Goddard, L. Mol, O. R. Oellermann, The maximum average connectivity of orientations of graphs, *J. Comb. Optim.* **43** (2022) 543–570.

[5] R. Casablanca, L. Mol, O. R. Oellermann, Average connectivity of minimally 2-connected graphs and average edge-connectivity of minimally 2-edge-connected graphs, *Discrete Appl. Math.* **289** (2021) 233–247.

[6] P. Dankelmann, O. R. Oellermann, Bounds on the average connectivity of a graph, *Discrete Appl. Math.* **129** (2003) 305–318.

[7] P. Dankelmann, O. R. Oellermann, Degree sequences of optimally edge-connected graphs, *Ars Combin.* **77** (2005) 161–168.

[8] P. Dankelmann, O. R. Oellermann, H. C. Swart, The average Steiner distance of a graph, *J. Graph Theory* **22** (1996) 15–22.

[9] D. P. Day, O. R. Oellermann, H. C. Swart, Steiner distance hereditary graphs, *SIAM J. Discrete Math.* **7** (1994) 437–442.

[10] D. P. Day, O. R. Oellermann, H. C. Swart, A characterization of 3-Steiner distance hereditary graphs, *Networks* **30** (1997) 59–63.

[11] A. Esfahanian, O. R. Oellermann, Distance hereditary graphs and multidestination message routing in multicomputers, *J. Combin. Math. Combin. Comput.* **13** (1993) 213–222.
[12] M. A. Henning, M. Nielsen, O. R. Oellermann, Local Steiner convexity, *European J. Combin.* **30** (2009) 1186–1193.
[13] M. A. Henning, O. R. Oellermann, The average connectivity of a digraph, *Discrete Appl. Math.* **140** (2004) 143– 153.
[14] E. Howorka, A characterization of distance-hereditary graphs, *Quart. J. Math. Oxford Ser. 2* **28** (1977) 417–420.
[15] R. E. Jamison, On the average number of nodes in a subtree of a tree, *J. Combin. Theory. Ser. B* **35** (1983) 207–223.
[16] M. E. Kroeker, L. Mol, O. R. Oellermann, *Australas. J. Combin. Australasian J. Combin.* **71** (2018) 161–183.
[17] E. Kubicka, G. Kubicki, O. R. Oellermann, Steiner intervals in graphs, *Discrete Appl. Math.* **81** (1998) 181–190.
[18] L. Mol, O. R. Oellermann, Maximizing the mean subtree order, *J. Graph Theory* **91** (2019) 326–352.
[19] L. Mol, O. R. Oellermann, V. Oswal, On the average (edge-)connectivity of minimally k-(edge-)connected graphs, *Bull. Inst. Combin. Appl.* **94** (2022) 95–110.
[20] M. Nielsen, O. R. Oellermann, Steiner trees and convex geometries, *SIAM J. Discrete Math.* **23** (2009) 680–693.
[21] M. Nielsen, O. R. Oellermann, Helly theorems for 3-Steiner and 3-monophonic convexity in graphs, *Discrete Math.* **311** (2011) 872–880.
[22] M. Nielsen, O. R. Oellermann, Separation properties for 3-Steiner and 3-monophonic convexity in graphs, *Discrete Math.* **312** (2012) 3293–3305.
[23] M. Nielsen, O. R. Oellermann, Local 3-monophonic convexity, *J. Combin. Math. Combin. Comput.* **80** (2012) 11–24.