



A Festschrift to Honour Jim Greer: Guest Editors' Introduction

A Special Issue of the International Journal of Artificial Intelligence in Education

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Festschrift Overview

This special issue of the International Journal of Artificial Intelligence in Education (IJAIED) is dedicated to the memory of Jim Greer, our former colleague and friend, who passed away suddenly on June 16, 2018. Jim was well known as one of the pioneers of artificial intelligence in education (AIED) and the related area of user modelling, adaptation and personalization (UMAP). His active research career started at the time the fields of AIED and UMAP were emerging as distinct research areas between 1987 and 1991, and his intellect, drive and personality influenced an entire generation of researchers. His influence was three-fold. First, Jim had the ability to generate and appreciate original ideas, especially those with a great practical appeal, leading to a formidable and innovative research record. Second, Jim had a playful and adventurous attitude to life and research, the spirit of a true explorer, enhanced by his great sense of humour. This was particularly inspiring for young researchers since it made research look like fun, not like onerous work. Third, Jim was empathetic, caring, and wise, traits that led him to engage in mentoring not only his own students, but any young researchers he met. This is why so many people remember him for the kind words of encouragement they heard from him at their first conference, or with his readiness to show any student how to get to the meat of the problem (or of the lobster at a conference dinner).

At the AIED and UMAP conferences immediately following Jim's passing there was a general consensus that something should be done to recognize his major impact over the span of his 30-year career. The idea of creating a special

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issue of IJAIED as an honour to Jim emerged over the next few months. The goal was to create a “Festschrift”, a collection of papers by researchers who felt they had been inspired by Jim and/or influenced by his research insights.

The Festschrift special issue was formally approved by the IJAIED editorial board in 2019, with the two of us appointed as “guest” editors. We created an open Call for Papers that was distributed widely to the AIED, UMAP, and related communities during the (northern) summer of 2019. The Call requested that

“...each [submitted] paper should be a contribution to the AIED field presenting a novel research project or result, an integrative summary of an ongoing research program, or an insightful reflection or survey of a field of research that overlaps one or more of Jim’s various interests. To ensure that the special issue is a true tribute to Jim, we ask that each paper explicitly communicate Jim’s influence on the research or researcher.”

Papers started to arrive in late 2019 and continued to flow in over the next many months. By June of 2021, after full reviewing (often with several reviewing cycles) 24 papers had ultimately been accepted for the special issue. It is our pleasure to present this Festschrift. We believe it is a fitting tribute to Jim Greer’s influence on the researchers and generally on the fields of AIED and UMAP.

Jim Greer was a longtime Professor of Computer Science at the University of Saskatchewan. Throughout his life Jim had an unwavering commitment to teaching and learning, earning many degrees himself, teaching at the high school and university levels, taking leadership roles in improving the teaching and learning environment at the University, and exploring deep issues in advanced learning technology in his research career. For all his efforts, Jim was awarded the Province of Saskatchewan Centennial Medal in 2006, which “recognizes individuals who have made significant contributions to society and honours outstanding achievements”.

Jim grew up on a farm near Weyburn, Saskatchewan, completed high school at St. Peter’s College in Muenster, Saskatchewan, and came to the University of Saskatchewan (UofS) in 1970 where he completed his B.Sc. in Mathematics in 1973 and his B.Ed. in Mathematics Education in 1976. He taught high school in Saskatoon, Saskatchewan, from 1974 to 1976, and then in Lethbridge, Alberta, until 1982. In 1982, in a life-transforming move, he and his wife Marianne, with their young family in tow (son Phil and daughter Erin), upped stakes and headed off for further education and new careers. The first stop was back at UofS, where Jim completed an M.Ed. in Mathematics Education in 1984 and an Advanced Certificate in Computational Science. After that they were off to the University of Texas at Austin, where Jim earned both an M.S. in Computer Science and a Ph.D. in Computer Science Education. In 1987 Jim and Marianne came back to UofS again, where Jim joined the Department of Computational Science (now Computer Science) as a postdoctoral fellow, working with Gord McCalla. Together, Jim and Gord established the Laboratory for Advanced Research in Intelligent Educational Systems (ARIES), a lab that went on to carry out world class research in advanced learning technology for the next three decades.

Jim soon graduated from the postdoc into a faculty position in Computer Science, a position he held for the rest of his career. In his professorial role he taught a wide variety of classes at all levels of the curriculum and took on a constant stream of graduate students. He performed both of these roles with distinction, winning the UofS Master Teacher Award in 1998 and the UofS Distinguished Graduate Supervisor Award in 2005. Jim was also a talented administrator. He was involved in a variety of committees at the Department, College, and University levels, and he frequently carried out lots of unsung, behind-the-scenes administrative duties. His style was collaborative, always open to diverse perspectives and generous in sharing credit. Quite literally, he put the word “collegial” into “Collegial Committees”. Inevitably, in 2000, Jim took on the responsibility of Computer Science Department Head, a position at which he excelled.

During his time as Head, the Department’s faculty complement grew by some 25% and the staff numbers tripled. Jim also presided over the move of the Department to “new digs” in a heritage building on campus, an innovative redeployment of one of the oldest buildings on campus to serve one of the newest Departments. Jim also knew that creating opportunities to laugh together was a key to a productive and happy work environment. So, it was not a coincidence that during his time as Head, there was a series of innovative and elaborate “anonymous” pranks carried out in the Department, coordinated behind the scenes by Jim working with willing graduate students. One cold winter Jim’s conspiratorial team spent every weekend in January creating a new Monday surprise to lighten up the dim winter days. One of these was a large diorama placed in the main foyer of the Department, a “cone of silence”, a tent-like structure with two plastic bubbles connected by a plastic “corridor”. Under one bubble was an effigy of a poor graduate student trapped in conversation with the effigy under the other bubble representing a particularly loquacious supervisor (who for privacy reasons will be known only as GIM). Another of these was an accurate 3-D model of the Department’s office layout, with each office containing a different kind of nut (peanut, walnut, chestnut etc.), each nut in some way appropriate to the faculty member who resided there. April 1 was perhaps Jim’s biggest yearly opportunity. Undoubtedly the most elaborate April Fool’s prank he engineered was the actual disappearance of a faculty office, not just the contents, but the entire office itself. This was achieved by barricading a small area inside the door so that when the professor opened his office door all he saw was a janitor’s closet, complete with a mop and a bucket. Sometimes the pranks spilled over to conferences. At one memorable ITS conference (in 2000), the ARIES team (directed by Jim, and including Susan Bull, Gord and Julita) acted out a theatrical performance instead of giving a standard 20-min talk to demonstrate in action the process of the active learner modeling in I-Help, spontaneously incorporating prominent AIED researchers from the audience as “extras” into the “play”. At another conference, participants had to contend with a blow-up remote-controlled Stropky, the I-Help personal agent, as it roamed through the crowds at coffee breaks. It was Jim’s playfulness and humanity that helped to create a friendly and welcoming atmosphere in each community or team in which he was involved. Nearing the end of Jim’s time as Computer Science Department Head, collegiality was so strong that the Department was

able to advertise faculty positions promising candidates that they would be joining a Department with “the best climate in Canada”.

After his headship and a well-earned leave, in 2007 Jim moved full time into more senior levels of University leadership, with a mandate to encourage better teaching and learning. He became Director of the UofS Centre for Teaching and Learning as well as of the Gwenna Moss Centre for Teaching Effectiveness. Again, Jim was a leader who was able to find resources to radically grow these centres, and to develop a wide variety of activities aimed at improving teaching at UofS, but also with the goal of helping students learn how to be more successful learners in the university environment. Under his lead, his team created a program for developing skills for academic teaching for new faculty and Ph.D students and a “learning commons”, a peer-teaching initiative to support first year students in their transition into their new life at the University. He held these leadership posts until 2014, when a major reorganization of these units was implemented as part of yet another University downsizing exercise. At this point, Jim transformed again, into Senior Strategist for Learning Analytics. In this role he essentially became a free-lance evangelist for the power of “learning analytics” applied to large University databases to shed light on teaching and learning issues. Working with a small team, he carried out data mining projects for various units across campus, often finding interesting patterns and phenomena, which highlighted important changes that could be made to benefit students, faculty, staff, and the institution.

Finally, it shouldn’t be forgotten that throughout this very accomplished career, Jim remained first and foremost a family man. No matter how busy he was in his professional life he was always there with love and support for his wife Marianne, their son Phil and his wife Sheena, their daughter Erin and their grandchildren Clark, Paul, Ivy, Ada, James and Theo.

Jim’s Research Career

Jim’s research interests in AIED and UMAP were motivated by his deep commitment to learning, teaching and technology on campus. Jim’s research career can be roughly divided into 3 phases, each approximately a decade long.

In phase 1, from the mid-80’s until the mid-90’s, Jim was largely interested in how AI could inform learning technology. One focus was student modelling in support of personalized and adaptive learning systems. An important system built in this era by Jim and Gord McCalla and their students was the SCENT-3 system (McCalla & Greer, 1988) to help students as they wrote programs to solve introductory programming problems, especially problems requiring the use of recursion. At the heart of this system was a new representation scheme called “granularity hierarchies” (Greer & McCalla, 1989) that allowed possible student programming strategies to be represented at multiple levels of granularity, allowing robust diagnosis even when the system was faced with very buggy or very unusual student code. Jim also experimented with student models that supported mixed logical and stereotypical knowledge representations, an approach that supported initialization of the student model, as well as its maintenance as interactions with the student revealed more about the student’s

knowledge states (Huang et al., 1991). Another project involved using qualitative reasoning in student modelling (Baril et al., 1991), while still another explored plan recognition issues in adaptive learning systems (Greer et al., 1993). Near the end of this first era, Jim's research was influenced by the Bayesian networks trend in the student modeling community (and more generally, the trend towards probabilistic AI). Jim's take on this trend was original, combining Bayesian networks with granularity hierarchies (Collins et al., 1996). In 1991 as part of the NATO-sponsored Advanced Educational Technology workshop series, Jim and Gord directed a workshop on student modelling in Ste. Adèle Québec that spun off a book, an edited collection of papers written by attendees, that has had considerable influence (Greer & McCalla, 1994). The chapter by Holt et al. (1994) is a particularly good overview of student modelling issues of the day. Not all of Jim's research in this era was oriented around student modelling. A highly novel system, designed and built by Jim's and Gord's Ph.D. student Shawkat Bhuiyan, was PETAL (Bhuiyan et al., 1992), which made an end run around the need for student modelling by directly scaffolding students' problem solving at the "mental model" level as they learned to program recursively. PETAL was shown to be highly effective during a 6 week long control group study. Jim with his graduate student Mary Mark also created a complete ITS called the VCR tutor (Mark & Greer, 1995) that helped people program their "video cassette recorders" (an ancient device to record television shows), which typically had very complex interfaces. This tutor was also highly effective, and was demonstrated to provide its learners with statistically significant performance gains in using the VCR, a rare result for ITSs in those days. This project, in particular, led Mary and Jim to real insights as to how to evaluate ITSs, resulting in an extremely well cited paper on this subject (Mark & Greer, 1993). Mary and Jim revisited the evaluation issue as part of the IJAIED 25th anniversary special issue in Greer and Mark (2016), reflecting on the impact of their earlier paper and how the evaluation landscape had evolved in the intervening 2 decades.

In phase 2 of Jim's research career, from the mid-90's until around 2007, while still drawing on AI ideas, Jim's interests broadened as he began to concentrate on developing tools and techniques that supported learning in social contexts, powered by emerging distributed information and communications technologies, especially the web. His ideas during this phase contributed not only to AIED but also to the collaborative learning research community that was emerging in the mid-90's. One early focus of Jim's phase 2 research was peer help. The PHelpS (Peer Help System) project (McCalla et al., 1997; Collins et al., 1997) employed user modelling techniques to recommend "ready, willing, and able" workers who could help their peers overcome the problems and impasses they encountered in a workplace environment. The PHelpS "proof of concept" prototype was tested in the Saskatoon Regional Psychiatric Centre, a unit of the Canadian Correctional Service. The second project was the CPR (Cooperative Peer Response) system (Bishop et al., 1997), an early venture into open peer forums (tested in UofS courses). These two systems were eventually combined into an "intelligent helpdesk" (Greer et al., 1998) to support university courses, with the combined system designated as "I-Help" (a name that preceded the appearance of Apple's nomenclature of "iAnything"; the system was later relabeled as "iHelp" to express Jim's love of Apple computers). The I-Help system inspired

many new ideas and deeper explorations of specific issues. One of these (following up his earlier work on Bayesian networks) was inspectable Bayesian open student models, to allow potential peer helpers/helppees to inspect each other's attributes when deciding whether to give/accept help from a particular peer (Zapata-Rivera & Greer, 2000, 2004). Another was a multi-agent architecture that assigned a personal agent to each learner that could act on behalf of that learner as well as incorporating agents that carried out system functions (Vassileva et al., 1999; Vassileva et al., 2003). The notion of "active learner model" emerged from I-Help as well, where "model" (interpreted as a verb) meant an active computation (not a pre-existing knowledge structure) carried out as needed in the context of its end use (McCalla et al., 2000). Several influential papers overviewing the I-Help system and the lessons learned were produced at the time (Greer et al., 2001; Bull et al., 2001). Later, as part of the 25th anniversary special issue of IJAIED, a longer term retrospective looked back on how this system transformed all of our thinking in the ARIES laboratory (Vassileva et al., 2016). Jim, of course, worked on much other research in this era drawing on the new technologies of the time, including work on managing learning object repositories (Brooks et al., 2005), pedagogical planning using learning objects (Mohan et al., 2003), student modelling in the semantic web (Winter et al., 2005), and the generation of instructional hypermedia using the APHID system (Thomson et al., 2000). Jim was also interested in technical issues, such as how to scale up user modelling systems (Brooks et al., 2004) and social impact issues, especially the huge importance of guaranteeing a learner's privacy and enhancing trust even in situations where learner models were open and inspectable (Anwar et al., 2006; Anwar & Greer, 2011).

In phase 3, from around 2007 onwards, Jim began to focus more and more on the real world impact of advanced learning technology. He wanted to build systems that were effective in the real world of teaching and learning (especially at universities). But, following up his privacy and trust interests, he was also worried about how advanced learning technologies could be misused and abused in the same real world. He and his students were part of a multi-institutional international research effort (the OpenCast Matterhorn project) to capture videos of classroom lectures and automatically annotate them for later use by students (Thompson et al., 2008). While machine learning and other AI technologies were used in this work leading to publications in the AIED literature (Brooks et al., 2009), Jim and his collaborators published mostly in more general computing and education conferences like E-Learn (Barokas et al., 2010) and Computers and Education (Brooks et al., 2014a). Jim's research also began to lead him inexorably to the power of learning analytics. He was an early member of the SoLAR learning analytics research community and began to publish papers in the new Learning Analytics and Knowledge (LAK) conference (Brooks et al., 2011) and to write papers in edited collections focused on the topic (Brooks et al., 2014b). In his new position as Director of Learning and Teaching at UofS (not coincidentally coincident with phase 3 of Jim's research career) Jim also saw the potential of learning analytics to be applied to the University's databases and other electronic information to inform teaching and learning at the UofS. Numerous projects were initiated, showing the usefulness of mentorship to early career academic success, demonstrating the value of early interventions

in overcoming student learning problems, gaining insights into faculty attitudes to teaching and learning, shedding light on issues in student recruitment and retention, and so on. These studies did sometimes reflect back into the scholarly literature (e.g. Greer et al., 2016; Macfadyen et al., 2017). And his work sometimes did result in the development of novel systems to support teaching and learning at the University, such as the SARA personalized student advising system (Greer et al., 2015) or ClassApp (Orji et al., 2018a), that were of direct interest to the advanced learning technology research community. But, in general his work was mainly targeted at University decision-making. Jim was extremely proud of this kind of practical spin off from his efforts, as he relentlessly promoted the transformative value of learning analytics around campus. This is not to say that Jim lost interest in scholarly research. Even very late in his career he was still co-supervising graduate students, right up to the end. Some of this research has now come to fruition, resulting in publications targeted at conferences like Persuasive (Orji et al., 2018b) and UMAP (Orji et al., 2019). Jim is even a posthumous co-author of a paper (with Julita Vassileva and Rita Orji) in the AIED journal, in this his own Festschrift (Orji et al., 2021)!

Over the 30 years of his research career, working with graduate students and colleagues, Jim built a stellar research record. He was the author or co-author of some 150 papers in fully refereed international journals and conference and workshop proceedings (a number that is still growing as his students and colleagues continue to explore directions initiated with Jim). Jim also took a leadership role in his research communities, serving as President of the AIED Society from 2005–2007; Chair of UM Inc., the coordinating organization for the user modelling community, in the early 2000's; Program Chair of the international AIED conference in 1995; General Chair of the AIED conference in 2007; General Chair of the User Modelling conference in 1999; and Co-Director of the NATO-sponsored Advanced Research Workshop on Student Modelling in 1991. He helped to organize many research workshops in leading edge areas. He was a member of over 100 conference program committees and joined the editorial boards of a number of international journals in both the advanced learning technology and user modelling areas. However, Jim will be most remembered for his mentoring role, not only by the dozens of graduate students he supervised or co-supervised at the UofS, but also by numerous researchers in AIED and UMAP from all over the world. As the papers in this Festschrift illustrate first hand, many researchers, now established and well recognized, tell stories of how inspirational and supportive Jim was, especially at the beginning of their research careers.

The Papers in the Festschrift

There are a total of 24 papers in this special issue. They touch on many issues in advanced learning technology and adaptive systems, so any kind of categorization inevitably hugely simplifies the contributions of each paper. However, it is traditional to try to put some sort of order on the papers in a special issue, so we have decided to roughly divide them into 5 categories based on Jim's major research interests: (i) learner modelling and personalization; (ii) evaluation; (iii) peer learning,

collaboration and the social dimension; (iv) privacy; and (v) learning analytics and educational data mining.

The papers are split between two issues of the International Journal of Artificial Intelligence in Education. Issue 3 of volume 31 of the journal contains the first 11 papers on the topics of learning modelling and personalization; and evaluation. Issue 4 of volume 31 contains the next 13 papers on the topics of peer learning, collaboration and the social dimension; privacy; and learning analytics and educational data mining.

Learner Modelling and Personalization

There are 7 papers that we've placed into the "learner modelling and personalization" category, a key interest of Jim throughout his entire career.

The first of these papers is by Valerie Shute, Ginny Smith, Renata Kuba, Chih-Pu Dai, Seyedahmad Rahimi, Zhichun Liu and Russell Almond and is entitled "The Design, Development, and Testing of Learning Supports for the Physics Playground Game". The first author, Val Shute, a longtime friend of Jim, outlines her motivating axiom in developing advanced learning technology, one that Jim would have fully agreed with: "How can we accurately measure student learning (in real time, at various grain sizes, and as transparently as possible) of targeted knowledge and skills, and then use that information to provide personalized support for further development?" This paper is a study of the impact of various supports for learning in the "serious" game Physics Playground. In particular it shows how an effective and engaging system to support learning isn't created instantly in an inspired moment but is instead the result of an iterative process of design, development and testing cycles leading to insight about what works (and doesn't) in each cycle and further refinement in the next cycle. The paper concludes that "... accurately modeling and supporting all kinds of learners using engaging, interactive environments is Jim Greer's lovely legacy to us all."

The second paper in this section is by Diego Zapata-Rivera and is entitled "Open Student Modeling Research and Its Connections to Educational Assessment". Diego was a Ph.D. student supervised by Jim in the late 1990's and early "noughties", a person who Jim continued to interact with for the rest of his life. During his Ph.D. program Diego worked with Jim on open and inspectable Bayesian student models, and Diego didn't forget this heritage when he joined the Educational Testing Service and his interests moved more generally into assessment. Diego is now a Distinguished Researcher at ETS and this paper shows how open student modelling "has inspired and continues to inspire a line of research on innovative assessments and the design and evaluation of score report systems that are used to share assessment/student modeling information with various educational stakeholders to support learning". Jim would have been pleased that ideas evolving from research two decades ago are now being used to inform not just researchers in advanced learning technology but also "teachers, students, parents, administrators, [and] policy makers".

The third paper in the learner modelling category is by Sandra Katz, Patricia Albacete, Irene-Angelica Chounta, Pamela Jordan, Bruce McLaren and Diego

Zapata-Rivera and is entitled “Linking Dialogue with Student Modelling to Create an Adaptive Tutoring System for Conceptual Physics”. The authors are centered at the Learning Research and Development Center at the University of Pittsburgh, but there are also authors from Carnegie-Mellon University, the University of Duisburg-Essen, and the Educational Testing Service. Many of the authors knew Jim well, and Diego Zapata-Rivera, as mentioned above, was Jim’s former Ph.D. student. The paper concurs with Jim’s strongly held view that adaptivity to individual differences (captured in student models) is a crucial element for effective learning technology. The paper examines the role of student modelling in a system called Rimac that supports tutorial dialogues about physics. Two classroom-based studies of Rimac were carried out. One study showed that a version of Rimac with static student models (initialized using pretest scores) outperformed a version without student models for high prior knowledge students. The other study showed that a version of Rimac in which the student models were dynamically updated during the learning process outperformed the static student model version for both high and low prior knowledge students.

The fourth learner modelling and personalization paper is by Phil Winne and is entitled “Open Learner Models Working in Symbiosis with Self-Regulating Learners: A Research Agenda”. Phil Winne had many interactions with Jim stretching back nearly 30 years, perhaps the highlight being the support Jim (and the ARIES Laboratory more generally) provided for the NATO Advanced Research Institute on Syntheses of Instructional Science and Computing Science for Instructional Computing Systems, which took place in Calgary, Alberta, in July 1990, directed by Phil and Marlene Jones. This research institute was an intense 2 week gathering at the University of Calgary campus explicitly aimed at forging interdisciplinary bonds between instructional scientists (usually based in Education faculties) and computer scientists working on advanced learning technology. Jim, himself, had feet in both camps, of course, so was very enthused about how well the interactions went. Jim would also have been enthused about Phil Winne’s paper in this Festschrift, which focuses on three issues that were of deep interest to him: open modelling, metacognition, and learning analytics to inform both the learners and the learner models. In particular Phil argues that learner models should try to capture the learning processes of learners by analyzing the trace data they leave behind, which will allow feedback to be provided to the learners about these learning processes so they can self-regulate how they learn. Learner modelling to support such metacognition is an increasingly hot topic in AIED, although there is much yet to explore. Still, as Phil concludes, “[s]ystems that gather trace data and future work to make use of those data will position the field to make advances building on the innovative work of early pioneers in open learner modeling”. One such pioneer was Jim Greer.

The fifth paper fits in the learner modelling and personalization category but also partly in the collaboration category. It is by Susanne Lajoie and is entitled “Student Modeling for Individuals and Groups: The BioWorld and HOWARD Platforms”. This paper synthesizes a 25-year effort by Lajoie and her colleagues looking into how to support learning in medical domains. Jim spent parts of two sabbatical leaves in Montréal, a good fraction of the time in Susanne Lajoie’s ATLAS (Advanced Technologies for Learning in Authentic Settings) lab. Jim and Susanne were very

close friends, and shared a respect for the deep synergies possible between social science and computer science perspectives in building effective advanced learning technologies. In this paper, Lajoie discusses Jim Greer's influence on her research, focused through two systems: Bioworld and HOWARD. Bioworld is aimed at individual learners and uses student modelling fueled by educational data mining to understand aspects of the clinical reasoning of medical students. HOWARD is an environment that supports medical students who are learning in small groups, and uses learning analytics to help teachers interpret group learning behaviour. It is interesting to note that Jim himself collaborated on early versions of the Bioworld system while he was on his first leave in Montréal in 1995.

The sixth paper in this section is by Susan Bull, and is entitled "Jim Greer's 25-Year Influence on a Research Programme on Open Learner Models". Susan Bull is a pioneer of open learner modelling research and has been consistently one of the leaders in this area in both AIED and UMAP. Susan spent 2 years as a research associate in the ARIES laboratory from late 1999 to 2001, and thus worked closely with Jim. At the same time Julita Vassileva had just become a new faculty member at UofS, so it was a time of great creativity and energy. A main focus of the lab was iHelp, which by that time had evolved into a "production system" being deployed in computer science classes. iHelp, though, was also a very rich learning environment that stimulated many interesting new ideas and techniques. Susan played a prominent role in opening up the iHelp learner models. In this paper, Susan goes well beyond iHelp, though, to look at Jim's ongoing commitment to open modelling from that time on, and his major influence on this increasingly important sub-area of AIED.

The last paper in the learner modelling and personalization section is by Chris Brooks, Rebecca M. Quintana, Heeryung Choi, Chris Quintana, Timothy NeCamp and Joshua Gardner and is entitled "Towards Culturally Relevant Personalization at Scale: Experiments with Data Science Learners". Chris Brooks was one of Jim's last Ph.D. students (co-supervised by Carl Gutwin). Although Chris formally defended his Ph.D. thesis in 2012, he had been actively involved in a wide assortment of ARIES lab projects in a diversity of roles from the time he was an undergraduate at UofS in the late 1990's. Jim and Chris continued to stay in close contact, even as Chris embarked upon his own academic career at the University of Michigan, where the research reported in this paper was centered. The paper is about supporting learning in courses with a diverse global student body, in particular examining the effects of providing personalized support to students taking a course that is part of a broader data science program. The personalization was based on the country from which the student accessed the course, and studies were done as to how this personalization affected both the learners' motivation and learning.

Evaluation

Papers in the second category of Jim's research interests are oriented around evaluation issues, of students, of systems, and of pedagogical instruments. We have placed 4 papers in this section.

The first of these is by Vivekanandan Suresh Kumar and David Boulanger and is entitled “Automated Essay Scoring and the Deep Learning Black Box: How are Rubric Scores Determined?”. Vive was a Ph.D. student in the late 1990’s, co-supervised by Jim Greer and Gord McCalla. As Vive explains in the paper Jim was not only an inspiration to him during his Ph.D. but also in the years to come. He recounts a particularly vivid discussion with Jim about the potential of learning analytics to support education and the possibility of providing insight even with access only to “small data”. In the paper Vive and his co-author David Boulanger have followed this up as they investigate the issue of automated scoring of student essays. Deep learning and various natural language processing techniques were applied to essays from a 2012 automated student assessment contest to see if they could predict the fine-grained rubric scores assigned to these essays by human raters. The techniques achieved success “well beyond the agreement level between ... two human raters” grading the same essays. The paper provides an extensive analysis of the techniques as they affected each rubric and discusses the prospects for automatically grading essays through predicting rubric scores that would allow clear explanations to be provided to students as to why they received the grade they did. Although this paper is not about evaluation of AIED systems it is focused on how to automatically evaluate student work in ways comprehensible to the student.

The second paper in the evaluation section is by Josu Arruarte, Mikel Larrañaga, Ana Arruarte and Jon A. Elorriaga and is entitled “Measuring the Quality of Test-based Exercises based on the Performance of Students”. Ana Arruarte and Jon Ander Elorriaga spent the winter of 1993 as visiting Ph.D. students in the ARIES laboratory where they were welcomed “warmly ... in the cold Saskatoon winter”. This visit initiated long term interactions between the ARIES laboratory and the University of the Basque Country, including future visits of other students and researchers to ARIES and a return visit by Jim to San Sebastian in conjunction with ITS-02 (where he nearly won a bull in a raffle at a country fair and was beginning to wonder how he would get it back home to Saskatchewan!) In this paper for the special issue a visual learning analytics tool called TEA is introduced for evaluating the quality of test-based exercises, both at the item level and at the overall test level, to be used by teachers in determining the quality of their tests. Systems that can inform actual teachers in real educational settings about important aspects of their interactions with students are exactly the kind of systems that Jim would have found compelling.

The third paper in the evaluation section is by Amin Mousavi, Matthew Schmidt, Vicki Squires and Ken Wilson and is entitled “Assessing the Effectiveness of Student Advice Recommender Agent (SARA): The Case of Automated Personalized Feedback”. The authors are all from the University of Saskatchewan, and although from Education not Computer Science, they had frequent interactions with Jim due to his university-wide proselytizing for learning analytics later in his career. The paper is a study of whether the personalized feedback provided by the SARA Student Advice Recommender Agent (mentioned above) to students in an introductory university biology course is effective. A main goal of the paper is to examine various statistical methods for matching students to provide appropriately balanced comparison groups for the study. Jim would have been very encouraged to see that SARA, a system that

he helped to design and build, was being used and studied, and yielding interesting insights into the evaluation methodology of personalized learning systems – a long term goal of Jim and his former student Mary Mark.

The last paper in the evaluation section is by Ben du Boulay, and is entitled “Jim Greer’s and Mary Mark’s Reviews of Evaluation Methods for Adaptive Systems: A Brief Comment about New Goals”. Ben is one of the “thought leaders” in AIED and had many discussions with Jim over the years at conferences and elsewhere, on matters profound and, one assumes, occasionally, not so profound. In this insightful paper, Ben steps beyond Jim Greer’s and Mary Mark’s landmark 1993 IJAIED evaluation paper and their follow up paper in the 2016 IJAIED 25th anniversary special issue to look at new issues for evaluating adaptive learning systems, as these systems must be “orchestrated” to work in complex real-world situations. Issues involve being able to measure factors beyond content such as “the learner’s appetite for further learning”, and orchestration factors, such as “the balance of activity, cooperation and agency between the human teacher and the adaptive systems, as well as between the learner, the systems, the teacher and, indeed, other learners”.

Peer Learning, Collaboration, and the Social Dimension

From the time of PHelpS onwards, Jim was deeply interested in peer learning, collaboration, and the social dimension of learning. We have slotted 3 papers into this category.

The first paper in this section is by Amna Liaqat, Cosmin Munteanu and Carrie Demmans Epp and is entitled “Collaborating with Mature English Language Learners to Combine Peer and Automated Feedback: A User-Centered Approach to Designing Writing Support”. Carrie Demmans Epp was a member of the ARIES laboratory, completing her M.Sc. thesis focused on open learner modelling in a pronunciation tutor in 2010 under Gord McCalla’s supervision. Now a faculty member at the University of Alberta, Carrie and her students are continuing to pursue research into open learner modelling and language learning, as their paper in this Festschrift shows. The paper describes two studies of mature English Language Learners (ELLS), recent immigrants to Canada. The first mixed methods study analyzed how the ELLs performed writing tasks and the role of peer review of each other’s work. The second study was carried out with a subset of the same ELLs using participatory design methodologies to identify characteristics needed in a socio-technical environment to support mature language learners. Jim would have been particularly impressed with the paper’s commitment to a wide variety of empirical methods, and its strong argument for peer review and the value of creating platforms supporting peer review that include open learner modelling.

The second paper in this section is by H. Ulrich Hoppe, Dorian Doberstein and Tobias Hecking from the COLLIDE laboratory at the University of Duisburg-Essen and is entitled “Using Sequence Analysis to Determine the Well-functioning of Small Groups in Large Online Courses”. The COLLIDE laboratory has a focus on collaborative learning. Longstanding mutual interests between COLLIDE and ARIES (e.g. in peer-matching) resulted in strong friendships and flow of ideas over

the years at conferences and workshops. This paper shows how it is possible to analyze coded logs of the interactions among collaborative learners working in small groups to discover interesting characteristics about how a group is functioning. These can then be used to provide pedagogically helpful feedback and scaffolding. The approach is based on sequence alignment techniques, originally explored in the context of DNA sequencing in bioinformatics. Jim would have been very interested in this paper because of his understanding of the value of collaborations among students, but also because he consistently advocated that AIED researchers should be adventurous in drawing on the very latest technologies, the value of which this paper clearly illustrates.

The third paper in this section is by Fidelia Orji, Julita Vassileva and Jim Greer and is entitled “Evaluating a Persuasive Intervention for Engagement in a Large University Class”. Julita and Jim met at UM-94 in Cape Cod and he kindly mentored her in eating lobsters at the conference dinner. The friendship struck then lasted for nearly a quarter of a century, and brought Julita to Canada and the ARIES lab as a postdoc in 1997 and later as a faculty member at the UofS. Of course, it may seem a little odd that Jim is a co-author of a paper in a special issue dedicated to his memory. However, this paper has its roots in Fidelia Orji’s M.Sc. thesis research, co-supervised by Julita and Jim, in which Jim played an active and important role up until his untimely passing. The paper presents the results of a fairly large scale, semester long field study of the persuasive effect of three socially-oriented persuasive strategies: social influence, social comparison and competition on student engagement with the learning materials in a university class. Persuasive strategies are inspired by theories from social psychology and have been widely and successfully applied to change user behaviour in the areas of eCommerce, public health, safety, etc. In this work, the persuasive strategies were implemented as simple social visualizations, combined with the personalized advice of the SARA system, the focus of another paper in this special issue. Needless to say, Jim would be pleased that the results of the study opened new research directions into inexpensive and domain-independent ways to engage students in online learning activities. He would have been even happier to see that Fidelia’s M.Sc. research came to a successful conclusion, that Fidelia herself continued on to her Ph.D. under Julita’s supervision, and that she recently won the Vanier Scholarship, the most prestigious Ph.D. scholarship in Canada.

Privacy

Jim’s concern about privacy issues deepened over time in lock step with his increasing confidence that user modelling and data mining would have a powerful impact on the world. In one conversation with Jim (probably in the mid-1990’s) he recounted a “light bulb” moment where he had realized as he made a recent car purchase that the car dealer could have sold him a very expensive car if he had known details of Jim’s interests and motivations, and in fact that a good salesperson could sell a person almost anything if they had just the right knowledge about that person. In other words, Jim starkly saw the potential “dark side” of user modelling, and the

critical importance of ensuring user privacy even in a personalized system. There are 2 papers in the privacy category in the special issue.

The first paper with a focus on privacy is by Rita Yusri, Adel Abusitta and Esma Aïmeur and is entitled “Teens-Online: A Game Theory-based Collaborative Platform for Privacy Education”. Esma Aïmeur met Jim when attending her first conference in the AIED area, ITS-96, in Montréal. As he did with any new researcher, Jim went out of his way to welcome her to the community, something she greatly appreciated. Over the coming years the admiration turned out to be mutual. This paper describes a platform that supports privacy awareness among teens, while at the same time (somewhat paradoxically) encouraging teens to collaborate and interact with each other in discussing privacy issues. If such interactions are to be done in ways that ensure privacy and thus retain student confidence and trust, however, it is important to put teens into appropriate partnerships. The focus of the paper is a partner matching algorithm that is based on student behaviour and student knowledge needs, an algorithm that worked well in an empirical evaluation. Jim would have been very happy with this paper from a couple of angles: it does peer to peer matching (one of Jim’s long-term interests) for an interesting new purpose and it is concerned with an important issue that was dear to his heart, privacy.

The second paper in the privacy section is by Mohd Anwar and is entitled “Supporting Privacy, Trust, and Personalization in Online Learning”. Mohd Anwar was a Ph.D. student under Jim Greer’s supervision in the early to mid 2000’s, exactly the time when Jim’s concerns about privacy were starting to peak. Together, the two of them did groundbreaking work on privacy in learning domains with many influential publications. The paper in the Festschrift is in some sense a follow up to Mohd’s earlier work with Jim, as it delves into the interconnected issues of privacy, trust, and personalization. It explores three theories of privacy and three different mechanisms for ensuring privacy, with the goal of determining if privacy, trust, and personalization are desirable in online learning, and, if so, how to achieve trust and personalization without compromising privacy.

Learning Analytics and Educational Data Mining

As Jim’s career progressed, he was increasingly drawn to the power of learning analytics and educational data mining to shed light on real issues in education, both to inform systems directly supporting student learning and to inform decision makers at the institutional level. It is not surprising, therefore, that the learning analytics and educational data mining category has the most papers in this special issue: 8. The papers in this section are eclectic in their subject matter and goals, but all of them include an important role for statistical and educational data mining techniques.

The first paper in this section is by Jay Jennings and Kasia Muldner and is entitled “When Does Scaffolding Provide Too Much Assistance? A Code-Tracing Tutor Investigation”. As a new graduate student Kasia first met Jim at an AIED conference in the early 2000’s and Jim was, as usual, kind and encouraging. Some years later her research interests and his had dovetailed so well in their mutual affection for Bayesian student modelling that he ended up serving as the external examiner for

her Ph.D. thesis. It is reassuring, as Kasia notes, that even in this role he was still kind and encouraging! Jay's and Kasia's paper for the special issue is in the "traditional" AIED domain of programming (Jim's own first domain of interest). The paper is focused on the important issue of how to best support students as they trace their code. A code tracing tutor was built and used by 97 introductory programming students. Learning outcome data was kept and features of interest from log files of student behaviour were extracted. The data was analyzed using statistical techniques and unsupervised learning to cluster students, yielding insights into opportunities for future personalization of the tutor.

The next paper in this section is by Hung Chau, Igor Labutov, Khushboo Thaker, Daqing He and Peter Brusilovsky and is entitled "Automatic Concept Extraction for Domain and Student Modeling in Adaptive Textbooks". Peter Brusilovsky has for a long time been a leading researcher in both the AIED and UMAP research communities, and is one of the founders of the adaptive hypermedia sub-field. Peter and Jim had a longstanding friendship. They first met "electronically" in 1988 when Peter, then a young researcher in the Soviet Union, sent an e-mail to us in the ARIES laboratory with the exotic (to us) new ".su" domain name, one of the fruits of Glasnost and Perestroika. This paper in the special issue carries on Peter's longstanding interest in adaptive hypermedia, this time focused on textbooks that are adaptive to a learner's goals and current knowledge state. The paper presents FACE, "a supervised feature-based machine learning method for automatic concept extractions from digital textbooks" that can be used to inform both the domain and student models that are the key to an adaptive textbook. FACE has been evaluated with two goals in mind: "how well it approximates concept annotations produced by human experts and how well it supports the needs of student modeling."

The third paper in this section is by Stephanie Frost and Gord McCalla and is entitled "A Planning Algorithm to Support Learning in Open-ended, Unstructured Environments". Of course, from 1987 until his passing, Jim and Gord were close collaborators, colleagues, and friends, co-founders of the ARIES lab, and joint contributors to many research (and other) initiatives over the years. This paper in the special issue is an outgrowth of Stephanie Frost's M.Sc. research, supervised by Gord with Jim and Julita as active committee members. After her M.Sc. Stephanie went on to work in the University of Saskatchewan Teaching and Learning Centre, where Jim was not only her boss but also her collaborator on a number of new research endeavours there (including the SARA system, already mentioned several times). The paper in the special issue presents a new pedagogical planning algorithm called the CFLS planner (Collaborative Filtering based on Learning Sequences) that has been designed for an open-ended unstructured learning environment consisting of "learning objects" consumed by learners at their own discretion. Unlike in a closed course environment, in such an open-ended environment a planning system will generally not have external metadata about the learning objects and thus has to depend solely on information inferred from observed behaviour patterns of learners. To recommend a plan for a given learner the CFLS uses collaborative filtering to find a neighbourhood of other learners who have followed a similar sequence of learning objects to that followed by the learner so far, and then produces a plan based on the most successful subsequent sequence of learning objects navigated by

the learners in the neighbourhood. In a simulation study the CFLS planner worked highly effectively, even compared to a planning system that was able to use external metadata about the prerequisite structure among the learning objects unavailable to the CFLS planner. This paper is a demonstration of the possibility of providing meaningful and personalized advice to learners through inferences gleaned from student behaviour alone.

The fourth paper in this section is by Hongxin Yan, Fuhua Lin and Kinshuk and is entitled “Including Learning Analytics in the Loop of Self-paced Online Course Learning Design”. Fuhua (Oscar) Lin and Kinshuk both had longstanding connections with Jim, not only interacting over research issues but also through Jim’s role as an external advisor to the School of Computing and Information Systems at Athabasca University (Oscar’s home university and a place where Kinshuk spent many years before moving to the University of North Texas). The paper in the special issue presents a model for course design that draws heavily on learning analytics. Consistent with Athabasca University’s mandate as an open university, the paper is especially aimed at “self-paced online learning”. The paper argues strongly that learning analytics should be part of the “design loop” during course design, and provides a set of recommendations as to design strategies to use, recommendations in which diagnosis, learner profiling, continuous assessment, and adaptivity to individual differences among learners all feature prominently. Jim would certainly have been fully “on board” with these recommendations!

The fifth paper in this section is by Ramtin Yazdanian, Robert West and Pierre Dillenbourg, and is entitled “Keeping Up with the Trends: Analyzing the Dynamics of Online Learning and Hiring Platforms in the Software Programming Domain”. Pierre Dillenbourg and Jim knew each other for over 25 years, and it was always a treat to be able to observe the two of them “joust” over the issues whenever they would meet (each with their wicked sense of humour on full display) and to occasionally join in if you dared! Pierre has been a leader particularly in the area of collaborative learning, but this paper is about lifelong learning, specifically learning in professional domains. The authors have analyzed data from 4 platforms used by computer science professionals: the Stack Overflow question and answer system; Google Trends, which summarizes search trends; Udemy, which allows anybody to create a MOOC; and Stack Overflow Jobs, a job ad platform. Interesting patterns about when new topics and skills appear on each platform have been found and shed light on how new knowledge dynamically emerges within a professional community. Knowing about such patterns can allow training program creators to better track change and to provide learning support that is more attuned to the emerging needs of the profession. Jim would have been excited about the potential of this kind of broad and deep mining of real-world data to shed light on important issues in lifelong learning.

The sixth paper in this section is by Hamid Mahrooeian and Ben Daniel and is entitled “Is New Zealand’s Higher Education Sector Ready to Employ Analytics Initiatives to Enhance its Decision-making Process?” Ben Daniel joined the ARIES laboratory as an interdisciplinary Ph.D. student in the early 2000’s. Ben was initially recruited to UofS by Jim when the two met at a conference in Japan in 1999. Ben did not end up being supervised by Jim (Gord McCalla and Rick Schwier acted as

co-supervisors), but Jim was a very active member of Ben's committee and the two of them had many deep and interesting interactions during Ben's Ph.D. program and his early post-Ph.D. career in Saskatoon. Ben moved on to the Higher Education Development Centre at the University of Otago in New Zealand, where he is now Head. In their contribution to the special issue Ben's former Ph.D. student Hamid Mahroeian and Ben have analyzed how research intensive higher education institutions in New Zealand utilize learning analytics to support their decision making. The paper draws conclusions about where these institutions use learning analytics (largely for monitoring operational activities) and, more interestingly perhaps, where they do not (for improving the quality of teaching and learning and strategic decision making). The paper also examines the obstacles preventing the deeper and broader use of learning analytics by these institutions, likely similar obstacles facing such institutions around the world. This is the kind of real world study that Jim as Director of the University of Saskatchewan Teaching and Learning Centre would have fully supported should it have been proposed to him in a Canadian context.

The seventh paper in this section is by Yizhou Fan, Wannisa Matcha, Nora'ayu Ahmad Uzir, Qiong Wang and Dragan Gašević and is entitled "Learning Analytics to Reveal Links Between Learning Design and Self-Regulated Learning". Dragan Gašević and Jim first met as members of the LORNET Canadian national research network of excellence exploring deep issues in advanced learning technology. After LORNET ended in 2008 both began to be increasingly attracted to the power of learning analytics to be a major game changer in learning and teaching, and Dragan soon went on to become one of the leaders of the then nascent learning analytics field. In this paper three learning analytics techniques (cluster analysis, process mining, and epistemic network analysis) have been applied to a dataset collected from a MOOC offered on a Chinese MOOC platform to teachers on the topic of teaching in flipped classrooms. The goal of the research was to shed light on the relationship between learning design and learning tactics, and in particular to investigate the possibility of improving learners' self-regulated learning skills in their choice of learning tactics. A number of interesting patterns were discovered distinguishing the learning tactics of groups of learners clustered by their academic performance. Jim's former life as a high school teacher and his later life as Director of the UofS Teaching and Learning Centre gave him much personal experience in learning design and its issues. Thus, this paper's novel use of learning analytics to explore learning design and learning tactics would have been of great interest to him.

The eighth paper in the learning analytics and educational data mining section is by Alicja Piotrkowicz, Kaiwen Wang, Jennifer Hallam and Vania Dimitrova and is entitled "Data-driven Exploration of Engagement with Workplace-based Assessment in the Clinical Skills Domain". Vania and Jim knew each other well. Both long time leaders in AIED, they shared a mutual interest in applying AIED methodologies to the problems of supporting learning in real world educational environments. This paper is focused on the training of medical students, particularly the workplace-based assessment of the students' clinical skills during their placements. A set of features were developed for analyzing data collected during the medical students' workplace-based assessments, and process mining and text analytics were used to provide insights about student engagement and medical education practice. More

generally the paper demonstrates the possibility of learning analytics to be useful in “lifelong” learning contexts that are practice-based and that stretch over years.

Some Final Remarks

It is clear that Jim has had a strong and lasting impact on artificial intelligence in education and on advanced learning technology and adaptive systems more generally. The large number of papers in the special issue (24), and the even larger number of authors (73), is some proof of that. Moreover, the diversity of topics covered by these papers, drawing on ideas from all corners of Jim’s multi-faceted interests, is an indication that Jim’s influence has not only been deep but also broad. Many of the authors are former members of the ARIES laboratory: graduate students, research associates, colleagues, or visitors who sojourned for considerable periods in ARIES. These researchers have gone on to forge their own independent research careers. Many other authors with no direct connection to the ARIES laboratory, apart, perhaps, from occasional visits, have clearly been directly influenced by Jim’s ideas or his inspiration. Jim would have been pleased by the fact that in addition to the authors he knew personally, there are so many authors he did not know who, nevertheless, have been involved in research projects he would have found interesting. Further, he would have been pleased that so many of the co-authors of papers in this special issue are students or other young researchers. Jim’s encouragement of young researchers was perhaps his most enduring and most endearing characteristic. That the torch he lit is being passed to new generations of researchers would have been his proudest accomplishment, and will be his most lasting legacy.

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