review article
received: 2010-06-14

UDC: 796.01

BIRTH, GROWTH, AND CHALLENGES OF "KINESMETRICS" IN THE USA

Weimo ZHU [1]

[1] University of Illinois at Urbana-Champaign, Department of Kinesiology & Community Health, 205 Freer Hall, MC-052, Urbana, IL 61801, USA.

e-mail: weimozhu@illinois.edu

ABSTRACT

The term "Kinesmetrics" was coined by Weimo Zhu in 1999 when he created a new doctoral program at the University of Illinois at Urbana-Champaign (UIUC), USA, with a focus to "develop and apply measurement theory, statistics and mathematical analysis to the field of Kinesiology." Since then, a number of Ph.D. scholars in Kinesmetrics have been trained at UIUC, which also regularly hosts visiting scholars from all over the world. In fall 2008, a new Kinesmetrics program was established at the Middle Tennessee State University by Minsoo Kang, a UIUC Kinesmetrics Ph.D. graduate, and the International Forum of Kinesiometrics was held at the University of Primorska in Koper, Slovenia, in 2009. Meanwhile, Kinesmetrics scholars/programs in the USA are experiencing many challenges, e.g., reduced faculty positions, limited funding resources, a variety of data characteristics and measurement issues due to the interdisciplinary nature of Kinesiology, etc. After a brief review of the historical background and foundation of Kinesmetrics, this paper focused on the current challenges faced by Kinesmetrics, as a subdiscipline within Kinesiology, and how these challenges can best be addressed. Future directions of Kinesmetrics were also outlined.

Keywords: kineziometrics, development, new program, challenge

ROJSTVO, RAST IN IZZIVI "KINEZMETRIKE" V ZDA

IZVLEČEK

Termin "kinezmetrika" (ang.; slo. kineziometrija) je leta 1999 skoval Weimo Zhu, ko je ustanavljal nov doktorski študij na Univerzi v Illinoisu (University of Illinois at Urbana-Champaign, UIUC) v ZDA s ciljem razviti in uporabiti merilno teorijo, statistiko in matematično analizo na področju kineziologije. Od tedaj se je na UIUC izobrazilo mnogo doktorjev kinezmetrike. UIUC tudi redno gostuje znanstvenike s celega sve-

ta. Jeseni 2008 je Minsoo Kang, ki je doktoriral iz kinezmetrike na UIUCC, ustanovili nov program kinezmetrike na državni univerzi Middle Tennessee State University. V letu 2009 pa je bil na Univerzi na Primorskem v Kopru organiziran mednarodni znanstveni sestanek Kineziometrija. Medtem so tako znanstveniki s področja kinezmetrike kot sami študijski programi v ZDA postavljeni pred mnoge izzive, kot so zmanjšano število učiteljskih mest na fakultetah, zmanjšano financiranje, različne vrste podatkov in meritev zaradi interdisciplinarne narave kineziologije, in podobno. Po kratkem pregledu zgodovinskega ozadja kinezmetrike, se članek osredotoči na trenutne izzive kinezmetrike kot veje kineziologije in na možne načine spopadanja z njimi. Prav tako poudari smernice v kinezmetriki za prihodnost.

Ključne besede: kinezmetrika, razvoj, novi program, izziv

BIRTH, GROWTH, AND CHALLENGES OF "KINESMETRICS" IN THE USA

"Whatever exists at all exists in some amount. To know it thoroughly involves knowing its quantity as well as its quality" (Thorndike, 1918, 16). This is also true in understanding human movement. To be able to measure and evaluate what is of interest in human movement is an important part of Kinesiology, a discipline or study that was initially called "physical education," then "exercise science." Kinesmetrics is a subdiscipline in Kinesiology with a focus on studying measurement and evaluation. While the term was introduced more than a decade ago, it is still unknown to many professionals in Kinesiology, especially colleagues outside of North America. The purpose of this paper is to introduce Kinesmetrics, including its birth, historical background and foundation, current status and challenges, and future directions.

BIRTH OF "KINESMETRICS"

Shortly after I took a position with the University of Illinois at Urbana-Champaign (UIUC), USA, in 1999, I decided to create a new doctoral program in measurement and evaluation. I was struggling with what to name the program. I first thought to simply call it "Measurement and Evaluation," but quickly gave that name up since it was too general. So, I did some literature searches and through those readings I realized that measurement in Kinesiology has been struggling for a unique name, as well as its own subdiscipline status, for a long time. A number of alternative names (e.g., "physical edumetrics" and "psychomotormetric"), in fact, had been proposed (Safrit, 1989). Considering "Kinesiology' is known as a general term to represent the study of human

movement and "metrics" has long been used in many disciplines as their quantitative focus (e.g., "biometrics" in biology, "econometrics" in economics, and "psychometrics" in psychology, etc.), I coined the term "Kinesmetrics." It was defined as a discipline "intended to develop and apply measurement theory, statistics and mathematical analysis to the field of Kinesiology."

The knowledge basis and the theoretical foundation of Kinesmetrics includes six categories: (a) Measurement theory, (b) Statistical/mathematical methods, (c) Research design, (d) Data characteristics and measurement issues in a subdiscipline, (e) Legal and ethical issues of measurement and research, and (f) Computers and technology. More detailed descriptions of these categories can be found in Table 1.

Table 1: Knowledge Basis and Theoretical Foundation of Kinesmetrics.

Category	**Description**
Measurement theory	Any well-developed test or measure is based on a measurement theory model. The procedures for estimating the key characteristics of the test or measure, such as validity and reliability, are dictated by the model. Each model has a unique set of assumptions and is based on a statistical or mathematical model. Mathematical and statistical theories used to derive these procedures are referred to as measurement theories. Classical test theory and item response theory are two familiar examples of such theories.
Statistical/mathematical methods	The statistical method is one of the mathematical methods, as well as one of the most important scientific approaches, used to assist researchers in describing/modeling data, drawing inferences from data, and studying causal relationships. According to their designed purposes, statistical methods can be classified as descriptive or inferential statistics; according to their characteristics, they can also be classified as parametric or nonparametric, univariate or multivariate statistics, etc. ANOVA, correlation, discriminant function analysis, regression, and structural equating modeling are just a few examples of a huge pool of existing methods.
Research design	Research design refers to the methods developed for the discovery and confirmation of causal relationships among variables. In addition to covering the general knowledge of experiments, such as single-factor, factorial, multifactoral, balanced lattice and incomplete block designs, it

Category	Description
	includes other important issues or topics involved in designing a study, such as sampling, research procedures, subject selection, and principles of analyzing data and reporting results.
Data characteristics/ measurement issues in a subdiscipline	Kinesiology is a multidisciplinary study of human movements and its major subdisciplines include physical education, exercise science, sports nutrition, physical activity epidemiology, biomechanics, exercise and sports psychology, motor behavior, athletic training, sport history, sport sociology, and sports administration, etc. Data characteristics and measurement issues are often different from one subdiscipline to another. For example, typically data collected in physical education are clustered in a hierarchical structure and many measures in exercise science experiments are taken repeatedly. To analyze these data appropriately, a good understanding of the nature of these characteristics and issues is required.
Legal and ethical issues	Decisions made, based on a test or measure, and the results of a research study have consequences on people's lives. To ensure a test is fairly designed and a research study is conducted ethically, basic knowledge about legal and ethical issues related to research and measurement is essential.
Computer/technology	Computers and technology have changed our lives, as well as measurement practices. General knowledge of computers (hardware and software), technological measurement equipment, and measurement and statistical programs are necessary for any Kinesmetrician. A good understanding of the latest technologies and their potential applications to improve measurement practices is also essential.

HISTORICAL BACKGROUND AND FOUNDATION OF "KINESMETRICS"

"The history of science is largely coextensive with the history of measurement" (Tryon, 1991, p.1). This is true for measurement practice in Kinesiology. While the term "Kinesmetrics" is relatively new, it was developed based on a long and rich history of measurement practice in the field of physical education and exercise science. In fact, according to Safrit (1989), the history of measurement can be traced back to

the late 1800s although many of the early works focused only on the measurement of physical dimensions of the human body. Tables 2 and 3 summarize some examples of early developments in applied and theoretical measurement in Kinesiology described by Safrit (1989).

Table 2: Selected Early Examples of "Applied Measurement" in Kinesiology (Safrit, 1989).

Type	**Year**	**Key Person(s)/Events**
Physical Type		
	1861	Hitchcock developed standards of age, height, and weight and of chest, arm and forearm girths
Strength		
	1870s	Sargent developed the Intercollegiate Strength Test
	1925	Rogers developed the Strength Index and Physical Fitness Index
	1948	Clarke developed cable tensiometer test
Cardiorespiratory Function		
	1905	Crampton developed the Blood Ptosis Test, the first test of cardiac function
	1920s	Schneider designed a test to determine fatigue and physical function for flying
	1931	Tuttle modified a block-step test known as "Tuttle Pulse-Ratio Test" to measure endurance and the general state of training
	1943	Brouha et al. developed the well-known Harvard Step Test
	1954	Balke developed Balke Treadmill Test
Sport Skills		
	1913	Athletic Badge Tests by the Playground and Recreation Association of America
	1924	Brace developed tests to measure fundamental skills for a specific sport
	1938	Glassow and Broer published a book devoted to skills tests and batteries
Physical Fitness		
	1954	Kraus-Weber Test was developed to measure minimal function of the low back area
	1976	AAHPERD developed the Youth Fitness Test

Type	Year	Key Person(s)/Events
	1980	AAHPERD developed the Health-Related Physical Fitness Test
	1987	Institute for Aerobic Research developed FITNESSGRAM
	1987	President's Council and Chrysler/AAU published revised version of fitness tests
	1988	AAHPERD developed Physical Best program
General Motor Ability		
	1894	Normal School of Gymnastics and Gymnastics Societies administered test battery to measure jumping, climbing etc.
	1930s	Test batteries to measure basic motor ability
Knowledge Test		
	1987	McGee and Farrow reproduced many knowledge tests in physical education in a book format.

Table 3: Selected Early Examples of "Theoretical Measurement" in Kinesiology (Safrit, 1989).

Year	Key Person(s)/Events
1947	Alexander used trend analysis for repeated measured data
1958	Feldt and McKee introduced ANOVA for reliability analysis
1972	Hale and Hale introduced two theoretical models for measuring changes
1974	Schutz introduced measures of error in motor control
1975	Disch et al. introduced and used factor analysis
1976	Safrit et al. introduced the reliability theory, including generalizability theory
1977	Safrit introduced criterion-referenced measurement theory and methods
1977	Safrit et al. introduced and used multivariate techniques for construct validity
1984	Wood and Safrit introduced a multivariate approach for test battery's reliability analysis
1985	Safrit et al. introduced sequential testing
1986	Safrit et al. introduced meta-analytic techniques
1987	Spray, along with Disch, Safrit and Wood, introduced item response theory

Role of measurement in the field

Like Exercise Physiology, Exercise/Sport Psychology, Motor Development/Learning, Sports Medicine, Pedagogy, etc., Kinesmetrics is a subdiscipline in Kinesiology. With a few exceptions (e.g., Judith Spray from ACT), most measurement specialists

work in university settings. Similar to other faculty, measurement specialists' responsibilities include teaching, research and service. In addition, most measurement specialists serve as a consultant for colleagues and students in their units in regards to research design, statistical data analysis and grant proposal preparations.

Doctoral training in measurement

To be able to serve as a subdiscipline in the field and conduct measurement related research, being able to continuously prepare and supply "new blood" into the field is a must. Training new doctoral students is therefore necessary. Fortunately, training measurement specialists also has a rich history in North America. Many well-known universities/colleges, such as Indiana University, Springfield College, University of British Columbia, University of Colorado, University of Georgia, University of Houston, University of Iowa, and University of Wisconsin, had doctoral programs to train measurement specialists. The number of active programs at a given time, however, varied. For example, only five programs, i.e., University of Wisconsin, University of Georgia, University of Houston, University of British Columbia and Springfield College, actively trained doctoral students in measurement in the 1980s. For a more historical review on doctoral training in measurement, see "a genealogy" developed by Baumgartner and Safrit (2003).

Professional organization

An active professional organization is essential for the survival and growth of any discipline. This is also true for Kinesmetrics. The Measurement & Evaluation (M&E) Council has played an active role in the development of Kinesmetrics as a subdiscipline. According to Baumgartner (2006), Measurement and Evaluation was a section within the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) structure from 1949 through 1972 and became a council in 1973. Currently, it is one of 11 councils in the American Association for Physical Activity and Recreation, which is one of the six associations in AAHPERD. In addition to organizing programs at each year's AAHPERD national convention, the M&E Council has been actively involved in many major national measurement related projects. The development and participation in the 1958 AAHPERD Youth Fitness Test, 1980 AAHPERD Health-Related Fitness Test and the revision and expansion of the AAHPERD Sports Skills Test series from 1984 to 1991 are just a few examples. In addition, the M&E Council has organized its own M&E Symposium held every 3-4 years. Starting from 1975, 11 symposiums have been held and valuable information was presented at and published from these symposiums. Baumgartner (1992) has provided a summary on the first six symposiums.

Looking back, several notable characteristics have been observed in the early development of Kinesmetrics. First, measurement was recognized as a subdiscipline a long time ago and has been an important part of Kinesiology's knowledge base. Second, measurement specialists have been well trained and active in introducing new theories and methods to the field. As an example, just four years after the theory of generalizability was introduced (Cronbach, Gleser, & Nanda, 1972), it was already being applied and promoted in Kinesiology by Safrit et al. (1976). As another example, while the item response theory (IRT) was introduced to the field more than 20 years ago (Spray, 1987), it is still considered a "new" testing theory in the field of behavior medicine (Baranowski, 2006). As a result, professionals in Kinesiology, in general, are well trained in terms of measurement and statistical knowledge and skills. Third, measurement has been a "minority" subdiscipline for a long time. Usually, there is only one, if any, measurement faculty member in a Kinesiology department. Finally, most measurement research has been of the "applied" nature and there has been a lack of our own theoretical measurement research (Safrit, 1989).

CURRENT STATUS AND CHALLENGES OF KINESMETRICS

Many changes have occurred since Safrit's review two decades ago, and the most notable changes include kinesiology's evolution into an interdisciplinary field of study, the information and technology revolutions, reducing budgets in higher education and the reduction in quality of measurement training. Many challenges have arisen because of these changes, which are briefly described below.

Kinesiology as an interdisciplinary field

For many years, "physical education" was the "big umbrella" for most professions who studied human movement. The emergence of new subdisciplines within the field in the 1970s and 80s, such as exercise physiology, sports nutrition, physical activity epidemiology, athletic training, exercise and sports psychology, motor behavior, sports history, and sports sociology, quickly changed this. Various labels have been used for this "new" field, Exercise Science, Human Movement, Human Performance, etc. to name just a few. Fortunately, "Kinesiology," the study of human movement, has become the accepted broad label (Newell, 1990). In fact, Kinesiology as a field is now in its best historical moment because of the worldwide obesity epidemic and the well-documented positive role of physical activity on health. The nature of interdisciplinary fields, however, brings three major challenges to measurement specialist in Kinesiology. First, data varies to a much greater degree than in other fields, such as in education or education psychology, in which most data are dichotomous or polychotomous. In contrast, all kinds of data formats, from dichotomous to continuous, can be found in Ki-

nesiology. Second, to be able to effectively develop an appropriate research design and analyze the data using the best fit techniques, one must understand the nature/content of a subdiscipline. To do so, a measurement specialist must know, or at least be familiar with the subdiscipline. While knowing one or two subdisciplines may not be a huge challenge, mastering so many subdisciplines within a discipline becomes very difficult to impossible. Finally, because of rapidly increasing knowledge content in the field, the competition for required courses has become intensive. The traditionally required measurement course at the undergraduate level often becomes an elective one at many universities and now few Kinesiology graduate programs provide their own graduate level measurement course.

Information and technology revolution

There is no question that information and technology have changed our lives, including the function of measurement specialists in Kinesiology. On the positive side, never before have we had such convenient access to information about new theories and methods from our spawning disciplines, such as psychometrics and statistics. In addition, it is easier now to generate and access huge, multi-dimensional data sets through the internet and super-computing which helps address problems that could not be examined before. For example, through a combination of global positioning system (GPS) and objective physical activity monitors, we were able to easily track and study a person's physical activity space to help understand the interaction between physical activity and environment and social context (Zhu, 2003). Rich data and strong computing power also provide us new approaches to explore and analyze data. Techniques like data mining (Zhu & Maxwell, 2006) and bootstrapping/computer intensive statistical methods (Zhu, 1997) are just two examples. On the negative side of the ever changing information and technology world, we have to spend considerable time to consistently learn new methods and ways to process and manage the new information and technology. Because of the development of convenient measurement and statistical software, data analyses can be completed by a few simple clicks; thus, the measurement specialist's role is also changing. Instead of running the data analyses themselves, they spend more time providing guidance on how to appropriately run and interpret the data analyses or trying to limit the "garbage in, garbage out" practice, in which individuals blindly accept what the computer says.

Reducing budget

Because of economic constraints, funding for higher education has been constantly reduced. The negative impact on Kinesmetrics has been significant. For example, when a measurement specialist retires, the position is often unfilled or replaced by a grant-

generating faculty position. As a result of this practice, three well-known doctoral programs in North America, i.e., University of British Columbia, University of Houston, and University of Wisconsin-Madison, were closed after their measurement professors' retired or left. The pressure to pursue external grants has grown so much greater that measurement specialists have to spend considerable time seeking funding and developing studies to support their own applied measurement research. As a result, limited energy and resources are devoted on theoretical research related to Kinesmetrics.

Reduced quality in Kinesmetrics training

Because of the above changes and associated negative impact, instruction and training in Kinesmetrics are reducing. Most undergraduate measurement courses are now taught by non-measurement specialists; few universities provide Kinesiology focused graduate level measurement courses; and there are fewer measurement doctoral programs available. As a result, there is an overall concern about the quality of the training of students and researchers in Kinesiology. As an example, there is widespread abuse of "$p<.05$," in which the "significance" of a study is merely based on how small a p-value was generated from a statistical software although it could be biased by the sample size employed in a study (Zhu, 2010). As another example, a recent survey of measurement practice in exercise and sport psychology found that many advanced theories and methods developed in last two decades in psychometrics or educational measurement, such as IRT, differential item function analysis, computerized adaptive testing, etc., have been ignored by the field of exercise and sport psychology (Zhu, in press).

MEETING CHALLENGES AND FUTURE DIRECTIONS

The challenges to Kinesmetrics are strong and real. Between giving up and facing/addressing the challenges, the latter is the only choice. Two quotes by Safrit below (1983, p. 10), though made over 30 years ago (note: original quotes were published in 1979), are still true today:

- What does the future hold for the measurement specialist in physical education? Is this specialist destined to serve as the corner druggist in a small town – dispensing information on available tests, writing prescriptions for the development new tests, and educating each new generation of consumers on the basics of test theory? Certainly these are worthwhile endeavors, but other dimensions of measurement also merit attention.
- Over fifty years history (note: more than 80 years now!) should be enough to convince us that the measurement theoretician outside of our field does not have sufficient interest in our measurement problems to make a significant contribution to their resolution.

Wood (1989) called for change to meet the challenges:

- Change is natural, change is necessary, and change is volatile. The challenge for the 1990s is planning and coping with change. If we fail to meet this challenge, the only applause we will hear is the sound of one hand clapping. (p. 106–107).
- Looney (1997) called for meeting the challenges by conducting "home" improvements first. Specially, she called for measurement specialists to: (a) keep exploring new measurement theories and methods, such as IRT and Rasch analysis, to get our tools up to date and varied, and (b) increase communications and collaborations with other subdisciplines within the field. Baumgartner (2007) called for more research to determine solutions to measurement problems in health and human performance. In fact, some significant efforts have been made to respond to these calls and the following are a few examples.

New measurement journal

With the leadership of Ted A. Baumgartner, a measurement journal "*Measurement in Physical Education and Exercise Science*" was created in 1997. It is now published by Taylor & Francis Ltd <http://www.tandf.co.uk/journals/hmpe>. The journal serves as an excellent scholarly resource focusing on the issues of Kinesmetrics.

New Kinesmetrics graduate programs

The first "Kinesmetrics" doctoral program was created at UIUC. The course work and learning experience was based on the six-category knowledge base and theoretical foundation described earlier, including measurement theory, statistical/mathematical methods, research design, data characteristics/measurement issues in the subdiscipline, the legal and ethical issues of measurement and research, and computers and technology. Table 4 lists some course examples in these categories. Since then, a number of Kinesmetric Ph.D. scholars have trained at UIUC and our Kinesmetrics Lab regularly hosts visiting scholars from all over the world. In fall 2008, a new Kinesmetrics program was established by Dr. Minsoo Kang, a UIUC Ph.D. graduate, at the Middle Tennessee State University.

Table 4: Examples of course in UIUC Kinesmetrics' doctoral program.

Course #	**Name and credit**
Measurement Theory (3 units)	
EPSY 520	Use of Tests in Consulting, 1 Unit
EPSY 585A	Theories of Measurement (CTT), 1 Unit*
EPSY 585B	Theories of Measurement (IRT), 1 Unit*

Course #	**Name and credit**
KIN 594	Advanced Measurement Concepts in Kinesiology, 1 Unit*
PSYC 506	Psychological Scaling: Unidimensional Methods, 1 Unit**
PSYC 509	Psychological Scaling: Multidimensional Methods, 1 Unit**
PSYC 531	Psychological Measurement in Industry, 1 Unit**
SP ED 424	Tests and Measurements in Special Education**
Statistics (3 units)	
CHLH 463	Statistical Techniques in Epidemiological Research, 1 Unit**
EPSY 581	Multivariate Correlational Tech. in Educational Research, 1 Unit*
EPSY 588	Covariance Structure and Factor Models, 1 Unit*
EPSY 590	Hierarchical Linear Modeling**
EPSY 584	Multivariate Analysis in Psychology and Education, 1 Unit*
EPSY 580	Statistical Methods in Education, 1 Unit
EPSY 582	Advanced Statistical Methods in Education, 1 Unit**
STAT 424	Analysis of Variance, 1 Unit
STAT 425	Applied Regression and Design, 1 Unit
STAT 426	Sampling and Categorical Data, 1 Unit**
STAT 428	Statistical Computing, 1 Unit
STAT 429	Time Series Analysis, 1 Unit**
STAT 458	Mathematical Modeling in Life, 1 Unit
STAT 510	Mathematical Statistics, I, 1 Unit
STAT 511	Mathematical Statistics, II, 1 Unit
STAT 525	Current Research in Applied and Computational Statistics, 1 Unit**
STAT 571	Multivariate Analysis, 1 Unit
VP 650	Epidemiology, ½ Unit
VP 524	Biostatistics, 1 Unit
Research Design/Methods (2 units)	
CHLT 578	Applied Epidemiology, 1 Unit**
EPSY 471	Evaluation Methods, 3 hours, 1 Unit
EPSY 583	Single Subject Research Design, 1 Unit**
KIN 494	Qualitative Research in Education
EPSY 577	Methods of Qualitative Research, 1 Unit
LA 564	Methods of Social/Behav. Research in Designed Environments, 1 Unit
PSYC 332	Research Methods in Social Psychology: Laboratory Method, 1Unit*
PSYC 333	Research Methods in Social Psychology: Natural Settings, 1 Unit*
PSYC 435	Mathematical Formulations in Psychological Theory, 1 Unit
SOC 480	Methods of Field Research, 1 Unit
SOC 481	Survey Research, I, 1 Unit
SOC 488	Demographic Methods, 1 Unit
SOC 582	Survey Research Methods, II, 1 Unit

Course #	Name and credit
Computers	
CS 110	Programming Laboratory (Section CP), 1 Unit**
CS 225	Data Structure and Software Principles, 1 Unit
CS 300	Data Structure for Noncomputer Majors, 2 hours (1/2 unit)**
EPSY 457	Computer Use in Education, 3 hours, 1 Unit
General Areas	
CHLH 540	Health Behavior: Theoretical Perspectives, 1 Unit
KIN 455	Quantitative Analysis of Human Motion, 3 hours, 1 Unit
KIN 459	Physical Activity and Aging, 3 hours, 1 Unit
KIN 590	Independent Study
SP ED 510	Legal Aspects of Disabilities, 1 Unit
Dissertation	
KIN 599	Dissertation research, 8 Units*

*Note. * required, **strongly recommended, 1 Unit = 3 or 4 credit hours.*

New graduate text

Edited by Wood and Zhu and contributions by a team of 22 top scholars in the field, a new graduate level measurement text "*Measurement Theory and Practice in Kinesiology*" was published in 2006. It consists of four parts (measurement basics, current issue in measurement, advanced statistical techniques, and measurement practice) and 16 chapters. It provides an update on the current knowledge basis and foundation of Kinesmetrics. As noted by Baumgartner (2007, 212), the book "just like the Safrit and Wood (1989) book, showcases measurement research. Undoubtedly, it will increase the quality and quantity of measurement research in health and human performance."

Reaching out to other subdisciplines

Between the 1st and 7th Measurement and Evaluation symposium, the topics and contents of the symposium were mainly on measurement itself. Starting from the 8th symposium in 1996, Terry M. Wood, who organized the symposium at the Oregon State University, made a significant change by inviting experts from other subdisciplines in Kinesiology to discuss the challenging measurement issues they faced and by partnering them with measurement specialists to respond to the issues. Supported by the Cooper Institute and organized by James Morrow and Steven Blair, the 9th M&E symposium went even further by focusing on a single critical measurement problem or theme in the field. Physical activity and related measurement issues were addressed at that symposium and the conference proceeding was published in a special supplement in *Research Quarterly for Exercise and Sport* (Supplement 2, Vol. 71, 2000). Work-

ing jointly with the M&E Council and the American College of Sports Medicine, the Kinesmetrics Lab at UIUC has hosted two international Kinesmetrics conferences, one focused on measurement and research issues and challenges in aging in 2003, jointly with the 10th M&E symposium, and another on walking and health in 2005. Two publications, a book (Zhu & Chodzko-Zajko, 2006) and a *Medicine & Science in Sports & Exercise* supplement (July, 2008), were generated by the conferences. The 11th M&E symposium was held again jointly with the Cooper Institute in October 2007, with a focus on the diversity in physical activity and health.

Addressing critical problems and issues in the field

Measurement specialists have also made significant efforts to address critical measurement issues. Physical fitness testing (Mood, Jackson, & Morrow, 2007; Morrow, Zhu, Franks, Meredith, & Spain, 2009; Zhu, Plowman, Park, 2010; see also a special issue in *Measurement in Physical Education & Exercise Science*, Vol. 12, Issue 3, 2008), physical activity (Kang, Marshall, Barreira, & Lee, 2009), national standard assessment (NASPE, 2008, 2010), assessing students' learning in higher education (Zhu, 2007), promoting physical activity using the latest technology (Zhu, 2008), disability (Lee, Zhu, Hedrick, & Fernhall, 2010) and diversity (Gao & Zhu, in press) are just a few examples.

Future directions

Clearly, advances in Kinesiology cannot have been made without Kinesmetrics. Meanwhile, to survive, to keep growing, and to make meaningful contributions to the field, Kinesmetrics scholars (Kinesmetricans!) need to create more doctoral programs in Kinesmetrics, improve instruction quality by taking advantage of new information technology (e.g., creating online undergraduate and graduate measurement courses), and to get involved in measurement and research issues critical to Kinesiology and society (e.g., physical activity and health, childhood obesity, fitness testing, dose-response issues, construction of better and more convenient measures, online testing, the promotion of physical activity using new technology, etc.). As Baumgartner said (2007, 215), "The possibilities for measurement research are unlimited in terms of research questions, topics and research techniques." It is a pleasure to see the concept of Kinesmetrics being picked up around the world. A program of "Kinesmetrics" was established at the Korea National Sport University and the first meeting of the *International Forum of Kinesiometrics* was held at the University of Primorska in Koper, Slovenia, May 21 and 22, 2009. Thus, Kinesmetrics is growing!

CONCLUSION

Developed based on a long and rich history of measurement research and practice in the field of Kinesiology, Kinesmetrics is a subdiscipline intended to develop and apply measurement theory, statistics and mathematical analysis to Kinesiology. While the field of Kinesmetrics has experienced ups and downs, its future should remain bright as long as kinesmetricans keep making "home improvements," collaborating with other subdisciplines in the field and being actively involved in addressing problems and issues critical to society and Kinesiology.

Acknowledgement

Some of the content of this paper was presented at the first meeting of the *International Forum of Kinesiometrics* and a recent newsletter by the M&E Council.

REFERENCES

Baranowski, T. (2006). Crisis and chaos in behavioral nutrition and physical activity. International Journal of Behavioral Nutrition and Physical Activity, 3(27), DOI:10.1186/1479–5868–3–27.

Baumgartner, T. (1992). History and background of measurement symposiums. In T. Baumgartner, & K. Wagoner (eds.), Psychomotor Measurement and Evaluation Past, Present, and Future: A Symposium in Honor of M. Jo Safrit's Retirement (pp. 1–3). Athens, GA: The University of Georgia.

Baumgartner, T. (2006). Measurement and Evaluation Council: Past, present, and future. In W. Zhu, & W. Chodzko-Zajko (eds.). Measurement issues in aging and physical activity: Proceedings of the 10th Measurement and Evaluation Symposium (pp. 137–143). Champaign, IL: Human Kinetics.

Baumgartner, T. (2007). Measurement research: Where have we been and where are we going? Measurement in Physical Education and Exercise Science, 11, 209–216.

Baumgartner, T. A., & Safrit, M. J. (2003). A genealogy of measurement specialists in physical education and exercise science. Measurement in Physical Education and Exercise Science, 7, 121–127.

Cronbach, L. J., Gleser, G. C., Nanda, H., & Rajaratnam, N. (1972). The dependability of behavioral measurements: Theory of generalizability for scores and profiles. New York: John Wiley.

Gao, Y., & Zhu, W. (in press). Differential item functioning analysis of 2003–2004 NHANES physical activity questionnaire. Research Quarterly for Exercise and Sport.

Kang, M., Marshall, S. J., Barreira, T. V., & Lee, J. O. (2009). Effect of pedometer-based physical activity interventions: A meta-analysis. Research Quarterly for Exercise and Sport, 80(3), 648–655.

Lee, M., Zhu, W., Hedrick, B., & Fernhall, B. (2010). Determining MET values of physical activities for persons with paraplegia. Disability and Rehabilitation, 32(4), 336–343.

Looney, M. A. (1997). "Home" improvement: The task for measurement specialist. Measurement in Physical Education and Exercise Science, 1, 105–116.

Mood, D. P., Jackson, A. W., & Morrow, J. R. (2007). Measurement of physical fitness and physical activity: Fifty years of change. Measurement in Physical Education and Exercise Science, 11, 217–227.

Morrow, J. R., Jr., Zhu, W., Franks, B. D., Meredith, M. D., & Spain, C. (2009). 1958-2008: 50 Years of youth fitness tests in the United States. Research Quarterly for Exercise and Sport, 80(1), 1–11.

National Association for Sport and Physical Education (2008). PE metrics: Assessing the national standards, Standard 1. Reston, VA: Author.

National Association for Sport and Physical Education (2010). PE metrics: Assessing the national standards 1-6 in elementary school. Reston, VA: Author.

Newell, K. M. (1990). Kinesiology: The label for the study of physical activity in higher education. Quest, 42, 269–278.

Safrit, M. J. (1983). Measurement and evaluation in physical education: Time to pay the piper. In L. D. Hensley & W. B. East (eds.), Proceedings of the Fourth Measurement and Evaluation Symposium (pp. 1–11). Cedar Falls, Iowa: University of Northern Iowa.

Safrit, M. J. (1989). An overview of measurement. In M. J. Safrit, & T. M. Wood (eds.). Measurement concepts in physical education and exercise science (pp. 3–20). Champaign, IL: Human Kinetics.

Safrit, M. J., Atwater, A. E., Baumgartner, T. A., & West, C. (eds.). (1976). Reliability theory. Washington DC: American Alliance for Health, Physical Education and Recreation.

Safrit, M. J., & Wood, T. M. (eds.). (1989). Measurement concepts in physical education and exercise science. Champaign, IL: Human Kinetics.

Spray, J. A. (1987). Recent developments in measurement and possible applications to the measurement of psychomotor behavior. Research Quarterly for Exercise and Sport, 58, 203–209.

Thorndike, E. L. (1918). The nature, purposes, and general methods of measurement of educational products. In S. A. Courtis (ed.), The Measurement of Educational Products (17th Yearbook of the National Society for the Study of Education, Pt. 2. pp. 16–24). Bloomington, IL: Public School.

Tryon, W. W. (ed.) (1991). Activity measurement in psychology and medicine. New York: Plenum.

Wood, T. M. (1989). Measurement and change: The sound of one hand clapping. In M. J. Safrit (ed.), Measurement Theory and Practice in Exercise Science and Sport (pp. 92–108). Bloomington, IN: OT Publishing.

Wood, T. M., & Zhu, W. (eds.). (2006). Measurement Theory and Practice in Kinesiology. Champaign, IL: Human Kinetics.

Zhu, W. (1997). Making bootstrap statistical inferences: A tutorial. Research Quarterly for Exercise and Sport, 68(1), 44–55.

Zhu, W. (2003). Assessing physical activity space: Issues and challenges. Proceedings II of 2003 Daegu Universiade Conference: Facing the Challenge (pp. 601–608). 2003 Daegu Universiade Conference Organizing Committee.

Zhu, W. (2007). Assessing kinesiology students' learning in higher education. Quest, 59, 124–142.

Zhu, W. (2008). Promoting physical activity using technology. Research Digest, 9(3), 1–6.

Zhu, W. (2010). Sadly, the earth is still round "$p < .05$". Research Quarterly for Exercise and Sport, 81(Suppl 1), A6 – A7.

Zhu, W. (in press). Measurement practice in sport and exercise psychology: A historical, comparative and "psychometric" perspective. In G. Tenenbaum, R. Eklund, & A. Kamata (eds.), Handbook of measurement in sport and exercise psychology. Champaign, IL: Human Kinetics.

Zhu, W., & Chodzko-Zajko, W. (eds.). (2006). Measurement issues in aging and physical activity: Proceedings of the 10th Measurement and Evaluation Symposium. Champaign, IL: Human Kinetics.

Zhu, W., & Maxwell, S. (2006). Analyzing data from large and small data sets. In T. Wood, & W. Zhu (eds.), Measurement Theory and Practice in Kinesiology (pp. 199–216). Champaign, IL: Human Kinetics.

Zhu, W., Plowman, S. A., & Park, Y. (2010). A primar-test centered equating method for setting cut-off score. Research Quarterly for Exercise and Sport, *8*, 400–409.