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Trachtenberg speed math and multiplication performance of Danao learners: a quasi-experimental pilot study

Rose Mary L. Almacen[1], Ronnel Victor B. Kilat[2], Lislee C. Valle[2], Romel C. Mutya[1], Dawn Iris Calibo-Senit[3], Margarito B. Callao[4], Jennifer B. Carillo[4], Rowena P. Dato-on[5], Adrian P. Ybañez[6]

[1]Office of the Campus Director, Cebu Technological University-Danao Campus, Danao City, Philippines
[2]College of Education, Arts and Sciences, Cebu Technological University, Danao Campus, Danao City, Philippines
[3]Office of the Research Director, Siquijor State College, Larena, Philippines
[4]College of Sciences and Education, Cebu Technological University, Barili Campus, Barili, Philippines
[5]Office of the Campus Director, Cebu Technological University, Daanbantayan Campus, Daanbantayan, Cebu
[6]Institute for Molecular Genetics, Parasitology and Vector-borne Diseases, Cebu Technological University, Cebu City, Philippines

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ABSTRACT

Multiplication fluency remains a persistent challenge for many Filipino learners, yet community-based evidence on low-cost supplementary interventions is limited. This study examined whether a six-week Trachtenberg speed math intervention was associated with improved multiplication performance among learners aged 8 to 13 years in three local communities in Danao City, Philippines. The study used a one-group pretest-posttest quasi-experimental pilot design conducted during a community-based numeracy intervention. Paired scores from 135 participants were analyzed using paired-samples t-tests, mean gains, 95% confidence intervals (95% CI), and within-subject effect sizes (dz). Scores increased significantly in Maslog from 27.31 to 49.82, in Sabang from 32.68 to 49.84, and in Taytay from 31.91 to 48.78 (all $p<0.001$). For the overall sample, scores improved from M=30.63 (SD=16.54) to M=49.47 (SD=18.91), with a mean gain of 18.84 points (95% CI [16.61, 21.07]), $t(134)=16.72$, $p<0.001$, $dz=1.44$. The findings suggest that Trachtenberg speed math may serve as a promising supplementary multiplication support in remedial and community settings. However, the absence of a comparison group and incomplete instrument validation require cautious, non-causal interpretation.

Corresponding Author:

Rose Mary L. Almacen
Office of the Campus Director, Cebu Technological University-Danao Campus
Danao City, Cebu, Philippines
Email: rosemary.almacen@ctu.edu.ph

1. INTRODUCTION

Multiplication fluency is a foundational component of elementary mathematics because it supports later work in division, fractions, algebra, and problem solving. Early mathematics knowledge has been shown to predict later school success, and fluency research defines competent performance as the accurate and rapid solution of arithmetic facts rather than accuracy alone [1], [2]. When multiplication facts are not sufficiently consolidated, learners must devote more effort to basic computation and may struggle to engage with higher-order tasks [1], [2]. For this reason, multiplication support remains a central concern in elementary numeracy instruction.

This concern is especially relevant in the Philippine context. Long-term evidence indicates persistent weaknesses in foundational mathematics and reading among Filipino learners, while machine-learning analyses of low-performing mathematics students point to substantial performance disparities across school sectors and learner profiles [3], [4]. Studies of Filipino elementary mathematics instruction also indicate that classroom practice can vary across curricular and implementation contexts, which makes supplementary numeracy support important for learners who require additional assistance [5]. These conditions make low-cost supplementary strategies appealing to schools and community extension programs serving learners with weak basic skills.

One possible supplementary strategy is the Trachtenberg speed math system. This rule-based arithmetic method organizes multiplication into explicit, repeatable procedures instead of relying solely on rote memorization of tables [6]. From a learning perspective, such structuring may reduce working-memory demands and support schema formation during mental multiplication, especially when learners are still developing automaticity [7]. Strategic multiplication instruction has also been shown to improve accuracy, use of advanced strategies, and flexibility among children with mathematics difficulties [8]. Taken together, these ideas provide a plausible rationale for examining Trachtenberg as a structured support method rather than as a replacement for regular mathematics instruction.

Broader multiplication-intervention research further suggests that systematic practice can improve fact recall and that different structured modalities can yield meaningful fluency gains in primary school learners [9], [10]. Such evidence is relevant to community-based programs because learners often need repeated guided practice before multiplication facts become fluent and usable in later mathematical work. However, direct community-based Philippine evidence on Trachtenberg remains limited, and little is known about how it performs as a supplementary outreach strategy for learners who already struggle with multiplication. This gap is important because interventions that are simple, low-cost, and feasible outside regular classroom instruction may be useful in community-based extension programs.

Research on arithmetic development also suggests that working memory, strategy selection, and gradual automatization influence how fluently children solve multiplication problems. In particular, arithmetic performance varies with age and strategy demands, and reduced cognitive load may support more efficient responding during multiplication [11]. Studies of alternative multiplication methods such as Japanese line multiplication, finger multiplication, formula-based multiplication, and concept-focused multiplication strategies suggest that nontraditional procedures can increase learner engagement or improve performance in selected contexts, although the evidence is often small-scale and context-bound [12]–[16].

This study is novel because it provides one of the first community-based Philippine reports examining the Trachtenberg speed math system as a supplementary multiplication intervention for learners with identified multiplication difficulties. Unlike most discussions of Trachtenberg that are instructional or theoretical, this study reports pretest-posttest evidence from three local communities and estimates both statistical significance and practical magnitude of score change. The study therefore contributes preliminary local evidence on how a low-cost, rule-based arithmetic support may be used in community extension and remedial numeracy settings. The present study addressed the local evidence gap by examining whether multiplication scores improved after a six-week Trachtenberg intervention delivered in three local communities in Danao City. More specifically, the study aimed to estimate pre-post score change, describe the magnitude of improvement, and assess the intervention's practical promise as a low-cost numeracy support in community settings.

2. METHOD

2.1. Research design and setting

This study used a one-group pretest-posttest quasi-experimental pilot design conducted as part of a university community extension numeracy intervention. The design was appropriate for estimating initial change in a real-world outreach setting, but it does not provide the level of causal control available in randomized or comparison-group designs [17], [18]. The intervention was implemented in Maslog, Sabang, and Taytay, three local administrative communities in Danao City, Cebu, Philippines. Hence, the analysis focused on preliminary change over time rather than on definitive causal attribution.

2.2. Participants and recruitment

Participants were learners aged 8 to 13 years who were identified during community outreach as having difficulty with multiplication, particularly with larger numbers. Purposive recruitment was used because the intervention was intended for children who showed an immediate need for numeracy support in the target communities. The final analytic dataset included 135 learners with complete paired pretest and posttest scores: 45 from Maslog, 44 from Sabang, and 46 from Taytay. Although the participating community

and eligible age range were documented, complete individual age distribution, sex or gender distribution, exact grade-level breakdowns, and detailed attendance histories were not systematically encoded for all participants. These omissions restricted subgroup analysis and are acknowledged as important limitations for interpreting and generalizing the findings.

2.3. Intervention procedure

The intervention was delivered across six weekly sessions as a supplementary community-based numeracy activity. The program began with orientation, house-to-house visits, and baseline testing, after which learners received guided instruction on selected Trachtenberg multiplication rules, including rules for 11, 12, 5, 6, 7, 8, and 9, followed by supervised practice and post testing in the final session [6]. The method was intended to help learners manage multiplication through consistent procedural steps rather than through memorization alone. This structure is consistent with evidence that repeated multiplication practice and explicit strategy support can improve fact recall and performance among elementary learners [8]–[10].

2.4. Research instrument

The outcome measure was a multiplication performance test administered before and after the six-week intervention. The test was developed for the community extension activity and was aligned with the multiplication skills taught during the Trachtenberg sessions, particularly rules for 11, 12, 5, 6, 7, 8, and 9. The test generated numerical scores that allowed paired pretest-posttest comparison for each learner. However, the instrument was not accompanied by formal psychometric documentation. The study did not establish internal consistency, test-retest reliability, inter-scorer agreement, criterion-related validity, or formal alignment with a standardized multiplication fluency measure. The available study documentation also did not provide sufficient detail on the complete item pool, score range, time limit, parallel-form equivalence, or scoring rubric. This is a major methodological limitation because multiplication fluency assessment ideally captures both speed and accuracy and should be supported by clear reliability and validity evidence [2]. Hence, the outcome should be interpreted as a multiplication performance score from the intervention activity rather than as a fully standardized multiplication fluency measure.

Multiplication assessment also benefits from tasks that reveal conceptual understanding rather than rote recall alone [19]. Related assessment scholarship further indicates that mathematics assessment is most useful when it captures more than end-point correctness alone and when it informs instructional decisions [20]–[22]. Diagnostic and classroom assessment studies have emphasized the value of developmentally appropriate measures, operationally sensitive tasks, and assessment systems that support improvement rather than mere judgment [20]–[22]. Because the present instrument did not include complete psychometric validation, future studies should use fully documented multiplication fluency measures that specify item structure, timing rules, scoring procedures, reliability evidence, validity evidence, and alignment with both accuracy and speed components of multiplication performance.

2.5. Data analysis

Descriptive statistics were used to summarize pretest and posttest scores by study site and for the full sample. Paired-samples t-tests were used to estimate mean change, and 95% confidence intervals (95% CI) and within-subject effect sizes (dz) were reported to support interpretation of practical magnitude. Study site was the only grouping variable consistently encoded in the analytic dataset; therefore, subgroup interpretation was limited to study-site-level pretest-posttest changes. Age-, sex- or gender-, grade-level-, baseline-proficiency-, and attendance-based subgroup analyses were not conducted because these variables were not completely available for all participants. Consequently, the analysis could not determine whether score gains differed by developmental stage, learner profile, grade placement, initial proficiency, or degree of intervention exposure. Because the dataset contained paired scores but not full instrument documentation or complete diagnostic distributions for difference scores, the analyses should be interpreted as estimates of pre-post change rather than as complete parametric validation. This caution is consistent with literature on quasi-experimental inference and threats to internal validity in one-group designs [17], [18].

The analytic caution in this study also reflects broader methodological guidance for pretest-posttest and field-based research. Experimental and quasi-experimental scholarship has long noted that minimally controlled field designs are vulnerable to alternative explanations unless comparison structures or stronger controls are present [23]. Pilot-study literature likewise cautions against overstating efficacy when design constraints remain substantial and when procedures, instruments, and implementation details are incompletely documented [24]–[26]. Guidance on pretest-posttest designs further supports careful analytic reporting and transparent interpretation of change scores [27]. For this reason, the present statistical results are interpreted as evidence of change over time rather than proof of treatment superiority.

2.6. Ethical considerations

The activity was conducted as part of a university community extension program. The Cebu Technological University (CTU) Local Research Ethics Committee approved the study. Informed consent and assent were obtained from parents or guardians and participating learners before data collection. No learner-identifying information was included in the analytic dataset.

3. RESULTS AND DISCUSSION

3.1. Pretest-posttest changes in multiplication performance

Table 1 summarizes the pretest-posttest multiplication scores for each study site and for the overall sample. Consistent with recommendations to interpret fluency outcomes using both mean change and effect magnitude [2], [19], all paired comparisons showed statistically significant increases in multiplication scores. Mean scores increased from 27.31 to 49.82 in Maslog, from 32.68 to 49.84 in Sabang, and from 31.91 to 48.78 in Taytay, with all tests significant at $p<0.001$. For the overall sample, scores improved from M=30.63 (standard deviation (SD)=16.54) to M=49.47 (SD=18.91), yielding a mean gain of 18.84 points (95% CI [16.61, 21.07]), $t(134)=16.72$, $p<0.001$, $dz=1.44$. By study site, effect sizes were also large: $dz=1.67$ for Maslog, $dz=1.59$ for Sabang, and $dz=1.19$ for Taytay. These study-site-level results represent the only subgroup analysis because other participant characteristics were not consistently encoded in the analytic dataset.

Table 1. Pretest-posttest multiplication scores by study site and for the overall sample

Study site	Pretest M (SD)	Posttest M (SD)	Mean gain	t(df)	p
Maslog (n=45)	27.31 (13.17)	49.82 (17.98)	22.51	11.22 (44)	<0.001
Sabang (n=44)	32.68 (19.48)	49.84 (19.30)	17.16	10.52 (43)	<0.001
Taytay (n=46)	31.91 (16.30)	48.78 (19.80)	16.87	8.07 (45)	<0.001
Overall (N=135)	30.63 (16.54)	49.47 (18.91)	18.84	16.72 (134)	<0.001

Note. dz and 95% CI are reported in the text; all paired-samples t-tests were statistically significant at $p<0.001$.

3.2. Interpretation of findings and relevance to education

These results indicate that the Trachtenberg sessions were associated with better multiplication performance across all three participating communities. The consistency of improvement is educationally meaningful because the gains were not limited to a single site and persisted despite differences in baseline means. This pattern aligns with evidence that structured multiplication practice can improve fact recall and that short, class-wide or small-group fluency interventions can produce measurable growth in primary learners [9], [10]. At the same time, the present findings should be interpreted as preliminary evidence of promise rather than as proof of superiority over conventional instruction.

A mechanism-based explanation is also plausible. Rule-based multiplication procedures may help learners by organizing problem solving into smaller steps, which can reduce working-memory load and support the gradual development of automaticity during mental multiplication [7]. In related work, strategy-focused multiplication instruction improved the accuracy and strategic flexibility of children with mathematics difficulties [8]. The current pattern of gains is consistent with that line of reasoning, particularly because the participants were recruited specifically for their multiplication difficulty.

The intervention may also have been helpful because it provided repeated, guided exposure to multiplication in a structured, supervised, and consistent setting over several weeks. Systematic practice programs have been shown to strengthen multiplication fact recall and sustain improvement beyond the immediate teaching period [9]. Similarly, recent research comparing peer-mediated and technology-mediated multiplication fluency supports has shown that different structured modalities can yield significant pre-post growth when learners are given regular opportunities to practice [10]. These parallels suggest that the benefit observed here may reflect the combined value of repeated practice, explicit routines, and sustained facilitator support rather than any single feature in isolation.

The study also has practical relevance beyond the immediate score gains. Multiplication fluency supports later school success and underpins learners' ability to engage more efficiently with broader mathematical tasks [1], [2]. In community and remedial settings where time, materials, and teacher support may be limited, a paper-and-pencil rule system that can be practiced repeatedly may represent a useful supplementary option. This implication is especially relevant in the Philippines, where foundational mathematics weaknesses remain a continuing concern and where classroom instruction can vary across contexts [3]–[5].

Findings from related work on alternative multiplication instruction likewise suggest that learners' responses to a method are not only cognitive but also affective. Small-scale action and classroom studies have reported increases in interest, confidence, enjoyment, or perceived accessibility when visual or embodied multiplication approaches were introduced, although such studies also identified limitations in speed, transfer, and alignment with conventional algorithms [12], [13], [15]. Early-grade conceptual work similarly emphasizes that multiplication support should help learners make sense of grouping, repeated actions, and relationships among quantities, rather than relying exclusively on table memorization [14], [16]. These findings support the need to view Trachtenberg as one possible supplementary strategy within a broader set of multiplication supports rather than as a stand-alone solution.

Several limitations require emphasis. Because the study used a one-group pretest-posttest design, the observed gains cannot be attributed solely to the Trachtenberg intervention, since testing effects, maturation, regression to the mean, increased attention from facilitators, and other time-related influences remain plausible rival explanations [17], [18]. The multiplication performance test was aligned with the intervention content, but formal psychometric documentation was not established. The study did not provide internal consistency, test-retest reliability, inter-scorer agreement, criterion-related validity, or formal comparison with a standardized multiplication fluency measure. This limits measurement transparency and requires the findings to be interpreted as changes in intervention-based multiplication performance scores rather than as definitive evidence of improved standardized multiplication fluency. In addition, only study-site-level subgroup reporting was possible because individual age distribution, sex or gender, grade level, baseline proficiency, and attendance information were not completely available for all participants in the analytic dataset. This restricts interpretability and generalizability because the study cannot determine whether gains varied by developmental stage, learner profile, grade placement, initial proficiency, or degree of intervention exposure. Future studies should therefore use comparison groups, fully documented fluency measures, complete learner-profile variables, attendance monitoring, and delayed follow-up testing before broader adoption is recommended.

Pilot studies and feasibility literature also underscore the importance of transparent reporting of procedures, instrument adequacy, and implementation feasibility in early-stage intervention work. Such literature cautions against overstating efficacy when design constraints remain substantial and argues that preparatory or pilot studies should clarify what can and cannot be concluded from the available evidence [24]–[26]. This perspective further supports the present manuscript's cautious framing of the findings as promising but preliminary. It also explains why the present paper treats the study-site-level results as descriptive subgroup evidence rather than as evidence of differential effectiveness across sites.

4. CONCLUSION

This study examined whether multiplication scores improved after a six-week Trachtenberg speed math intervention among learners aged 8 to 13 years in three local communities in Danao City. Paired pretest-posttest scores showed statistically significant gains in each study site and in the overall sample. These findings suggest that Trachtenberg speed math may be a promising supplementary numeracy support for community-based and remedial settings. However, stronger controlled studies with clearly documented and psychometrically supported multiplication fluency measures, complete learner-profile data, attendance records, and retention assessments are needed before causal, subgroup-specific, or large-scale instructional claims are made.

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The authors state that no external funding beyond institutional community extension support was specifically earmarked for this manuscript. The intervention was implemented as a university community extension activity.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Rose Mary L. Almacen	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Ronnel Victor B. Kilat		✓		✓	✓			✓		✓				
Lislee C. Valle		✓		✓	✓	✓				✓	✓			
Romel C. Mutya		✓				✓	✓			✓				
Dawn Iris Calibo-Senit		✓		✓						✓	✓			
Margarito B. Callao		✓				✓	✓			✓				
Jennifer B. Carillo		✓		✓		✓				✓				
Rowena P. Dato-on		✓		✓						✓	✓			
Adrian P. Ybañez	✓	✓		✓	✓		✓			✓		✓	✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

INFORMED CONSENT

Informed consent and assent were obtained from all individuals involved in the study, specifically from the parents or guardians of participating learners and from the learners themselves.

ETHICAL APPROVAL

The research involving human participants complied with relevant national regulations and institutional policies, in accordance with the principles of the Helsinki Declaration, and was approved by the Local Research Ethics Committee of Cebu Technological University.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [RMLA], upon reasonable request.

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BIOGRAPHIES OF AUTHORS

Rose Mary L. Almacen is the Campus Director of Cebu Technological University (CTU) Danao Campus (since 2015), and the former vice-president for student affairs of the CTU (2022–2025). As a senior academic administrator and researcher whose core interests encompass Education 4.0, management, construction, science, and applied innovation, she advances indicator systems and pedagogical frameworks to strengthen institutional preparedness, regulatory compliance, and student achievement. Her scholarly contributions include peer-reviewed publications in internationally indexed journals with over 60 citations. At the practice-and-policy level, she has served in various leadership capacities, including Chairperson for Research and Development and Chairperson for Math and Science. She currently leads projects that integrate quality management systems and innovative utility models—such as sustainable material production from agricultural by-products—into the university's strategic growth, while spearheading community-based extension programs focused on livelihood, teacher training, and mathematics education. She can be contacted at email: rosemary.almacen@ctu.edu.ph.

Ronnel Victor B. Kilat is an associate professor at Cebu Technological University and an emerging researcher with interests in AI adoption in teaching and learning innovation, community development, and research-based educational improvement. He can be contacted at email: ronnelvictor.kilat@ctu.edu.ph.

Lislee C. Valle is an associate professor at the College of Education, Arts and Sciences, Cebu Technological University–Danao Campus. She holds a Doctor of Development Education degree, a Master of Education major in Mathematics from Cebu Technological University, and a Bachelor of Secondary Education major in Mathematics from the University of San Jose-Recoletos. She is currently pursuing a Ph.D. in Education major in Mathematics at the University of the Philippines Open University, Los Baños, Philippines. Her research focuses on teaching pedagogies and mathematics education, and she has led community extension projects to improve teachers' knowledge and skills in technology, pedagogy, and mathematical content. She can be contacted at email: lislee.valle@ctu.edu.ph.

Romel C. Mutya is a college instructor at Cebu Technological University–Danao Campus, teaching biology and research subjects in undergraduate and graduate school. He is the Chairman of the MAEd Teaching Science and a regular member of the National Research Council of the Philippines. He was among the Philippine participants in the Global Youth Scientists Summit in Singapore in January 2025. He has published learning materials, utility models, and more than 30 research papers in national and international journals, and he has served as a reviewer for more than 10 international journals. His research interests include science education, biology, social sciences, public administration, and educational management. He holds a Doctorate in Public Administration, a Master of Arts in Education major in Teaching Biology from Cebu Technological University, and a Bachelor of Secondary Education major in Biological Science from the Surigao State College of Technology-Main Campus. He is currently pursuing a Doctor of Education major in Science Education as a DOST scholar and a Ph.D. in Research and Evaluation at Cebu Normal University. He can be contacted at email: romel.mutya@gmail.com; romel.mutya@ctu.edu.ph.

Dawn Iris Calibo-Senit is the research director and associate professor of Information Technology at Siquijor State College. She holds a Doctor of Information Technology degree from the Technological Institute of the Philippines–Manila, along with a master's degree in Public Administration and a master's degree in Science Teaching major in Computer Science, and has completed academic units toward a Ph.D. in Technological Management. Her scholarly work spans information theory, computer science, data mining, and systems development and design, with three copyrighted software systems registered with the Intellectual Property Office of the Philippines. Beyond her contributions to information technology research, she actively engages in interdisciplinary research integrating data-driven technologies with environmental and agricultural sustainability initiatives. She currently serves as program leader of the Siquijor Native Cattle Research Center (SiqCat), a research initiative funded by the Office of the Philippine Futures Thinking Society. She can be contacted at email: dawniriscalibo@gmail.com.

Margarito B. Callao is an associate professor I and full-time faculty member of Cebu Technological University–Barili Campus, where he is associated with the Bachelor of Secondary Education major in Science Program. He holds a Bachelor of Secondary Education major in Mathematics from the University of Mindanao, a Master of Arts in Education major in Educational and Leadership Management, a Master of Arts in Teaching major in Mathematics, and a Doctor of Public Administration from Southwestern University, as well as a Doctor in Development Education from Cebu Technological University. His academic and research interests include mathematics and science education, educational management, and public administration. He has also authored instructional materials, including books in algebra and statistics, and continues to contribute to teaching, research, and academic development. He can be contacted at email: margarito.callao@ctu.edu.ph.

Jennifer B. Carillo is an associate professor I and Mathematics Educator at Cebu Technological University–Barili Campus, Philippines. She is currently a doctoral candidate in the Doctor of Philosophy in Education program, majoring in Mathematics Education at the University of the Philippines Open University. She holds a Master of Arts in Education, major in Mathematics Education, and a Bachelor of Secondary Education, major in Mathematics, from Cebu Normal University. With more than 13 years of experience in tertiary education, her work focuses on mathematics education, curriculum development, assessment in learning, educational technology, and research-based instruction. She can be contacted at email: jennifer.carillo@gws.ctu.edu.ph.

Rowena P. Dato-on is a faculty member at the Cebu Technological University Daanbantayan Campus and teaches Statistics and Research subjects. She holds a Doctor of Philosophy in Technology Management and is currently pursuing a Doctor of Development Education. She has a master's degree in Education, both in Mathematics and in Administration and Supervision. Her undergraduate course was a bachelor's degree in Secondary Education, major in Mathematics, with a minor in Technology and Livelihood Education. She has attended international conferences, published research in the Journal of Agriculture and Technology Management and other reputable journals, and presented papers at various conferences, both locally and internationally. In 2016, Dr. Dato-on was a Commission on Higher Education (CHEd) scholar during the Faculty Training for the New General Education Core Course: Training of GE Trainors held at Ateneo de Manila University (AdMU). Currently, she serves as the Director of Research and Development and Dean of Graduate School Programs at Cebu Technological University Daanbantayan Campus, where she has received recognitions for her academic contributions and mentorship. Dr. Dato-on is an active member of various professional organizations and regularly attends seminars and workshops in her field of expertise. She can be contacted at email: rowena072669@gmail.com.

Adrian P. Ybañez is a distinguished Philippine researcher, professor VI at Cebu Technological University, and former Vice-President for Research and Development, leading the Institute for Molecular Genetics, Parasitology and Vector-borne Diseases (IMGPVBD). His expertise spans veterinary medicine, parasitology, microbiology, vector-borne diseases, molecular biology, phylogenetics, epidemiology, public health, and the social sciences. He earned his Ph.D. in Veterinary Sciences from Obihiro University of Agriculture and Veterinary Medicine in Japan and has accumulated more than 1,800 Google Scholar citations. Recognized among leading Asian and Philippine researchers in the medical and health sciences, he advances work on animal health, infectious diseases, and interdisciplinary approaches. He can be contacted at email: dr.adrianpybanez@gmail.com.