Volume *01* June 2021

ISSN 2758-1985

Cambodian Journal of Educational Development

Email: *cameditorialboard@gmail.com*

Website: *www.cjed.hiroshima-u.ac.jp*

Cambodian Journal of Educational Development

Volume 01 June 2021

Copyright © Cambodian Journal of Educational Development (CJED)

This publication is supported by Hiroshima University and Japan International Cooperation Center (JICE) in Cambodia.

No part of this publication may be reproduced, stored, or transmitted in any material form or by any means including electronic, mechanical, photocopying, recording or otherwise without the prior written permission of the publisher.

Editors and Reviewers

Editorial Advisory Boards

Takuya Baba, *Ph.D.* *Graduate School of Humanities and Social Sciences, Hiroshima University, Japan*

Kinya Shimizu, *Ph.D.* *Graduate School of Humanities and Social Sciences, Hiroshima University, Japan*

Takayoshi Maki, *Ph.D.* *Graduate School of Humanities and Social Sciences, Hiroshima University, Japan*

Editor-in-Chief

Pov Sokunrith, *M.Ed.* *JDS Alumni, Batch 17th, Cambodia*

Associate Editors

Seng Sovath, *M.Ed.* *JDS Alumni, Batch 17th, Cambodia*

Meas Soth, *M.Ed.* *JDS Alumni, Batch 17th, Cambodia*

Yat Ponleak, *M.Ed.* *JDS Alumni, Batch 16th, Cambodia*

Lang Sophat, *M.Ed.* *JDS Alumni, Batch 16th, Cambodia*

Ouch Sreypouv, *M.Ed.* *JDS Alumni, Batch 15th, Cambodia*

Co-Editor

Heng Kimkong, *Ph.D. Candidate* *The University of Queensland, Australia*

Reviewers

Kinya Shimizu, *Ph.D.* *Graduate School of Humanities and Social Sciences, Hiroshima University, Japan*

Mariko Omori, *Ph.D.* *Graduate School of Humanities and Social Sciences, Hiroshima University, Japan*

Junita Widiati Arfani, *Ph.D.* *Centre for World Trade Studies, Universitas Gadjah Mada, Indonesia*

Asami Shimoda, *M.A* *National Institute of Technology, Hiroshima College, Japan*

Michael Padilla, *Ph.D.* *University of Georgia, The United States*

Oyunaa Purevdorj, *Ph.D.* *Policy Analysis Institute, Mongolia*

Joseph P Riley, *Ph.D.* *University of Georgia, The United States*

Keynotes from Advisory Editorial Board

I am very pleased to make a congratulatory remark at the occasion of launching the first issue of the journal "***Cambodian Journal of Educational Development***". Despite of existing academic journals over the world, its launching has a significant meaning for the academic circle within Cambodia or across countries. Especially this is difficult for the country in which the academic efforts have just started and the publication of journal involves a lot of efforts from the committed members of the circle.

Since the beginning of IDEC in 1994, we have received huge number of international students. This number itself marks the result of collective efforts by all involved. More importantly, we are able to eyewitness today the establishment of the academic journal with initiatives of graduates in Cambodia. Here, we should not forget the existence of academic gathering before this publication, and also support from IDEC alumni from abroad. This gathering has become an icon for collective efforts by graduates, who feel the necessity of academic forum within a country. As far as I am aware, this launching of the journal is the second example by alumni of IDEC, Hiroshima University.

I congratulate Cambodian students for their efforts and product and encourage all the graduates to continue an academic effort individually and collectively. I would like to thank Cambodian and Japanese governments and JICA who have supported many Cambodian students financially. Now, I proudly report to them that their investment has yielded some fruits such as a community of researchers, regular academic gathering among them, and this publication of their research results. I would like to thank my colleagues, Shimizu and Maki senseis to guide them up to here.

This is a very first step for long journey of education development through research. I sincerely wish that this small step will grow bigger with time.

TAKUYA BABA

Program Director, International Education Development Program,
Graduate School of Humanities and Social Sciences (2020-)
(one of which is the former Graduate School of International Development and Cooperation (1994-2019))

Keynotes from Editor-in-Chief

I am delighted to celebrate the launch of Cambodian Journal of Educational Development (CJED), a new multidisciplinary, peer-review journal that publishes original research in the field of education. On behalf of CJED, I am deeply pleased and honored to extend a very warm welcome to the readership of CJED Volume 01, 2021. I would like to take this opportunity to express my grateful thanks to Hiroshima University and Japan International Cooperation Agency (JICE) in Cambodia for their technical and financial support. And, I sincerely thank our authors, anonymous reviewers and especially, all editorial members who enthusiastically, willingly and voluntarily involve to contribute to the success of the journal.

The establishment of CJED aims to (1) document research articles of graduates and current students who are receiving and have received Japanese government's scholarship to study in Japan from various scholarship programs, including The Project for Human Resource Development Scholarship by Japanese Grant Aid (JDS), PEACE Student Exchange Program, SPIES, JICA Long-Term-Training, MEXT and so on, (2) promote research culture in Cambodia and (3) involve with the government of Cambodia in transforming Cambodia from an agriculture-based country to an industrial country through the implementation Industrial Development Policy 2015-2025.

We hope that our regular publication will become the primary platform for researchers to share findings and discuss all aspects of current and future education issues that benefits education reform in Cambodia.

POV SOKUNRITH

Editor-in-Chief

Contents

សង្ខិត្តន័យ—Abstracts

អត្ថបទទី១៖ ប្រភពនៃភាពជឿជាក់លើសមត្ថភាពនៃមុខវិជ្ជាវិទ្យាសាស្ត្ររបស់និស្សិតកម្ពុជា៖ និទ្ទាការ និងលំនាំ

សង្ខិត្តន័យ

ការលើកកម្ពស់ការអប់រំលើមុខវិជ្ជាវិទ្យាសាស្ត្រ បច្ចេកវិទ្យា វិស្វកម្ម និងគណិតវិទ្យា (ស្ទែម) គឺជារបៀបវារៈមួយក្នុងចំនោមរបៀបវារៈអាទិភាពរបស់រាជរដ្ឋាភិបាលកម្ពុជា ក្នុងការអភិវឌ្ឍធនធានមនុស្ស។ ទោះបីជាយ៉ាងណាក៏ដោយ ប្រទេសកម្ពុជាកំពុងប្រឈមនឹងការធ្លាក់ចុះគួរឱ្យព្រួយបារម្ភនៃការជ្រើសរើសមុខវិជ្ជាវិទ្យាសាស្ត្រនៅកម្រិតមធ្យមសិក្សាទុតិយភូមិ ដែលបណ្តាលឱ្យចំនួននិស្សិតចូលរៀនជំនាញស្ទែមធ្លាក់ចុះនៅកម្រិតឧត្តមសិក្សា។ ដូច្នេះ ការសិក្សានេះមានគោលបំណងឈ្វេងយល់ពីនិទ្ទាការ និងលំនាំនៃប្រភពភាពជឿជាក់លើសមត្ថភាពរបស់និស្សិតកម្ពុជាលើមុខវិជ្ជាវិទ្យាសាស្ត្រ។ អ្នកស្រាវជ្រាវបានជ្រើសរើសនិស្សិតឆ្នាំទី១ចំនួន ៨១៩នាក់ពីសាកលវិទ្យាល័យរដ្ឋចំនួន៤ និងឯកជនចំនួន២ ដើម្បីបំពេញកម្រងសំណួរដោយប្រើប្រាស់វិធីសាស្ត្រជ្រើសរើសដោយចៃដន្យ។ ការសិក្សានេះប្រើប្រាស់ស្ថិតិបែបពិពណ៌នាដើម្បីពិនិត្យលើកម្រិតនិទ្ទាការនៃប្រភពភាពជឿជាក់ក្នុងមុខវិជ្ជាវិទ្យាសាស្ត្រ និងស្ថិតិបែបសន្និដ្ឋានសម្រាប់វិភាគលើភាពខុសគ្នានៃលំនាំតាមរយៈវិធីសាស្ត្រ Independent Sample *t*-test និងOne-way ANOVA។ លទ្ធផលបានបង្ហាញថា បទពិសោធន៍ដែលទទួលបានពីអ្នកជុំវិញខ្លួនមានកម្រិតខ្ពស់ជាងគេ ហើយប្រភពនៃភាពជឿជាក់៣ផ្សេងទៀតដូចជា បទពិសោធន៍ផ្ទាល់ខ្លួនពីអតីតកាល ពាក្យសំដីរបស់អ្នកនៅជុំវិញខ្លួន និងស្ថានភាពផ្លូវអារម្មណ៍ មានកម្រិតទាប។ ចំណែកឯការវិភាគអំពីភាពខុសគ្នាពីលំនាំនៃប្រភពនៃភាពជឿជាក់បានបង្ហាញឱ្យឃើញថា អាយុនិស្សិត ផ្នែកសិក្សានៅមធ្យមសិក្សាទុតិយភូមិ ឯកទេសសិក្សានៅឧត្តមសិក្សា ស្ថានភាពសេដ្ឋកិច្ចគ្រួសារ កម្រិតនៃការអប់រំ និងមុខរបរឪពុកម្តាយដែលធ្វើឱ្យប្រភពទាំង៤នៃភាពជឿជាក់លើសមត្ថភាពរបស់និស្សិតក្នុងមុខវិជ្ជាវិទ្យាសាស្ត្រមានភាពខុសគ្នា ចំណែកឯ ភេទ និងទីកន្លែងកំណើតរបស់និស្សិតមិនធ្វើឱ្យមានភាពខុសគ្នាទេ។

ពាក្យគន្លឹះ ភាពជឿជាក់លើសមត្ថភាពក្នុងមុខវិជ្ជាវិទ្យាសាស្ត្រ និស្សិតកម្ពុជា ស្ទែម ផ្នែកវិទ្យាសាស្ត្រ នៅកម្រិតមធ្យមសិក្សាទុតិយភូមិ គ្រឹះស្ថានឧត្តមសិក្សា

អត្ថបទទី២៖ ការបណ្តុះបណ្តាលគរុសិស្សជាអ្នកស្រាវជ្រាវ ដៅតាមមជ្ឈមណ្ឌល

គរុកោសល្យភូមិភាគក្នុងប្រទេសកម្ពុជា៖ ទស្សនៈរបស់គរុសិស្ស

សង្ខិត្តន័យ

បង្រៀនជាអ្នកស្រាវជ្រាវ គឺជាទស្សនាទានមួយដែលស្នើឱ្យមានការដាក់បញ្ចូលការអនុវត្តសកម្មភាពស្រាវជ្រាវទៅក្នុងវិជ្ជាជីវៈគ្រូបង្រៀន ដើម្បីលើកកម្ពស់គុណភាពនៃការបង្រៀន។ នៅក្នុងបរិបទនៃប្រទេសកម្ពុជា ការដឹងឮអំពីការអនុវត្តសកម្មភាពស្រាវជ្រាវនៅមានតិចតួច ទាំងនៅក្នុងបរិបទការបណ្តុះបណ្តាលគ្រូបង្រៀន និងការអនុវត្តវិជ្ជាជីវៈប្រចាំថ្ងៃរបស់គ្រូបង្រៀន។ ដូចនេះ ករណីសិក្សាបែបគុណវិស័យមួយនេះ ត្រូវបានធ្វើឡើងក្នុងគោលបំណងបង្ហាញពីស្ថានភាពបច្ចុប្បន្ននៃការអនុវត្តសកម្មភាពស្រាវជ្រាវនៅក្នុងកម្មវិធីបណ្តុះបណ្តាលគ្រូបង្រៀនកម្រិតមូលដ្ឋាននៅប្រទេសកម្ពុជា។ ការសិក្សានេះបានអង្កេតលើទស្សនៈរបស់គរុសិស្ស និងដោយផ្តោតជាសំខាន់លើ សារសំខាន់ និង បញ្ហាប្រឈមនៃសកម្មភាពស្រាវជ្រាវគរុកោសល្យក្នុងវគ្គបណ្តុះបណ្តាលគ្រូបង្រៀនតាមប្រព័ន្ធពីរឆ្នាំ។ ការប្រមូលទិន្នន័យក្នុងការសិក្សានេះធ្វើឡើងតាមរយៈកិច្ចពិភាក្សាក្រុម ដោយមានការចូលរួមរបស់គរុសិស្សចំនួន ២២នាក់ ដែលបានឆ្លងកាត់ការបណ្តុះបណ្តាលសកម្មភាពស្រាវជ្រាវគរុកោសល្យនៅតាមមជ្ឈមណ្ឌលគរុកោសល្យចំនួនបួន។ ទិន្នន័យបែបគុណវិស័យដែលប្រមូលបានត្រូវបានត្រូវបានវិភាគដោយប្រើប្រាស់យុទ្ធវិធី បណ្តុំកូដអត្ថន័យ (Category coding) គួបផ្សំនឹងការវិភាគទំហំខ្លឹមសារ (Content analysis) និង ការវិភាគន័យភាសាបរិបទ (Discourse analysis)។ ការសិក្សានេះរកឃើញថា គរុសិស្សមួយភាគធំបានបង្ហាញទស្សនៈថា សកម្មភាពស្រាវជ្រាវគរុកោសល្យជាមធ្យោបាយមួយក្នុងការបង្កើនគុណវុឌ្ឍិវិជ្ជាជីវៈ។ ប៉ុន្តែ ការអនុវត្តសកម្មភាពស្រាវជ្រាវគរុកោសល្យរបស់ពួកគេត្រូវបានរាំងស្ទះជាចម្បងដោយកង្វះខាតការគាំទ្រការសិក្សាស្រាវជ្រាវ និងរវែងផលប៉ះពាល់បន្ទាប់បន្សំដោយបន្ទុកកិច្ចការ បញ្ហាថវិកា និងកង្វះខាតបំណិនភាសាបរទេស និងកុំព្យូទ័រ។ លទ្ធផលនៃការសិក្សានេះអាចប្រើប្រាស់ជាមូលដ្ឋានពិចារណាសម្រាប់អ្នកអនុវត្ត និងអភិវឌ្ឍកម្មវិធីបណ្តុះបណ្តាលគ្រូបង្រៀន ពិសេសក្នុងបរិបទនៃការជំរុញកម្មវិធីបណ្តុះបណ្តាលគ្រូបង្រៀនកម្រិតមូលដ្ឋានឱ្យដល់កម្រិតឧត្តមសិក្សា។

ពាក្យគន្លឹះ៖ គ្រូបង្រៀនជាអ្នកស្រាវជ្រាវ ការបណ្តុះបណ្តាលគ្រូបង្រៀន គរុសិស្ស ការយល់ឃើញ

អត្ថបទទី៣៖ សៀវភៅសិក្សាគោលភាសាអង់គ្លេស និងការប្រើប្រាស់សៀវភៅនៅបឋមសិក្សាកម្ពុជា៖ ករណីសិក្សានៅទីក្រុងភ្នំពេញ

សង្ខិត្តន័យ

គោលបំណងនៃការសិក្សានេះដើម្បីស្វែងរកមើលភាពសមស្របនៃខ្លឹមសារ និងប្រសិទ្ធភាពនៃការប្រើប្រាស់សៀវភៅសិក្សាភាសាអង់គ្លេសដើម្បីអភិវឌ្ឍគុណភាពអប់រំផ្នែកភាសាអង់គ្លេស។ ការសិក្សានេះបានប្រើវិធីសាស្ត្រស្រាវជ្រាវបែបចំរុះនៅតាមសាលារៀនបឋមសិក្សាចំនួន១២ គ្រូបឋមសិក្សាចំនួន ១២នាក់ និងសិស្សបឋមសិក្សាចំនួន ១២០ នាក់ នៅទីក្រុងភ្នំពេញ។ ការសិក្សានេះ ពិនិត្យមើលលើទស្សនរបស់គ្រូបង្រៀនលើសៀវភៅសិក្សាគោល និងការប្រើប្រាស់។ ការសិក្សានេះក៏សំដៅលើមតិយោបល់របស់គ្រូឧទ្ទេសលើការវាយតម្លៃ សៀវភៅសិក្សា និងទស្សន:របស់សិស្សតាមរយៈកម្រងសំណួរសម្ភាស។ លទ្ធផលនៃការសិក្សាបានបង្ហាញថា គ្រូឧទ្ទេស គ្រូបង្រៀន និងសិស្សបឋមសិក្សាបានឯកភាពគ្នាលើរូបរាងខាងក្រៅ និងការរៀបចំការរចនានៃសៀវភៅសិក្សាដោយយកចិត្តទុកដាក់ដែលធ្វើអោយមានការចាប់អារម្មណ៍ពីសំណាក់គ្រូបង្រៀន និងអ្នកសិក្សា។ ពួកគាត់បានយល់ស្របថាជំនាញអាន និងវាក្យស័ព្ទគឺសំខាន់នៅក្នុងខ្លឹមសារបង្រៀន និងរៀន។ ទោះបីជាយ៉ាងណាក៏ដោយ ការសិក្សានេះបានសង្កត់ធ្ងន់លើតម្រូវការនៃការកែលម្អសៀវភៅសិក្សាគោលដោយសារពួកគាត់ខ្វះសម្ភារៈឧបទ្ទេស មិនបានពង្រឹងជំនាញមីក្រូ និងម៉ាក្រូសម្រាប់អ្នកសិក្សាក្មេងៗ វេយ្យាករណ៍និងអត្ថបទអានមានភាពស្មុគស្មាញខ្លាំងពេកខ្ពស់ជាងកម្រិតសិក្សារបស់សិស្ស ហើយសារប្រយោជន៍នៃសៀវភៅសិក្សាគោលត្រូវបានគេវាយតម្លៃត្រឹមកម្រិតមធ្យ។ ការសិក្សាបានបង្ហាញផងដែរថា គ្រូបង្រៀនដែលមានមូលដ្ឋានចំណេះដឹងភាសាអង់គ្លេសបានអនុវត្តការប្រើប្រាស់សៀវភៅបានល្អប្រសើជាង នៅពេលដែលគ្រូបង្រៀនមិនមានមូលដ្ឋានចំណេះដឹងភាសាអង់គ្លេស ជាពិសេសគ្រូបង្រៀនដែលមានអាយុច្រើនមានការស្ទាក់ស្ទើរក្នុងការបង្រៀន។

ពាក្យគន្លឹះ៖ សៀវភៅសិក្សាគោល សាលាបឋមសិក្សា ភាពសមស្របនៃខ្លឹមសារ ប្រសិទ្ធភាពនៃសៀវភៅសិក្សាគោល

អត្ថបទទី៤៖ ទស្សន:របស់គរុនិស្សិតកម្ពុជាដែលពុំមែនឯកទេសភាសាអង់គ្លេស លើការសិក្សាភាសាអង់គ្លេសនៅវិទ្យាស្ថានជាតិអប់រំ

សង្ខិត្តន័យ

ករណីសិក្សានេះមានគោលបំណងឈ្វេងយល់ពីទស្សន: និងបញ្ហាប្រឈមរបស់គរុនិស្សិតដែលពុំមែនឯកទេសភាសាអង់គ្លេស ទៅលើការសិក្សាភាសាអង់គ្លេស ក្នុងអំឡុងពេលទទួលការបណ្តុះបណ្តាលនៅវិទ្យាស្ថានជាតិអប់រំ ក្នុងព្រះរាជាណាចក្រកម្ពុជា។ ការស្រាវជ្រាវនេះប្រើប្រាស់ពហុវិធីសាស្ត្របែបគុណវិស័យក្នុងការប្រមូលទិន្នន័យ។ គរុនិស្សិតឯកទេសផ្សេងៗ ក្រៅពីភាសាអង់គ្លេស ត្រូវបានជ្រើសរើសជាសំណាកតាមវិធីសាស្ត្រចៃដន្យតាមចំណាត់ថ្នាក់ ដើម្បីបំពេញកម្រងសំណួរចំនួន៤២នាក់ និងដើម្បីការសម្ភាសន៍ជាក្រុមចំនួន៩នាក់។ លទ្ធផលនៃការសិក្សាបានបង្ហាញថា គរុនិស្សិតឯកទេសក្រៅពីភាសាអង់គ្លេសភាគច្រើន បានផ្លាស់ប្តូរទស្សន:របស់ពួកគេទៅលើការសិក្សាភាសាអង់គ្លេស ដោយសារហេតុផលមួយចំនួនដូចជា កម្មវិធីសិក្សា វិធីសាស្ត្របង្រៀន ចំនួនសិស្សក្នុងថ្នាក់រៀន និងកង្វះខាតសម្ភារៈបរិក្ខារ។ អំឡុងពេលទទួលការបណ្តុះបណ្តាលនៅវិទ្យាស្ថានជាតិអប់រំ ពួកគេបានជួបប្រទះបញ្ហាប្រឈមចម្បងពីរគឺ សមត្ថភាព ភាសាអង់គ្លេសខុសៗគ្នា និងការសិក្សាលើមុខវិជ្ជាច្រើនពេក។ លទ្ធផលនៃការសិក្សានេះ ស្របគ្នាទៅនឹងលទ្ធផលស្រាវជ្រាវកន្លងមកពាក់ព័ន្ធនឹងទស្សន:ចំពោះការសិក្សាភាសាអង់គ្លេសរបស់គរុសិស្ស-និស្សិត និងនិស្សិតសាកលវិទ្យាល័យ ដែលពុំមែនឯកទេសភាសាអង់គ្លេស។

ពាក្យគន្លឹះ៖ ផ្ទត់គំនិតលើការសិក្សាភាសាអង់គ្លេស គរុនិស្សិតឯកទេសពុំមែនភាសាអង់គ្លេស គរុសិស្ស សិក្ខាកាម ប្រទេសកម្ពុជា

អត្ថបទទី៥៖ ចំណេះដឹង និងការយល់ឃើញរបស់គ្រូបង្រៀនក្នុងការអនុវត្ត បំណិនត្រិះរិះពិចារណា លើការបង្រៀនមុខវិជ្ជាគីមីវិទ្យា៖ ករណីសិក្សានៅសាលា មធ្យមសិក្សាទុតិយភូមិក្នុងខេត្តកំពង់ឆ្នាំង ប្រទេសកម្ពុជា

សង្ខិត្តន័យ

ការសិក្សានេះផ្តោតសំខាន់ទៅលើការកំណត់នូវកម្រិតចំណេះដឹងរបស់គ្រូបង្រៀនមុខវិជ្ជាគីមីវិទ្យា និងរបៀបនៃការយល់ឃើញរបស់ពួកគាត់ពាក់ព័ន្ធនឹងការបង្រៀនបំណិនត្រិះរិះពិចារណា។ ការសិក្សានេះបានប្រើប្រាស់វិធីសាស្ត្រស្រាវជ្រាវបែបចម្រុះ (Explanatory sequential mixed-method design) ដែលមានការចូលរួមពីគ្រូបង្រៀនចំនួន ៥០នាក់ មកពីវិទ្យាល័យចំនួន ១៦ នៅក្នុងខេត្តកំពង់ឆ្នាំង។ ស្ថិតិបែបពណ៌នាត្រូវបានប្រើក្នុងការវិភាគទិន្នន័យបែបបរិមាណវិស័យ ខណៈពេលដែលការកូដ ការវិភាគរកចំនួន និងខ្លឹមសារសំខាន់ៗ (content and thematic analysis) ត្រូវបានគេប្រើសម្រាប់ការវិភាគទិន្នន័យបែបគុណវិស័យ។ លទ្ធផលស្រាវជ្រាវបានបង្ហាញថា សៀវភៅសិក្សាគោលគីមីវិទ្យានៅមធ្យមសិក្សាទុតិយភូមិបានផ្តល់នូវបំណិនត្រិះរិះពិចារណាក្នុងកម្រិតទាប ដែលសៀវភៅទាំងនោះបានផ្តល់នូវកេស្តតាងតិចតួចដើម្បីជួយសិស្សអោយឈានដល់កម្រិតវិភាគ ដែលបានបង្ហាញនៅក្នុងទ្រឹស្តីប្លូមតាក់សូណូមី (Bloom's taxonomy)។ លើសពីនេះទៅទៀត ទោះបីជាលោកគ្រូ អ្នកគ្រូទាំងអស់មានចំណេះដឹងលើបំណិនត្រិះរិះពិចារណាច្បាស់លាស់ក៏ដោយ ពួកគាត់ទំនងជាមានការយល់ដឹងមិនច្បាស់លាស់ចំពោះចំនុចមួយចំនួនដែលទាក់ទងនឹងចំណេះដឹងនៃបំណិនត្រិះរិះពិចារណា។ បន្ថែមពីនេះទៀត គ្រូបង្រៀនភាគច្រើនមានយោបល់វិជ្ជមាន និងការយល់ស្របខ្លាំងទៅលើការបង្រៀនបំណិនត្រិះរិះពិចារណា ប៉ុន្តែការអនុវត្តនៃការផ្ទេរបំណិនត្រិះរិះពិចារណាទៅកាន់សិស្សនៅមានកម្រិតនៅឡើយ ដែលបញ្ហានេះកើតមានឡើងដោយសារតែកត្តាសំខាន់ៗមួយចំនួន។ ហេតុដូចនេះ ការសិក្សាបន្តទៀតចាំបាច់ត្រូវផ្តោតទៅលើការស្វែងរកកត្តាដែលជះឥទ្ធិពលទៅលើចំណេះដឹង និងការយល់ឃើញលើការបង្រៀនបំណិនត្រិះរិះពិចារណារបស់គ្រូ។

ពាក្យគន្លឹះ៖ បំណិនត្រិះរិះពិចារណា ការយល់ឃើញ ចំណេះដឹង គ្រូបង្រៀនមធ្យមសិក្សាទុតិយភូមិ សៀវភៅសិក្សាគោលគីមីវិទ្យា

អត្ថបទទី៦៖ការវាយតម្លៃចំណេះដឹងគណិតវិទ្យាក្នុងការបង្រៀនខ្លឹមសារប្រភាគ របស់គរុសិស្សកម្រិតបឋមសិក្សានៅកម្ពុជា

សង្ខិត្តន័យ

សិស្សកម្រិតបឋមសិក្សាមួយចំនួននៅក្នុងប្រទេសកម្ពុជា នៅមានកង្វះខាតលើចំណេះដឹងមូលដ្ឋាននៃមុខវិជ្ជាគណិតវិទ្យាជាពិសេសមេរៀនប្រភាគ ហើយលទ្ធផលសិក្សាខ្សោយរបស់សិស្សគឺទាក់ទងទៅនឹងការបង្រៀនរបស់គ្រូ។ គ្រូបង្រៀននៅកម្រិតបឋមសិក្សានៅមានចំណេះដឹងលើខ្លឹមសារ និងគរុកោសល្យ (PCK) នៅមានកម្រិតនៅឡើយដូចជាវិធីសាស្ត្រក្នុងការបង្រៀន និងការប្រើប្រាស់រូបតំណាង។ ដូចនេះការសិក្សានេះមានគោលបំណងការវាយតម្លៃលើចំណេះដឹងរបស់គរុសិស្សកម្រិតបឋមសិក្សា (PPSTs) អំពីចំណេះដឹងគណិតវិទ្យាក្នុងការបង្រៀន (MKT) លើខ្លឹមសារប្រភាគ។ ការសិក្សានេះបានប្រើប្រាស់វិធីសាស្ត្រសិក្សាស្រាវជ្រាវចម្រុះ ដោយមានការចូលរួមពីគរុសិស្សកម្រិតបឋមសិក្សាមកពីគ្រឹះស្ថានបណ្តុះបណ្តាលគ្រូចំនួនពីរ។ គរុសិស្សចំនួន២០៦នាក់ បានបំពេញកម្រងសំណួរចំនួន១៨សំណួរ លើចំណេះដឹងគណិតវិទ្យាក្នុងការបង្រៀនដែលផ្តោតលើបញ្ញត្តិរងទាំងប្រាំនៃប្រភាគ ហើយគរុសិស្សចំនួន៤៥នាក់ ត្រូវបានជ្រើសរើសដើម្បីចូលរួមសម្ភាសន៍។ ការសិក្សានេះបានរកឃើញថាគរុសិស្សទទួលបានលទ្ធផលខុសៗគ្នាទៅតាមបញ្ញត្តិរងរបស់ប្រភាគ។ ក្នុងចំណោមបញ្ញត្តិរងទាំងនោះ គរុសិស្សទទួលបានលទ្ធផលទាបជាងគេទៅលើបញ្ញត្តិរងដែលប្រភាគជាផ្នែកនៃវត្ថុទាំងមូល (part-whole)។ គរុសិស្សបានចាត់ទុកថាប្រភាគដែលជាផ្នែកនៃវត្ថុទាំងមូលជាប្រភាគដែលបែងចែកជាទំហំប៉ុនគ្នា និងមានការលំបាកក្នុងការបង្កើតរូបតំណាងផ្សេងគ្នាៗរបស់ប្រភាគ។ លើសពីនេះទៅទៀត គរុសិស្សមានចំណេះដឹងមិនគ្រប់គ្រាន់ផងដែរលើផ្នែកខ្លឹមសារឯកទេសគណិតវិទ្យា ដោយពួកគេមិនអាចពន្យល់បានពីហេតុផលនៃនិតិវិធីក្នុងការដោះស្រាយលំហាត់របស់ពួកគេ។ កម្រិតទាបនៃចំណេះដឹងផ្នែកខ្លឹមសារឯកទេសគណិតវិទ្យាធ្វើឱ្យចំណេះដឹងផ្នែកខ្លឹមសារ និងគរុកោសល្យនៅមានកម្រិតផងដែរ។ គរុសិស្សមានការលំបាកក្នុងការពន្យល់ពីគំនិតកាន់ច្រឡំរបស់សិស្ស និងលំបាកក្នុងការប្រើប្រាស់រូបតំណាងប្រភាគ។ ទោះបីជាយ៉ាងណាក៏ដោយ ជាទូទៅពួកគេបានយល់ដឹងពីការប្រើប្រាស់បញ្ញត្តិរងដែលប្រភាគជាផ្នែកនៃវត្ថុទាំងមូលមកបង្កើតជាឧទាហរណ៍ក្នុងការបង្រៀនខ្លឹមសារប្រភាគ។

ពាក្យគន្លឹះ៖ គរុសិស្សកម្រិតបឋមសិក្សា ចំណេះដឹងគណិតវិទ្យាក្នុងការបង្រៀន ចំណេះដឹងខ្លឹមសារ និងគរុកោសល្យ ចំណេះដឹងលើខ្លឹមសារមេរៀន បញ្ញត្តិរងទាំងប្រាំនៃប្រភាគ

អត្ថបទទី៧៖ ការរៀបចំតេស្តដើម្បីវិនិច្ឆ័យកំនិតភាន់ច្រលំរបស់គរុសិស្សកម្ពុជា អំពីអត្ថម និងម៉ូលេគុល

សង្ខិត្តន័យ

គោលបំណងនៃការសិក្សានេះគឺដើម្បីបង្កើតតេស្តមួយ ដោយរួមបញ្ចូលការប្រើប្រាស់សំណួរពហុជ្រើសរើស និងសំណួរស្រប ឬមិនស្រប ដើម្បីវិនិច្ឆ័យរកគំនិតភាន់ច្រឡំរបស់គរុសិស្សទៅលើទ្រឹស្តីអាតូម និងម៉ូលេគុលនៅក្នុងបរិបទកម្ពុជា។ ការបង្កើតតេស្តនេះមានបួនជំហានគឺ ១) ការកំណត់រកខ្លឹមសារ ២) ការស្រាវជ្រាវរកអ្វីដែលជាគំនិតភាន់ច្រលំរបស់សិស្ស និងគ្រូដែលមានពីមុនមក ៣) ការបង្កើតសំណួរទាំងឡាយនៅក្នុងតេស្ត និង៤) ការសាកល្បងតេស្តទៅលើទ្រឹស្តីអាតូម និងម៉ូលេគុល។ អ្នកស្រាវជ្រាវក៏បានប្រើសំណួរទម្រង់បើក(បែបពន្យល់) ទៅលើគ្រប់សំណួរទាំងអស់នៃតេស្តផងដែរ។ នៅក្នុងតេស្តមានសំណួរសរុបទាំងអស់ចំនួន១៧សំណួរ ដែលផ្តោតលើបួនសមាសភាគរួមមាន៖ លក្ខណៈរបស់អាតូម ទម្រង់អាតូម អ៊ីសូតូប និងម៉ូលេគុល។ តេស្តនេះត្រូវបានធ្វើការសាកល្បងដំបូងជាមួយនឹងគរុសិស្សចំនួន ៨៣នាក់ បន្ទាប់មកក៏បានអនុវត្តទៅលើគរុសិស្សចំនួន ១០៤៩នាក់ ដែលពួកគេកំពុងសិក្សានៅតាមសាលាគរុកោសល្យ និងវិក្រឹតការខេត្តចំនួនបួន និងវិទ្យាស្ថានគរុកោសល្យចំនួនពីរក្នុងប្រទេសកម្ពុជា។ កម្រិតភាពជឿជាក់របស់តេស្តបានកើនឡើងពី ០.៦០ នៅពេលធ្វើការសាកល្បង ទៅ ០.៨៨ នៅពេលធ្វើការសិក្សាចម្បង។ សម្រាប់ខ្លឹមសារនៅក្នុងតេស្តត្រូវបានត្រួតពិនិត្យ និងកែសម្រួលឡើងវិញដោយផ្អែកលើយោបល់របស់គ្រូឯកទេសគីមីវិទ្យាចំនួន៤នាក់។ លទ្ធផលបានបង្ហាញអោយឃើញថាតេស្តគឺមានភាពអាចជឿជាក់បាន និងមានសុពលភាពក្នុងការវាស់ពីគំនិតភាន់ច្រលំរបស់សិស្សលើទ្រឹស្តីអាតូម និងម៉ូលេគុលនៅក្នុងបរិបទនៃប្រទេសកម្ពុជា។ ការសិក្សានេះរកឃើញថាមានសំណួរចំនួន៥ដែលមានលក្ខណៈត្រិះរិះពិចារណា ដែលសំណួរទាំងនោះមានចម្លើយមិនត្រឹមត្រូវលើសពី៣០% នាំអោយយើងកំណត់បានថាចម្លើយទាំងនោះគឺជាគំនិតភាន់ច្រឡំ។

ពាក្យគន្លឹះ៖ គរុសិស្ស គំនិតភាន់ច្រឡំ តេស្តវិនិច្ឆ័យ អាតូម និងម៉ូលេគុល ប្រទេសកម្ពុជា

Sources of Cambodian Students' Science Self-Efficacy: Trends and Patterns

RATHA CHEY
Department of Policy, Ministry of Education, Youth and Sport, Phnom Penh, Cambodia
Email: ratha_chey@yahoo.com

Received: December 22, 2020/ Accepted: May 08, 2021

Abstract

Promoting science, technology, engineering and mathematics (STEM) education is one of the top agendas of the Royal Government of Cambodia for human resource development. However, Cambodia is facing a worrisome decline in enrolment in the high school science track, which may result in less proportion of students who choose to major in STEM-related fields in higher education. Thus, the current study seeks to identify the trends and patterns of the sources of Cambodian university students' science self-efficacy. By utilizing a multi-phase random sampling method, the researcher selected 819 first-year students from four public and two private higher education institutions (HEIs) to participate in a survey. The descriptive statistics was used to examine the trends of the sources of science self-efficacy and inferential statistics was employed to investigate the patterns of science self-efficacy by using the independent sample t-test and one-way ANOVA to determine the significant differences between students' characteristics and the sources of science self-efficacy. The results showed that vicarious experience was rated the highest while the other three sources (mastery experience, social persuasion, and physiological state) were low. With respect to the patterns of the sources, age, high school tracks, university major choices, family socioeconomic status (SES), and parental education and occupations made a significant difference to students' science self-efficacy, while gender and place of origin did not.

Keywords: Science self-efficacy; Cambodian students; STEM; High school science track; Higher education institutions

1. Introduction

The Royal Government of Cambodia (RGC) acknowledges that promoting human resources in STEM-related fields can help the country to realize its vision to achieve an upper-middle-income status by 2030 and a high-income status by 2050 (MoEYS, 2016). As a result, promoting quality human resources in the fields of STEM is on top of the agenda of the RGC. The agenda is clearly stated and emphasized in the National Strategic Development Plan (NSDP) 2019–2023 and Education Strategic Plan (ESP) 2019–2023.

To support and ensure the realization of the government's vision, the Ministry of Education, Youth and Sport (MoEYS) plays a critical role in promoting the quality of education, and more importantly, in producing a skilled and competent workforce in the STEM-related fields because these will be in high demand in the future. As a result, in 2016, MoEYS formulated a policy on Science, Technology, Engineering, and Mathematics education. The vision of the policy is to promote human resources in terms of quality and equity with specific regard to STEM fields to contribute to sustainable economic development in alignment with the Industrial Development Policy (IDP) 2015–2025 (MoEYS, 2016). Furthermore, the policy points out that to achieve the stated vision, some key strategies need to be implemented, such as providing professional development opportunities in STEM- related fields to faculty staff, promoting teaching, nurturing learning, and upgrading infrastructure to support STEM majors in higher education (MoEYS, 2016).

However, there is a worrisome declining trend in students' choice of science track in upper secondary schools. Unambiguously, it is observed that the number of students choosing science track in upper secondary schools has gradually decreased during the last six academic years 2013–2019, while there has been a gradual increase in the social science track (MoEYS, 2020). Although the government has not officially claimed whether this trend is positive or negative, students' choice of science track in upper secondary school was empirically found to affect their choice of STEM-related majors in higher education. Thus, the declining trend in the science track needs to be investigated. Unarguably, this scenario will sooner or later cause concern for the government and policymakers to tackle this issue promptly. As clearly stated in the NSDP 2029–2023, IDP 2015–2025, ESP 2019–2023, and Policy on STEM education, the vision of the government is to promote highly skilled workforce in STEM- related fields to respond to the future demand of the nation to transition itself from the current status of being a middle-income nation to an upper-middle-income nation by 2030 and a high-income nation by 2050. According to the enrollment trends in high schools, the policies and the demand of human resource development are not in agreement. This issue cannot be ignored, and relevant stakeholders need to pay great attention to it.

Previous studies in the context of Cambodia revealed a strong relationship between students' choices of STEM-related majors and their science self-efficacy. It has been found that students who had higher science and mathematics self-efficacy tended to favor STEM fields (Eam, Keo, Leng, Song, & Khieng, 2019; Kao & Shimizu, 2019). However, sources of students' science self-efficacy remain unidentified. Therefore, to fill this knowledge gap and to promote students' enrollment in STEM education, the current study was designed to investigate the trends and patterns of the sources of Cambodian university students' science self-efficacy. Two research questions guided the current study:

1. What is the level of the sources of students' science self-efficacy?
2. Are there any significant differences between students' sources of science self-efficacy and their demographic characteristics?

2. Review of literature

2.1 What is self-efficacy?

Over the last few decades, the self-efficacy theory has attracted the attention of many researchers and scholars (Gwénaëlle, Ellen & Pascal, 2011). Self-efficacy is defined as "beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations" (Bandura, 1995, p. 2). Kumar and Lal (2006) stated that the way an individual perceives and works is influenced by their self-efficacy. Self-efficacy plays an influential role in the way people perform activities and the choices they make. People who perceive low personal efficacy toward tasks tend to escape or quit, while those who feel more efficacious are likely to attempt to put their effort in the jobs with positive personal judgement on their capability (Schunk, 1985).

2.2 Studies on relationship between self-efficacy and academic and career choices

Numerous studies on self-efficacy asserted that self-efficacy plays a vital role in students' academic and career choices (Eam et al., 2019; Hackett, 1985, 1995; Hackett & Betz, 1981; Kao & Shimizu, 2019; Kolo, Jaafar, & Ahmad, 2017; Lent, Brown, & Larkin, 1986; Zeldin, Britner, & Pajares, 2008). In the context of Cambodia, Eam et al.'s (2019) study on factors affecting freshmen's choice between STEM and non-STEM majors revealed that there was a significant relation between students' science self-efficacy and science related majors and students who showed higher science self-efficacy tended to select STEM-related majors at universities. Regarding the relation between self-efficacy and career choices, Zeldin et al. (2008) employing a qualitative study to investigate the self-efficacy beliefs of men in mathematics, science and technology careers found that the selection of these mentioned occupations was significantly influenced by self-efficacy. Similarly, Zeldin and Pajares (2000) who conducted an interview study to explore the self-efficacy beliefs of women in mathematics, science, and technology found that the participants' self-efficacy was the crucial factor contributing to the selection of the mentioned careers. Another study on the role of mathematics self-efficacy in choosing the mathematics-related majors at colleges indicated that science- and mathematics-related college major choices were directly predicted by mathematics self-efficacy (Hackett, 1985). Regarding the role of self-efficacy in career choices, Lent, Lopez, and Bieschke (1991) conducted a study with 138 university students in America to investigate the relationship between mathematics self-efficacy and science-related career choice .They found that the choices related to science careers were significantly predicted by the mathematics self-efficacy. Lent et al. (1986) conducted a study to explore the relationship between self-efficacy and academic and career choices of undergraduate students. Results obtained from linear regression revealed that self-efficacy significantly predicted the perceived career options in technical and scientific areas. According to the empirical evidence drawn from these previous studies, it is clear that self-efficacy influences how students make their future academic and career choices.

2.3 Mastery experience

Bandura (1977) pointed out that an individual's self-efficacy is influenced by four main sources: mastery experience, social persuasion, vicarious experience, and physiological state. Dinther, Dochy, and Segers (2011) stated that mastery experience, considered an influential factor in self-efficacy expectations, refers to an individual's past success in performing certain previous tasks. By completing a job or overcoming a tricky situation, an individual tends to possess positive self-efficacy expectations toward similar tasks in the present. Moreover, even while facing harder tasks, an individual tends to persist when his/her self-efficacy has been increased by past achievements.

2.4 Social persuasion

Social persuasion is another source of personal efficacy in which a person is motivated by others. Although this source is not as influential as the mastery experience, encouragement can help an individual gain more confidence and self-trust to execute a difficult task. However, the persuaders must be careful while giving encouragement because false praise may lead to negative perceived self-efficacy. More importantly, the persuaders should keep in mind that verbal persuasion alone is not effective enough; providing more support to enhance an individual's performance needs to be considered as well (Bandura, 1977).

2.5 Vicarious experience

Bandura (1977) further elaborates that self-efficacy expectations are also influenced by vicarious experience. People not only depend on mastery experience and social persuasion alone to enhance their self-efficacy, but they also depend on learning and observing from others. This means that, through social comparison, people tend to compare their abilities to someone else's in performing a task. By seeing other people's performance, people judge their own abilities and put their efforts on the task. Therefore, modelling can change people's behavior toward performing a task (Bandura, 1977).

2.6 Physiological state

The last source of personal efficacy is physiological state. People who experience fear, stress, and anxiety toward a particular situation tend to perceive their self-efficacy negatively. While facing a threatening situation, such people find it hard and challenging to handle the situation because of the stress. Conversely, individuals who react to situations with positive emotional arousal tend to put in their efforts to the tasks, even though those tasks are challenging (Bandura, 1977).

Overall, according to Bandura (1977), there are four main sources of self-efficacy. However, in the Cambodian context, there is a lack of study exploring details of those sources of self-efficacy although self-efficacy has been found to affect students' choice of STEM majors in higher education (Eam et al., 2019; Kao & Shimizu, 2019).

3. Methodology

3.1 Research sample and sampling

This study employed a quantitative method. A total sample of 819 first-year students were selected through a multi-phase random sampling technique to participate in a survey. There were two steps in the sampling process. In the first step, six HEIs were purposively selected based on the enrolment statistics of foundation year 2017-2018 provided by the Department of Higher Education, MoEYS. In this stage, the researcher selected only the institutions where STEM and non-STEM-related majors were offered. It should be noted that only institutions that offer at least two STEM majors with an enrollment of 40 students or more were considered for the study., There were two reasons for this. First, the researcher attempted to diversify the participants' fields of STEM. Second, it was to secure the sufficient sample size in the study as in reality, some institutions offer fields in STEM, but the number of students is few which might be another concern if those institutions were included in the study. With respect to the non-STEM majors, there were no specific criteria because there are a variety of non-STEM fields offered by each institution, so it is not necessary to set any criteria for inclusion.

In the second stage, the researcher employed random sampling in order to select STEM and non-STEM classes from the six selected HEIs. In this process, firstly, the researcher requested the lists of all classes in each institution and then grouped those classes into STEM and non-STEM accordingly. With these two groups, the researcher started to randomly select two classes from each group. As a result, a total of four classes were selected from each institution.

3.2 Instrument

To measure the four sources of Cambodian university students' science self-efficacy, the study adapted Ellen and Pajares' (2009) measurement which has twenty-four six-point-Likert-scale items (1: definitely false, 2: false, 3: slightly false, 4: slightly true, 5: true and 6: definitely true). The measurement was originally used to measure the sources of mathematics self-efficacy, so all the items were reworded for science domain. After conducting the Factor Analysis, the researcher finally retained 22 items for this study. For mastery experience, one item was removed due to low loading value, so there are five items to measure this subconstruct. Next, like the case of the first subconstruct, one item was also removed from the vicarious experience while six items were retained for social persuasion physiological state, respectively. The Cronbach's alpha value was .883 for mastery experience, .750 for vicarious experience, .934 for social persuasion and .843 for physiological state. The value for the four sources construct was .926, suggesting that the construct was suitable and reliable for the current study.

The researcher translated the questionnaire from English into Khmer language, the native language of the participants, to avoid any misunderstanding and language barrier when the participants filled the questionnaire. To gain a reliable instrument for the data collection prior to the actual data collection, the questionnaire was piloted with 237 students from two private universities located in Phnom Penh and one public university in Battambang province. The result from the pilot showed that the instrument was reliable, with Cronbach's alpha of .850

and from the actual data collection, the value of Cronbach's alpha was .929, showing very high reliability of the instrument for the study (Leech, Barrett, & Morgan, 2005).

3.3 Data collection procedures

Within the scope of the study, two private universities located in Phnom Penh and four public universities—One located in Battambang province and the other three located in Phnom Penh—were considered for data collection. Freshmen pursuing STEM and non-STEM-related majors were the target participants of the study. During the fieldwork, the researcher met the participants in the classroom, and before handing the questionnaire, the participants were introduced to the researcher and were clearly explained about the purpose of the study. More importantly, the researcher read out loud the informed consent to seek for their approval to fill in the five-page questionnaire which had been translated into the Khmer language. Based on the consent form, the unwilling participants could withdraw; willing participants were asked to sign the consent form before filling out the questionnaire. To ensure that the participants clearly understood all the items in the questionnaire, the researcher clearly explained each item to them and stayed in the room until the participants had finished and submitted the questionnaires.

3.4 Data analysis

Statistical Package for Social Sciences (SPSS) Version 23 was used for data analysis. Technically, to obtain the reliable results from the data analysis, the researcher undertook two important steps. Firstly, the scores of the seven items were reversed because of their negative statements. Next, the Exploratory Factor Analysis (EFA) was conducted to test the construct validity of the items that were used to measure the four primary sources. Besides the EFA, Cronbach's alpha was also conducted to confirm the instrument's reliability.

Regarding the analysis methods used, both descriptive and inferential statistics were employed in the study. The descriptive statistics, including frequency, percentage, and means, was used to analyze answers for research question 1 which attempted to identify the trends of the sources of science self-efficacy. To answer the research question 2, inferential statistics was utilized. Specifically, an Independent sample t-test and one-way ANOVA were conducted to identify the patterns of the sources of self-efficacy in relation to students' demographic information.

4. Results and discussions

As shown in Figure 1 below, the results indicated a low to moderate level of students' sources of science self-efficacy. This result suggested that the sources of science self-efficacy did not reflect the realities of Cambodian students, except the vicarious experience which demonstrated a moderate level (M=4.21, SD=.81). This was followed by physiological state (M=3.98, SD=1.04), mastery experience (M=3.77, SD=.1.01) and social persuasion (M=3.47, SD=1.13). In this sense, it could be interpreted that on average, modelling in learning science tended to be one of the good sources of Cambodian students' science self-efficacy. However, according to the mean score of mastery experience, Cambodian students did not perform well in science. In addition, students may not receive praise from surrounding people such as peers,

teachers and parents. With the mean score of physiological state, students' emotional reaction and anxiety toward science learning is another concern. Bandura (1977) hypothesized that mastery experience is the most powerful source of self-efficacy. This hypothesis is not confirmed by the results of the current study as vicarious experience was found the most powerful one.

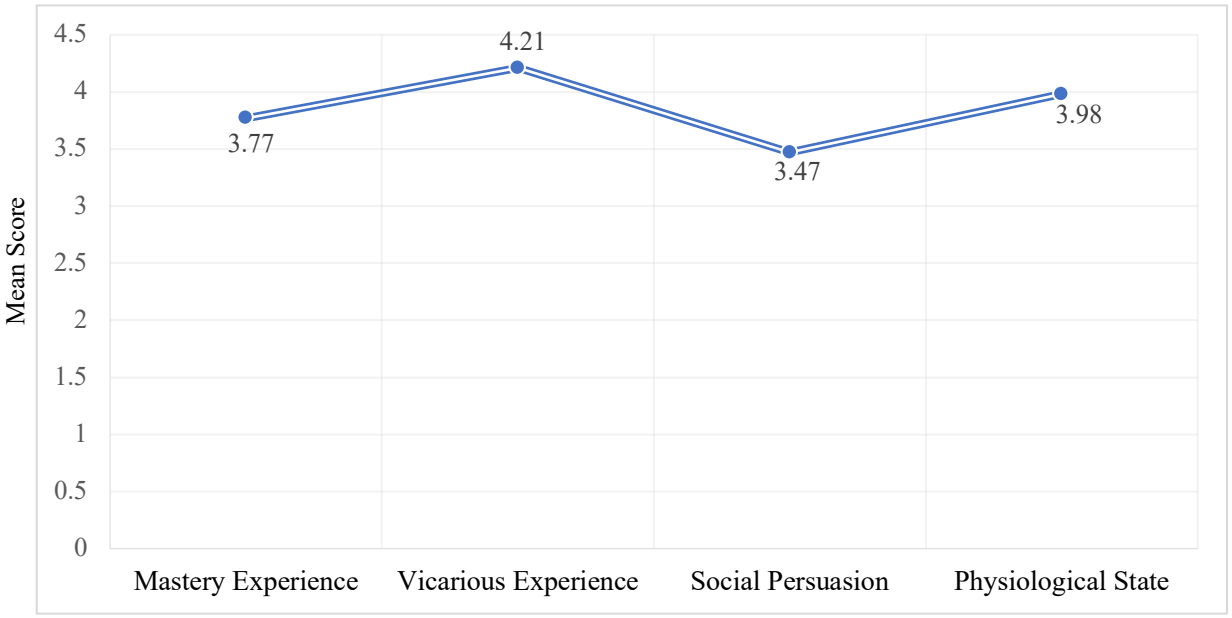


Figure 1. Trends of the sources of Cambodian students' science self-efficacy

The current study also investigated the patterns of the four sources of self-efficacy and its relationship with students' demographic information. The following results focus on the significant differences between each demographic variable and the four sources of self-efficacy, namely mastery experience, vicarious experience, social persuasion and physiological state.

4.1 Gender

According to the result generated from the independent sample t-test, gender did not make a significant difference in the four sources of self-efficacy. Thus, it does not matter whether the students are male or female when considering the sources of their science self-efficacy. The result of the current study was partly inconsistent with a study by Kiran and Sungur (2012) which revealed that gender difference was found in physiological state.

4.2 High school tracks

The result indicated that high school tracks made a significant difference in the four sources. All the students in science track rated the four sources to be true about them. The mean scores of the four sources were (M=4.17, t (453.03) =18.54, p=.000 for mastery experience; M= 4.45, t (459.81) =12.28, p=.000 for social persuasion; M=4.29, t (479.37) =12.46, p=.000 for vicarious experience; and M=4.29, t (479.37) =12.46, p=.000 for physiological state) respectively. Remarkably, the results showed that the social science track students did not think that the four sources of science self-efficacy were true about them because all the mean scores

were under 4. With these findings from the independent sample t-test, it could be interpreted that students who chose science track received good achievement in science, learned from others who performed better, took those people as role models in learning science and lastly did not feel stressed or scared of attending science classes.

4.3 Place of origin

In this study, place of origin refers to students' place of birth which was classified into Phnom Penh (capital city) and provinces. The independent sample t-test revealed that this variable did not make a significant difference in students' sources of science self-efficacy.

4.4 Majors at higher education

The results demonstrated that students who majored in STEM-related fields perceived that the sources were true about them, except social persuasion (for mastery experience, M=4.06, t (804.91) =8.64, p=.000; vicarious experience, M=4.37, t (795.81) =5.58, p=.000; social persuasion, M=3.82, t (817) =9.27, p=.000; and physiological state, M=4.27, t (795.81) =7.24, p=.000). In each source, except social persuasion, the mean scores were above 4 which indicated that three sources were true about them regarding their science self-efficacy. This finding could clearly show that students who decided to take one of the STEM-related fields experienced good performance in science subjects, enjoyed learning the ways of other people learned, and liked science classes.

4.5 Family SES

The result generated from the one-way ANOVA revealed that students who came from the high family SES (monthly income > 600$) rated the four sources true (F=7.85, p=.000 for mastery experience; and F=7.35, p=.000 for social persuasion), except for vicarious experience and physiological state. From this result, it could be interpreted that students may have received a lot of care and encouragement from their parents who had better economic status in learning science. In this sense, perhaps, students received more support in terms of money and study materials from their family whereas the parents who had low family SES could not sufficiently provide similar kinds of support. The result partly concurred with the study by Arslan (2013) which found that students from high family SES rated the items measuring mastery experience highly.

4.6 Age

Age could make a significant difference only in vicarious experience (F=5.09, p=.002). With this respect, students who were in the category of under 18 and between 18-21 groups rated true while the other groups did not. This result is interesting because young students could learn science better when surrounded by others, especially their peers who could be their role models.

4.7 Father's education

The result from One-Way ANOVA indicated that father's level of education contributed to significant differences in their children's sources of science self-efficacy as two of the sources were rated true by the participants (F=4.97, p=.001 for mastery experience; and F=5.64, p=001 for social persuasion), except vicarious experience and physiological state. Students whose parents received higher education chose the answer above *slightly true*. The finding could suggest that father who received higher education tended to help and support their children's learning as well as provide good physical and mental support; as a result, their children performed better in science. The mean scores from the participants could be interpreted that students whose parents received higher education rated the items above *slightly true*. Thus, father's level of education played a critical role in nurturing the sources of students' science self-efficacy.

4.8 Mother's education

Like father's education, mother's education differed significantly in two of the sources (F=6.34, p=.000 for mastery experience; and F=4.08, p=.003 for social persuasion), except vicarious experience and physiological state. The result showed that students whose mother received higher education acknowledged that the three sources, namely mastery experience, vicarious experience and social persuasion were true in their science self-efficacy with the mean scores 4.13 for mastery experience, 4.50 for vicarious experience and 3.81 (almost reached 4 which represents *slightly true*) for social persuasion with the respective levels of significance at .000, .003 and .004, respectively. Like the case of father's education, mother's level of education really mattered in improving students' sources of science self-efficacy.

4.9 Father's occupation

Father's occupation also contributed a significant difference to two of the sources (F=3.55, p=.000 for mastery experience; F=2.80, p=.005 for social persuasion), except the vicarious experience and physiological state. Students whose father worked in non-government organization (NGO) respectively rated mastery experience (M=4.31), vicarious experience (M=4.42) and social persuasion (M=3.92) true in relation to their science self-efficacy at .000, .022 and .012 levels of significance. Thus, the type of job that fathers hold plays a crucial role in enhancing students' sources of science self-efficacy.

4.10 Mother's occupation

Students' mother occupation could make a significant difference in only mastery experience (F=3.38, p=.001) as students whose mother worked in NGOs perceived that mastery experience contributed to their science self-efficacy (M=4.80). This was followed by students whose mother retired from work (M=4.10) for social persuasion at .001 and .009 respectively. Here, mother's employment status was also a major contributor to improving the sources of science self-efficacy, especially regarding students' mastery experience.

5. Conclusions

Based on the findings, the following conclusion can be drawn. Firstly, Cambodian university students' performance is not good from their previous grades. Answers to the questions about mastery experience which asked students to reflect on their past performance in science clearly indicated that students did not receive good science achievements. Secondly, items related to vicarious experience which is about students' observation and learning from surrounding people seems to be one of the good sources of science self-efficacy as the mean score was 4.21. Thus, modelling and learning from other people seem to be a good source of science self-efficacy. Thirdly, given the low mean score, social persuasion seems to help enhance Cambodian university students' science self-efficacy. The result related to physiological state, the last source of science self-efficacy suggests that Cambodian students seem to have negative attitudes toward learning science because their responses indicated their fear and negative emotional reactions to science classes.

With respect to the significant differences between the four sources of science self-efficacy and students' demographic characteristics, in general, there is no gender gap in the sources of science self-efficacy. Moreover, where the students come from, either the capital city or provinces, does not make any difference to their science self-efficacy. These two variables did not differ significantly in the four sources of Cambodian students' science self-efficacy, yet their age, family SES, parental occupations and parental education did. Young students whose ages were under 18 years old and between 18 to 21 tended to follow their role model in learning science which could help them improve their science self-efficacy. With respect to age, students did better in science from the previous grades, learned from surrounding people on how to learn well, felt positive in receiving encouragement and needed emotional support. Last but not least, the result regarding the economic status of students' family and parental educations showed that the higher the income as well as the higher level of education parents received could help contribute to improving students' sources of science self-efficacy.

For further investigation of this issue, future research should consider the students who are in tenth grade since in this grade students do not decide yet between the science and social science tracks. Moreover, future research may explore other key factors beyond the scope of this study. For example, future studies may examine the relationship between science self-efficacy and students' perception toward their classroom teachers as well as teachers' interaction with the students.

References

Arslan, A. (2013). Investigation of relationship between sources of self-efficacy beliefs ofsecondary school students and some variables. *Educational Sciences: Theory & Practice*, 13(4), 1983-1993. doi:10.12738/estp.2013.4.1753.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191-215.

Bandura, A. (1995). Exercise of personal and collective efficacy in changing societies. In B. Albert (Ed.), Self-efficacy in changing societies (pp. 1-45). Cambridge: Cambridge University Press.

Dinther, M. v., Dochy, F., & Segers, M. (2011). Factors affecting students' self-efficacy in higher education. Educational Research Review, 6(2), 95-108. doi:10.1016/j.edurev.2010.10.003.

Eam, P., Keo, B., Leng, P., Song, S., & Khieng, S. (2019). Correlates of STEM major choice: a quantitative look at Cambodian university freshmen. Research in Science & Technological Education, 1-19. doi:10.1080/02635143.2019.1682987.

Ellen L., U., & Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. Contemporary Educational Psychology 34(1), 89-101. doi:10.1016/j.cedpsych.2008.09.002.

Gwénaëlle, J., Ellen L., U., & Pascal, B. (2011). Sources of self-efficacy: An investigation of elementary school students in France. *Journal of Educational Psychology*, 103(3), 649-663. doi:10.1037/a0024048.

Hackett, G. (1985). Role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. *Journal of Counseling Psychology*, 32(1), 47-56.

Hackett, G. (1995). Self-efficacy in career choice and development. In B. Albert (Ed.), Self-efficacy in changing society (pp. 232-258). Cambridge: Cambridge University Press.

Hackett, G., & Betz, N. E. (1981). A self-efficacy approach to the career development of women. *Journal of Vocational Behavior* 18(3), 326-339.

Kao, S., & Shimizu, K. (2019). Factors affecting students' choice of science and engineering majors in higher education of Cambodia. *International Journal of Curriculum Development and Practice*, 21(1), 69-82.

Kiran, D., & Semra, S. (2012). Middle school students' science self-efficacy and its sources: Examination of gender differences. *Journal of Science Education and Technology,* 21(5), 619-630. doi:10.1007/s10956-011-9351-y.

Kolo, A. G., Jaafar, W. M. B. W., & Ahmad, N. B. (2017). Relationship between academic self-efficacy believed of college students and academic performance. *Journal of Humanities and Social Science* (IOSR-JHSS), 22(1), 75-80. doi:10.9790/0837-2201067580.

Kumar, R., & Lal, R. (2006). The role of self-efficacy and gender difference among the adolescents. Journal of the Indian Academy of Applied Psychology 32(3), 249-254.

Leech, N. L., Barrett, K. C., & Morgan, G. A. (2005). SPSS for intermediate statistics: Use and interpretation (2nd ed.). New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. *Journal of Counseling Psychology*, 33(1), 265-269.

Lent, R. W., Lopez, F. G., & Bieschke, K. J. (1991). Mathematics self-efficacy: Sources and relation to science-based career choice. *Journal of Counseling Psychology*, 38(4), 424-430.

MoEYS. (2016). Policy on science, technology, engineering and mathematics education. Phnom Penh: Ministry of Education, Youth and Sport.

MoEYS. (2019). Education strategic plan 2019-2023. Phnom Penh: Ministry of Education, Youth and Sport

RGC. (2015). Industrial development policy 2015-2025. Phnom Penh: Royal Government of Cambodia.

RGC. (2019). National strategic development plan 2019-2023. Phnom Penh: Royal Government of Cambodia.

Schunk, D. H. (1985). Self-efficacy and classroom learning. Psychology in the Schools, 22(2), 208-223.

Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, science, and technology careers. American Educational Research Journal, 37(1), 215-246.

Zeldin, A. L., Britner, S. L., & Pajares, F. (2008). A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science, and technology careers. *Journal of Research in Science Teaching*, 45(9), 1036-1058. doi:10.1002/tea.20195.

Educating Student Teachers as Researchers at Regional Teacher Training Centres in Cambodia: Student Teachers' Perceptions

PHALY CHHEM

Graduate School for International Development and Cooperation (IDEC), Hiroshima University, 1-5-1 Kagamiyama, Higashi Hiroshima, 739-8529, Japan, Email: chhempoly@gmail.com

Received: December 22, 2020/ Accepted: May 08, 2021

Abstract

"Teachers as Researchers" is a concept that suggests integrating research practice into the teaching profession to improve the quality of classroom instruction. Contextually, little is known about research practice in both teacher education and school-based teaching in Cambodia. Aiming to reveal the status quo of research practice in teacher education in Cambodia, this qualitative case study was conducted to investigate student teachers' perceptions of Pedagogical Research Training (PRT) in their two-year pre-service program. The study employed focus group discussions (FGD) with the 22 PRT-experiential student teachers from four Regional Teacher Training Centres (RTTCs) to examine the significance and challenges of the PRT. The qualitative data from the FGD were analyzed using category coding techniques, corroborated with content and discourse analysis. The findings showed that student teachers perceived the PRT as a means to gain professional qualifications. However, their research enthusiasm was significantly hindered by the insufficiency of academic support and slightly affected by workload, financial limitations and limited knowledge of foreign language and ICT. These findings have implications for those involved in the implementation and development of the pre-service curriculum while Cambodian teacher education is making its way to university.

Keywords: Teachers as researchers; Pre-service; Student teachers; Perceptions

1. Introduction

While the quality of education is vital for societal development, the quality of teachers is even more critical because it is a predictor of such quality of education. Developing effective teacher education systems is considered as one of the local and international strategies for improving not only the quality of teachers but also the quality of education as a long-term goal. However, the process of qualifying teachers is context-based. Different educational contexts need different strategies in developing effective teacher education, which in turn depends on the diversity of local recourses, socioeconomic conditions and political motivation (The World Bank, 2013). There are also different models of teacher education for schoolteachers. According to Robinson (2017), a teacher education system might be one or a mixture of the following models: 1) pre-industrial trends, 2) apprenticeship and work-based learning, 3)

specialist normal schools or training college programs, and 4) the university-based teacher education.

Robinson (2017) elaborates on the roles of university in teacher education as follows:

> In contrast with the key characteristics of the training college model …, the involvement of universities in teacher education has crudely highlighted an almost opposite set of characteristics. These includes: a focus on the preparation of secondary-level teachers; the recruitment of students with higher academic qualifications and often from higher social class backgrounds; and the development of a strong theoretical or scientific basis for teaching, rather than a practical or vocational one. (p. 57)

The trend towards university in teacher education is also considered as a main factor for the inclusion of research practice in the teacher education programs/curriculum. Research practice has had a high reputation in the process of professional education because it generates contextual knowledge (Cochran-Smith & Lytle, 1993). The needs of emancipation of teachers' thinking also emphasize the significant role of research in the teacher education sector because research sets free educationists' practices (Carol & John, 1995). At the same time, research seem to have a powerful influence on educational policies and school reforms.

Apart from academic research practice in higher education, "Teachers as Researchers" is a concept that proposes integrating research practices into teacher education and teaching profession to promote teachers' professional growth. Such a conception encourages school-based teachers to continuously engage in/with research, particularly action research, to develop personally and professionally. Since research practices have long been considered as an effective tool for fostering teachers' competencies and professional development (Bullock, 2016; Carol & John, 1995; Cochran-Smith & Lytle, 1999b; Odhiambo, 2010; Price, 2001), research activities could be found in many initial teacher education programs and school-based practices. There are, however, different research practices in the teaching profession. Basically, teacher research within teacher education and teaching profession stemmed from teachers' work, mainly in forms of "teachers' journals, oral inquiries, classroom/school studies, and essays" (Cochran-Smith & Lytle, 1993). There are also similar catchy phrases (e.g., action research, classroom research, practitioner research, teacher research and *pedagogical research*) used to describe those research practices in various institutional contexts (Cochran-Smith & Lytle, 1993; Feldman et al., 2004; Gurung & Schwartz, 2009; Odhiambo, 2010; Zeichner & Noffke, 2001). Evidence from empirical studies show that research engagement during pre-service teacher education benefits student teachers in terms of professional knowledge, instructional skills, collaboration and professional identities (Corzo & Ram, 2009; Hine, 2013; Kasula, 2015; Lattimer, 2012). Other findings have shown that research practices are effective for professional development and career learning (Beck & Kosnik, 2017, p. 117; Castle, 2006; Hwa, 2014; Willegems et al., 2018).

In Cambodia, teacher education has been developed gradually since the early 1980s. It is moving towards university-based teacher education (TTD, 2015). For example, two out of the six Regional Teacher Training Centres (RTTCs) across the country have considered upgrading their institutional status by piloting a university-based teacher education program since 2018. However, the concept of Teachers as Researchers has been introduced in the pre-service teacher training program since the late 1980s. In fact, there has been a series of research development within this teacher education system. Eventually, research training in the pre-service program was formally introduced in the 12+2 pre-service teacher training program in 2011 under the name "Pedagogical Research Training".

However, little is known about research practice in both teacher education and school-based teaching in Cambodia. In this regard, an empirical study on the pedagogical research training at RTTCs is required as it will help to elucidate the factual position and function of research training and practice as well as to shed light on the future development of research within the teacher education curriculum as RTTCs are preparing to develop into university-based teacher education institutions.

Therefore, this study attempts to fill this knowledge gap and to develop as better understanding of reveal the status quo of research training/practice in the pre-service teacher training program at four Regional Teacher Training Centres in Cambodia. To achieve this aim, perspectives of student teachers who are pedagogical research practitioners are examined through two main research questions:

1. *How do student teachers at RTTCs perceive the roles of research training?*
2. *What do student teachers at RTTCs perceive as challenges during their research practice?*

The diversity of education systems, policy borrowing, and localization have caused ambiguities in terminological usage in the field of teacher education (Beck & Kosnik, 2017, p. 107). While "teacher education" in this study denotes the overall educational systems designed for qualifying teachers (Beck & Kosnik, 2017; Singh & Verma, 2016; TTD, 2013), the context-based term "teacher training" is used to refer to the 2-year-long pre-service programs in Cambodian teacher education systems. This study uses the term "teacher educator" to describe someone who is bound with one or more responsibilities to provide student teachers with in-class lessons, to supervise student teachers during the practicum, and to supervise student teachers during research practices. Likewise, "student teacher" refers to someone who has enrolled in a pre-service program. Meanwhile, the term "research training," or more precisely "Pedagogical Research Training" (PRT), refers to one training activity in the training curriculum for Cambodian pre-service programs for student teachers. Purposively, PRT is selected as a *reduced, focused* case of this study.

2. Literature review

2.1 Competing views on research for the teaching profession

Research, or other popular forms of teacher inquiry such as action research, can now be seen in most teacher education programs. It is observable that research outcomes have emerged as a mandatory requirement for graduation, yet research studies share less attention and shelter under the practicum curriculum during, mainly, the final stage of teacher education programs (Akyel, 2015; Faikhamta & Clarke, 2013; Lovat et al., 1995). Integrating research into teacher education programs, specifically during the practicum, can push student teachers to acquire more knowledge to supplement what they have learned through coursework in class. It is particularly helpful if the coursework within the main curriculum might fail to provide student teachers with knowledge and skills that they need for their teaching career. Moreover, research training has been considered as a useful tool for student teachers' learning beyond the boundary of teacher education programs. Bullock (2016, p. 381) described research within teacher education as "one powerful way to encourage teacher candidates to develop authority over their own experiences." Thus, research activities provide student teachers with opportunities to learn from observations and critiques of their own professional trials during their first-hand teaching practices or internships.

However, it is sometimes argued that research competes with other demands and challenges of the teaching profession such as time constraints, expertise and professional identities. First, most teachers do not have much time because besides teaching, they are supposed to involve in other activities such as official meetings, parental meetings, lesson planning, and administration tasks. Hammersley (1993) raised a concern that the space for research in the lives of teachers today has become less than it used to be (p. 441). During the practicum, teacher trainees who are novice teachers act as schoolteachers, so they must spend a significant amount of time to learn to teach, making them have less time to focus on research. Second, although teachers and teacher trainees may have some research experiences from their general education or teacher education programs, their research competencies are always questionable.
In short, they have been trained in the teacher education program to become teachers rather than researchers. Although teacher research conducted by classroom teachers might be more practical for classroom practice, it cannot totally replace research done by academic researchers (Hammersley, 1993). This is because *teachers* and *researchers* are two different professions, bearing with different public credentials and serving different communities' needs. It is unsophisticated to equate one occupation to another—i.e., to equate teachers with researchers (Cochran-Smith & Lytle, 1993).

2.2 Conceptualization of research for teachers

According to Cochran-Smith and Lytle (1993), teacher research could be identified by three main criteria. First, teacher research should be systematic. The term "systematic" in Cochran-Smith and Lytle's description was confined to the fact that teachers conduct research in a logical flow, from setting up researchable questions, to gathering and recording information, to analysing and reporting by some means and/or in some form. Second, teacher research

should be intentional. The term "intentional" here referred to a sense of clear objectives in conducting research. This means that teacher research should be led by a planned and deliberate activity. Finally, teacher research should be designed as a form of inquiry. The term "inquiry" in in this context means that "teacher research stems from or generates questions and reflects teachers' desires to make sense of their own experiences" (Cochran-Smith & Lytle, 1993, p. 24).

From the conventional perspectives, there are always questions about how teacher research makes any academic contributions to the literature because teacher research is usually considered small-scale research. However, it should be viewed that all pieces of knowledge should be counted as worthy for teachers' professional improvement and that the contribution might be seen later when all bits of knowledge from teacher research have been compiled. Similarly, the validity and reliability criteria of teacher research should be review differently from research conducted by academic researchers.

2.3 The role of research in teacher education programs

2.3.1 Research in the pre-service program

The role of research within teaching profession has become more and more fundamental because both conducting and consuming research are believed to benefit teachers' knowledge, skills, and beliefs in their profession (Cochran-Smith & Lytle, 1999a). Regarding the significance of research engagement, different versions of practitioner research have been integrated into most of today's teacher education programs in the form of final research projects or coursework assignments for pre-service teachers (Cochran-Smith & Lytle, 1999b). In most cases, student teachers were (and still are) required to conduct small-scale, school-based research during the practicum or internship programs because it is believed to be the most appropriate period when student teachers can have chances to learn about the teaching profession in a real-world context. The teaching practicum is not only a platform where student teachers experienced their teaching career first-hand (White & Forgasz, 2017) but it is also the time for cultivating positive attitudes towards teacher research. The new educational environment of practice schools and pedagogical theories that student teachers had learnt from their teacher education coursework might function as "critical incidents" (Carol & John, 1995) which led *teacher trainees* to have many research questions. By looking from another angle, if the practicum was a space for professional learning, then teacher trainees' research stance was even more important. In fact, without research stance or research attitudes, teacher trainees might fail to observe, reflect on themselves, or learn from the best practices of others to improve their skills. In short, a clear research stance provides meanings to the practicum.

The significance of integrating research into the pre-service program has been widely discussed. Medwell and Wray (2014) developed a project which involved research collaboration of eight student teachers during their pre-service education programs to examine the importance of research undertaking for pre-service teachers. It was found that by engaging in authentic research projects, student teachers benefited in terms of reflective and inquiry skills

through their exposure to and analysis of problems related to teaching and learning in the real school contexts. Studies of student teachers' thinking on research showed that engaging with research during pre-service teacher education programs helped student teachers to form professional identities through self-reflection (see Gitlin et al., 1999; Lattimer, 2012; Martine & Nogués, 2015). These studies also found that both reading and producing research helped student teachers to improve not only their knowledge of schooling but also their positive thinking about research. Some researchers also found that research engagement during the pre-service program raised student teachers' awareness of professional development as they asked educational questions about classroom dynamics and framed their own instruction based on their understanding (see Akyel, 2015; Lattimer, 2012).

Castle (2006) suggested that if teacher education programs wanted to promote autonomy or teachers' rationales for teaching, then research should be included as an inquiry component of the programs. In the same field of professional knowledge, other studies on research programs within the pre-service teacher education found that conducting research during the practicum helped student teachers to improve their awareness of teachers' roles, increase their reflective skills, enhance their research skills, and raise the effectiveness of curriculum implementation (e.g., Corzo & Ram, 2009; Lattimer, 2012; Martine & Nogués, 2015; Price, 2001). Furthermore, student teachers themselves had reported that research practice benefited them in the aspects of professional knowledge and curriculum, confidence, and teamwork (see Lattimer, 2012; Niemi, 2012).

Research activities within the undergraduate program complied with efforts of enhancing student-centred learning and teaching because by engaging in research, participants gained not only knowledge but also critical thinking and reflective skills. Research involvement also improved learning strategies and self-directed learning. Bower (2010, p. 50) pointed out that research was a learner-centred practice which fostered enquiry, problem-solving, academic performance, and confidence. According to Bower (2010), integrating research into the undergraduate curriculum helped improve research knowledge and skills and motivated students to engage in research. In the same way as in other disciplines at university levels, research should be included in the teacher education curriculum to benefit student teachers in getting insights into teaching theories and practice during their teacher education programs. Medwell and Wray (2014) showed that student teachers who cooperated in classroom research during their pre-service program developed their research knowledge, improved their reflective thinking, and built their identities as school-based teacher-researchers.

Akyel (2015) studied 22 student teachers' perceptions of the extent to which research helped them in terms of professional development. The study showed that student teachers benefited from engaging in research during the teacher education program and that they gained insights into teaching and learning from their own research project (Akyel, 2015). Research also provided student teachers with the opportunity to "learn in and from their own practice" and to reflect on their own practice. However, in their role as novice teachers and as novice researchers, student teachers needed fundamental help and support in terms of comprehensive induction course and practical guidance from experienced researchers (Akyel, 2015).

2.3.2 Research after the pre-service program

So far, different models of teacher education programs have been provided to novice teachers. However, no single model has been proved to provide student teachers with the complete professional knowledge and skills needed for their future career. Meanwhile, a new trend of teacher education suggests an interest in building novice teachers' capacity to develop their own professional competency by themselves (Beck & Kosnik, 2017). It is important to note that one strategy to bring about quality in teacher education is to equip student teachers with skills that enable them to trace the development of knowledge within their contextual teaching practice. As such, including research skills into teacher education curriculum has been widely supported by recent research findings as the most appropriate means of preparing teachers to face teaching challenges in the contemporary educational contexts as well as in their future career (e.g., Barócsi, 2015; Jantarakantee et al., 2012; Lovat et al., 1995).

2.4 Challenges of research in teacher education

Support and facilitation were important for student teachers during their research undertaking because they faced challenges such as time constraints and overwhelming teaching workloads during their practicum (Akyel, 2015; Barócsi, 2015; Jantarakantee et al., 2012). Barócsi (2015) indicated that student teachers also lacked basic knowledge of research methodology, especially in terms of framing research problems and defining research design. It was found that student teachers reported four key elements that helped them succeed in their research projects: 1) initial lessons of research, 2) hard work, 3) patience and commitment, and 4) support from schools.

In some cases, student teachers misunderstood the concept and goals of research practice during their teaching practicum, which resulted in "negative attitude" toward teacher research because the research introduced to them was sometimes viewed as additional workloads for teachers as well as for student teachers (see Faikhamta & Clarke, 2013, p. 1). In another study on pre-service teachers' research, Gitlin et al. (1999) found that research engagement of mentors/supervisors had a significant impact on pre-service teachers' thinking on research and their own research practice.

In a case study conducted with a pre-service Teaching English as a Foreign Language (TEFL) teacher, Barócsi (2015) found that teacher trainees faced numerous difficulties in conducting research. The difficulties could be classified into four major categories:

> The challenges of the process were related to five (sic) major points: (a) finding the nature and the field of research, (b), choosing the title of the study, (c) working hard along various commitments, and (d) involving the group of students in the study. *(p. 241)*

Barócsi (2015) suggested improving the connections between engagement in research and the actual teaching practice (p. 242). There should be further training and lessons on research methodology to make sure that student teachers were clear about the rigorous concept of research in teacher education (Barócsi, 2015). Psychologically, having firm knowledge and

hands-on experience might reduce anxiety in a future confrontation. Thus, it is necessary that the teacher education program should provide student teachers with prior knowledge and skills needed to conduct research in their field of interest.

One of the key challenges for student teachers while conducting research during teaching practice was time management. A study by Akyel (2015) showed that student teachers encountered time constraints because they had to deal with teaching workloads. The lack of time was not only the challenge during their research practice in the teacher education program, but it was also viewed as a future challenge for novice teachers' research engagement when they started their teaching career. Of course, at the beginning of every job, there would be many new things to learn about. That is why student teachers also reported their worries about their research engagement in the future as they wished to be effective teachers and researchers (Akyel, 2015).

3. Methodology

This study adapts "*revelatory*" (italic in original) case study research design as it attempts to describe a "previously inaccessible" phenomenon (Yin, 2018, p. 50). This was because the case of this study was preliminarily known as a marginalized fact or had never been explored before. With the revelatory case study research method, the researcher had an "opportunity to observe and analyze a phenomenon previously inaccessible to social science inquiry" (Yin, 2018, p. 50). According to Creswell (2013), the purpose of a case study research is to explore a real-life phenomenon within a bounded system of *time* and *place* in order to develop an in-depth understanding of a particular social condition. In this study, pedagogical research training (PRT) is the reduced, focused case which is bound by 1) the four-semester pre-service programs, 2) the context of non-university-based teacher training of RTTCs, and 3) one training cohort (2018-2020).

Since the case is revelatory in characteristics, multiple sampling methods were used, purposively aiming to reach the right participants who had good knowledge and practical experience of the case. The core justification for the sampling method was to reach the information-rich participants for the focus group discussion (FGD) and in this regard, the sampling methods included 1) random purposeful: participants are student teachers who experienced PRT at RTTCs, 2) snowballing: the directors of RTTCs would facilitate the rapport between the researcher and the groups of student teachers, and 3) maximum variation: the size of sample would be decided on information saturation and/or time (Creswell, 2013, p. 158).

Furthermore, the interest of selecting FGD as a method of data collection was not only to save time and money, but it was the researcher's interest to see how the participants negotiate the meanings of the topic under discussion. For the data collection, the researcher visited the sites two times. First, the researcher observed the process of PRT and the preparation when student teachers were about to start practicing pedagogical research in Semester-2 of the program. The second visit was conducted at the end of Semester-3 of the pre-service program. Student

Table 1

The demographics of student-teacher participants in the focus group discussion

Participants (Pseudonyms)	Last education	Teaching hours/week	Teaching days/week	Foreign language	Own Personal Computer	Being on tertiary education
ICT1	UPS	8-12	6	English (3/5)*	Yes	N.
Math1	UPS	4-6	6	En (2/5)	Yes.	Yes.**
History1	B	4-8	6	En (1/5)	Yes.	No.
Biology1	UPS	4	6	En (1/5)	Yes.	No.
Engish11	B	4	6	En (4/5) French (1/5)	Yes.	No.
English12	UPS	9	6	En (5/5) Fr (1/5)	Yes.	Yes.
English2	B	4-6	3	En	No.	No.
History2	UPS	3-6	3	En	Yes.	No.
Biology2	UPS	2-4	4	En (3/5)	Yes.	No.
Math2	UPS	2-6	4	En (3/5)	Yes.	Yes.
Khmer2	B	8-12	5	En (3/5)	Yes.	No.
Physic2	UPS	3-6	3	En (3/5)	Yes.	No.
ICT2	UPS	3-4	3	En (4/5)	Yes.	Yes.
Biology3	UPS	8-12	3	En (2/5) Fr (1/5)	No.	Yes.
ICT3	UPS	12-14	3	En	Yes.	Yes.
Math3	UPS	8-12	3	En (3/5)	No.	No.
History3	B	2-4	2	En (2/5)	Yes.	No.
English3	UPS	8-12	4	En (4/5)	Yes.	Yes.
Khmer3	UPS	6-12	3	En (3/5)	Yes.	Yes.
Biology4	UPS	6-12	5	En	No.	No.
Physic4	UPS	7-14	6	En	Yes.	No.
History4	B	6-12	5	En (3/5)	No.	No.
Total = 22						

Note: - UPS = Upper Secondary School Certificate (BacII), B = Graduation of bachelor's degree
- En = Knowledge of English language, Fr = Knowledge of French language
- * The self-rated qualification of foreign language competency based on a 5-scale ratio.
- ** The participant was pursuing higher education in the form of a weekend/Sat-Sun programme while being on the pre-service programme at RTTC.

teachers were close to the end of their pedagogical research project and were preparing for a final report. At this stage, the directors of RTTCs helped organize the groups of student-teacher participants (or ST-participants), and the researcher facilitated the focus group discussion.

In this study, 22 student teachers from the four RTTCs, who are homogeneous in terms of the training cohort, took part in the focus group discussion (FGD). The qualitative data from FGD were transcribed and then analyzed using a "*category*" (italic in origin) method, supported by discourse and content analysis. According to Merriam and Tisdell (2016, p. 203), category data analysis happens when the bulk data are reduced to be "*answers*" (italic in original) to the research questions and that the key answers are generally reported in the forms of "*categories*" or "*themes*" or "*findings*" (italic in original). Thus, all significant information related to 1) the significant roles and 2) the challenges of PRT were accumulated and condensed into deep insights of the case under study (Merriam & Tisdell, 2016, p. 204). Meanwhile, discourse analysis was used to assure the understanding and interpretation based on language-in-use.

Finally, content analysis was used to extend the answers beyond the qualitative category analysis, which helped to form a better understanding in the form of quantitative interpretations. For ethical consideration, each student teacher was mentioned by his or her specialized subject and a coding number. For example, "English9" would mean a ST-participant who was specializing in teaching English subject. Table shows the participants' background.

4. Results and discussions

4.1 The significant roles of Pedagogical Research Training (PRT)

4.1.1 PRT as professional knowledge

First of all, student teachers reported that PRT helped improve their *general knowledge*. In fact, there were many references that implied the roles of PRT as a way to improve student teachers' knowledge. As one student teacher majoring in English subject tried to explain such an idea, "I think when we learn in class, we are not clear enough. Therefore, when the teachers [teacher educators] assign us to write pedagogical research, we learn more. It also improves our knowledge" (English3). History3 added, "I think that when we learn the in-class sessions, our knowledge is not clear. Our knowledge is poor. However, when we conduct pedagogical research, we have to *search* from all reliable sources. Our knowledge seems to improve. […] Our knowledge is much wider than it was before".

However, only a few participants elaborated on how PRT influenced their *pedagogical content knowledge.* Among those, one student teacher stated that, "For me, it is the [teaching] methods; [I have learned] new methods" (Math1). Apparently, student teachers could not perceive a clear link between PRT and the improvement of pedagogical content knowledge because they had chosen a wide range of research topics, which were not directly focusing on the pedagogical content knowledge.

During the pedagogical research practice, student teachers read many documents in their field of study. An ICT student teacher pointed out, "We read. And when we read, we read a wide range of materials" (ICT1). In addition, another student teacher added, "Therefore, it adds up to our knowledge that we earn from in-class instructions" (Math2). While the majority of student teachers would choose research topics in their field of study, PRT had a vital role in

improving their *subject content knowledge*. For example, one student teacher confirmed that, "We improve our knowledge of the topic about which we write. It is because we try to find as many documents related to the topic that we write as possible" (Physic4).

With regard to *research knowledge*, there were also some comprehensible comments raised by the participants and that represented their perceptions of PRT as an improvement of research knowledge:

- Research experience (English11)
- Writing with a standardized format (ICT1)
- How to bind a book (ICT1, ICT2, Biology1)
- Experience in writing a book (Bology2, Math3, Physic4)
- Basis of research (Math3)

4.1.2 PRT as professional study

During the focus group discussions, some student teachers also reported having gained *reflective skills*. For example, one student teacher mentioned, "When we study here [at RTTC], we learn the theories. During the practicum, we practice teaching. Therefore, we could add or make changes, or in other words, it [PRT] reflects both theories and hands-on practice" (Bilolgy1). Another student teacher raised a similar idea, "I receive *feedback* from my students [she meant she has learnt from feedbacks as a result of testing a teaching technique in her teaching-practice classes]" (Biology2). An ICT student teacher elaborated on his own practices to highlight the reflective skills, which finally helped him to choose a topic for his pedagogical research project (ICT3). He said,

> For ICT subject, upon the pedagogical research, first, I observe the classroom management when I was in the Practicum-I. When we could not manage the class well, we received **comments** [the participant's own word] from the visiting supervisors. Therefore, this year I finally decided to choose a topic about issues that make students unmotivated to learn ICT lessons.

Related to *self-evaluation*, some student teachers claimed that the pedagogical research practice helped them to think reasonably and creatively (e.g., English11) and that they could make a rational judgment on the pros and cons of, for example, a teaching method (e.g., Biology2). Overall, PRT helped student teachers learn to make evidence-based decisions and evaluation. Therefore, student teachers could justify their own performance regarding teaching practices and professional learning.

Although not much was explicitly said concerning how PRT shaped their abilities to work independently, such a perception could be inferred from some of the student teachers' responses. For instance, some participants provided critical clues regarding their performances that represented their *autonomy and self-regulation* during their research practices. As the data suggested, student teachers were responsible for their own pedagogical research project because:

- They made their own decision on their own research topics and plans.
- They tried their best to search for literature.
- They managed their own budget during their research practices.
- They consolidated their own knowledge and skills learnt from different contexts.
- They relied on their own abilities to overcome challenges during research practices.

4.1.3 PRT as professional practice

Development of teaching methods. One student teacher explained that PRT was a part of teaching practice; therefore, it added a meaning to the teaching practice during the practicum (Biology2). It could be inferred from her statements that in-class training sessions and the practicum were two platforms that linked the theories and the real-world practice. Besides, pedagogical research was another platform for consolidating and embracing the theories and practice, such as the one reported by a participant who said, "It helps us understand the lessons even better. So, it is easier to transfer such knowledge to our students […] the students also acquire the knowledge more easily" (Math3).

4.1.4 PRT as professional ethics

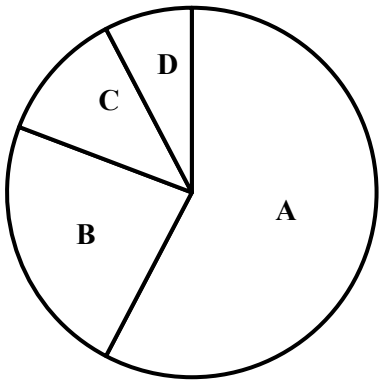
Involvement in development of educational resources. Some participants, (e.g., Enlgish11, English2 and ICT1) provided critical perceptive comments that the results of their pedagogical research practice would be an academic contribution to their peers and their juniors in the context of pre-service programs. Student teachers' perceptions were also aligned with those of teacher educators regarding the development of educational resources for both contexts of the teacher training program and school-based education.

Discussion

The findings of this study reflect two critical insights related to the concept of Teachers as Researchers. First, the significance of pedagogical research within the Cambodian pre-service program reported by the participants were quite similar to that of research practices at university-based teacher education. Pedagogical research here functioned as a tool that student teachers used to grasp and verify their knowledge (Akyel, 2015; Bower, 2010; Cochran-Smith & Lytle, 1999a; Lattimer, 2012; Medwell & Wray, 2014; Niemi, 2012), to improve their study skills (Akyel, 2015; Bower, 2010; Lattimer, 2012; Medwell & Wray, 2014; Niemi, 2012; White & Forgasz, 2017), to advance their instructional performance (Bower, 2010), and to shape their professional ethics (Gitlin et al., 1999; Lattimer, 2012; Martine & Nogués, 2015; Medwell & Wray, 2014). Second, this study also verifies that student teachers in the non-university-based teacher training programs also appreciate the significance of research practice. They have demonstrated their capacity and enthusiasm to conduct research to improve their professional qualification. However, the findings of this study leads to a skeptical view over the statement that "[r]each skills among teacher trainees are merely zero" (Dy et al., 2018).

Although these may not be new findings, they present the contextual lessons-learned for the case of PRT at the quasi-higher teacher education of RTTCs in Cambodia. The most important

message from this study is how student teachers perceive the roles of PRT in the teacher training curriculum. The following chart (Figure 1) highlights that student teachers see PRT as a means to gain professional qualification, especially professional knowledge. It is important to note that the qualitative content analysis below is based on verbal comments of 16 out of the 22 participants who discussed the significant roles of PRT.



- A = PRT as Professional Knowledge (58%)
- B = PRT as Professional Study (23%)
- C = PRT as Professional Ethics (11%)
- D = PRT as Professional Practice (8%)

Figure 1. Student teachers' perceptions of PRT

4.2 Challenges of PRT

4.1.1 What challenges

4.1.1.1 The insufficiency of academic support

The *insufficiency of academic resources* was reported repeatedly by the participants. The majority of the student teachers made similar complaints regarding the inadequate services of the campus libraries and the poor quality of the materials in the libraries. One student teacher made a short explanation that "The libraries do not have many documents or books" (Biology1). Such a remark was agreed by all of her peers. It was clear that student teachers could not rely on the local libraries for their pedagogical research projects. As one participant said, "If [it is] for pedagogical research, the documents in the library are nothing; [we] use the internet. In the libraries, there are not many books for research, or if so, only textbooks [for general education]" (History3). Another student teacher majoring in ICT subject added, "For me, the reference documents, for the most, nearly 90 per cent, I rely on the internet sources" (ICT3). It was no doubt that while the services of the local libraries were insufficient, some student teachers tried their best to access academic resources from different sources, including the internet, teacher trainers and school-based teachers, bookstores and local universities. For example, one participant said, "I have some books from the university, and I get some documents from the internet. I then compile them with the national textbooks. [He implies a notion that he could find enough documents for his pedagogical research project.]" (Physic4). Another issue was the *lack of research inputs* for student teachers. In this case, one English major participant stated, "For me, it is related to the writing format because we do not have any specific standards, that is why we are feeling confused about how to write" (English11). Immediately, another participant supported the idea in a suggestive tone that "[I] want [to see] a clearly defined format. Because they [teacher educators] just assign the topics, then let the research to be ours. We do not even know whether [our work is] right or wrong" (English12).

In some other cases, student teachers were forced to start the research processes without a single piece of research inputs. For instance, one student teacher revealed, "When it is time, we start [without any knowledge]. [If we make] any mistakes, the teachers [teacher educators as supervisors] help correct" (English2). Another student teacher who raised a similar situation said, "The challenge for me is that until now [It was two weeks before the due date for the submission of his research report] I have not received any guidance yet" (Math3).

4.1.1.2 The insufficiency of financial support

Student teachers needed a plenty of experimental and office materials during their practice of pedagogical research. They also needed internet access and ICT equipment. However, many participants expressed their unsatisfied feelings in their research experience because they had to rely on their own expense to make their research project work. Student teachers not only relied on the experimental materials used in their research but they also relied on their own budget for other expenditures related to the practice of pedagogical research, such as printing and binding the report book for final submission.. Such a perception was also supported by many participants, such as History1, Biology1, Physic2, History3, ICT3, and Hisotry4.

4.1.1.3 Workloads with time constraints

PRT happened simultaneously with the practicum, where the student teachers were under the supervisions of the teacher training centre and practicum centre. Such conditions created piles of work for student teachers. The following excerpts show that student teachers had encountered heavy workloads and time constraints during the practice of pedagogical research.

> For ICT subject, there is a problem with time. It is because in my subject, ICT, we mainly develop the lesson by ourselves. After that, we need to write a lesson plan. We need time to research on the lesson and to write lesson plans. (ICT3)
>
> As a request, if we conduct the pedagogical research, make it separated from the practicum. Not to write pedagogical research while having the teaching practice. It is time. Some student teachers have more-relaxed teaching hours; it is fine. Yet, some student teachers have many teaching hours, so they encounter difficulties upon the pedagogical research. (History4)

Though some student teachers seemed to accept the amount of time allocated for PRT during the practicum, they reported that they were constrained by heavy workloads. In most cases, the teaching practices were raised as huge workloads for student teachers; for example, English11 said, "For me, what hinders my pedagogical research writing is related to lesson-plan writing for the teaching practice. It is because I spend time to study the lessons, write the lesson plans, and prepare the teaching materials" (English11). Some other student teachers also provided similar comments.

> For me, History, if we consider the starting point form Month-1 [January] and the end in Month-3 [March], it is suitable if we only focus on pedagogical research writing. Yet, we need to study [at University] on Saturdays and Sundays. We also must teach

> two or three days per week, four hours per day. Therefore, we need to write lesson plans. (History3)

Student teachers' ideas about the workloads and time constraints during the PRT and the practicum, however, varied. For example, History1 said, "The school [RTTC] requires about 20 pages. Therefore, the time allocated [for PR] is quite a lot; what to say here is that they [teacher educators] let us write since the early of February." Another participant added, "[I am] not very busy. It is because we can edit the lesson plans and use them for other classes. After the tasks in teaching practice, I take some time for writing the pedagogical research. [He implies a notion that he has no problem with time management. It is not an excessive workload for him.]" (Physic4). However, student teachers of different subject majors seemed to have been affected differently by the workloads and the time constraints.

4.1.1.4 The limitations of foreign language and ICT skills

Some student teachers acknowledged that their abilities to use foreign languages and ICT skills were limited. The limitations of foreign language and ICT skills also affected their research competency. For example, one participant expressed her concerns that "Some documents are in the English language. We need to spend time to translate […] to understand the technical terminology" (Biology1). The following is an extract that revealed the limited abilities in the foreign language and ICT skills among some student teachers.

> For me, the difficulty in pedagogical research writing is that we do not know much English language. Some history documents are in the English language […] and the computer, we are not practical users. History3

> [In the library, there are some books in the English language]. Sometimes, as others have mentioned, our knowledge of the English language is limited. And another [difficulty] is computer usage. If we type, it is difficult. It is difficult to type [in Mathematics]; it is time-consuming. Math3

4.1.2 What caused the challenges

During the FGD, student teachers provided not only the challenges they experienced during the practice of pedagogical research, but also some sources of those challenges. **Error! R eference source not found.** provides a comprehensive understanding of the *challenges* of PRT and their respective *sources* that emerged from the focus group discussion. However, there were no comments that explained why student teachers lack competence in foreign language and ICT skills.

4.1.3 The impact of the challenges on the quality of PRT

Figure 2 below summarizes a rough comparison among the challenges of PRT based on frequencies of each challenge raised by the participants during the focus group discussion. From the chart, we could understand that the most significant factor that hindered PRT in the

pre-service program was the *insufficiency of academic support*. The term academic support here referred to 1) the lack of academic resources, both in the forms of paper-based and

Table 2

The challenges of PRT and the causes of the challenges

Challenges	Causes of the challenges
Academic support	- The existing guide for PRT was considered too vague, insufficient, and even inaccessible. As a result, there were ambiguous interpretations of the guideline, and eventually, it was the student teachers who were enduring those ambiguities. - Student teachers did not receive enough research inputs or more specifically, research competences. Therefore, the term "research" meant "go and find answers to the *assigned* questions in the existing printed materials." Unfortunately, the library services were limited due to the lack of resources and the poor facilities. - While the library services were not so satisfactory as expected, both teacher educators and student teachers turned to online resources. Unluckily, there was no free internet access in the RTTCs, which was considered as a lack of academic support. Such condition extended to be a financial burden because of the expenditure on the use of personal internet. - The research inputs/contents for student teachers were poorly designed and unstructured. In most cases, student teaches could hardly recall what exactly they had learnt, beneficially for their pedagogical research practices.
Financial support	- There were no school budgets allocated to support the process of PRT because such a training activity was considered a part of the practicum. Consequently, the focus was placed on the practicum rather than the PRT.
Workloads and a sense of time constraints	- The PRT and the practicum were two separate training activities with equal significance, and they were implemented and assessed simultaneously. In real practice, the time allocated for the PRT was eight weeks, which was the duration of the practicum in the second year of the pre-service program. This ambiguity was caused by the unclear PRT guideline. - On the face of it, greater attention would be spent on teaching practices rather than the PRT. As a result, a greater time allocation would be spent on the preparation of teaching practices rather than on the research activities.
Foreign language and ICT skills	- [No comments from the participants, i.e., there were not any clues that could be drawn from the qualitative data regarding the reasons for this challenge.]

computer-based resources and 2) the lack of research inputs for student teachers before getting them into research practices. Three other factors, such as 1) financial support, 2) workload and time constraints, and 3) Foreign language and ICT skills, were not prevalent since those challenges received fewer mentions, at only 13%, 13%, and 9% respectively.

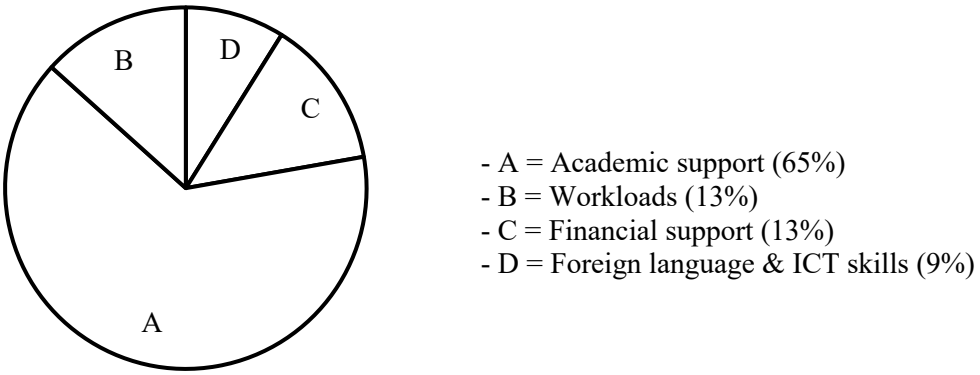


Figure 2. Student teachers' perceptions of the challenges of PRT

5. Discussion

The challenges reported by the participants fall into the same dimension as those reported in the previous literature. It becomes common that research training practice are confronted by time constraints, financial support, and researchers' capacity (see Akyel, 2015; Faikhamta & Clarke, 2013; Gitlin et al., 1999; Jantarakantee et al., 2012).

Thus, this study brings to the fore the contextual challenges where the non-university-based teacher training/education centres encounters during their attempts to promote the notion of Teachers as Researchers. From this study, it is clear that RTTCs, teacher educators and student teachers are faced with the lack of academic support in terms of well-structured research guidelines and research-friendly resource centres.

6. Conclusions

This qualitative case study set out to scrutinize student teachers' perceptions of research practice and the enduring challenges they face in the context of non-university-based teacher training at RTTCs in Cambodia. The major finding was that in general student teachers had positive perceptions of PRT in terms of the quality of the teacher training program at RTTCs because research practice helped improve their content knowledge, teaching practice, professional engagement, and study skills. Considerably, student teachers at RTTCs held high expectations that research practice is a tool for improving their professional knowledge. The findings also emphasized a triad connection among student teachers' perceptions, local policies for teacher education and the conception of Teachers as Researchers. Another major finding highlighted the insufficiency of academic support as the critical challenges of PRT. Such challenge included a lack of well-structured research inputs for student teachers, a lack of academic resources and a lack of clear research guidelines. In the meantime, financial hardship, heavy workloads, limited ICT and foreign language skills also emerged as subtle challenges for student teachers.

The findings also showed that student teachers perceived the significant roles of pedagogical research training and practice differently, yet positively in terms of professional training and learning. In addition, although a wide range of perceptions and practices are occurring at RTTCs, they serve a convergent training goal of to improve "research stance" (Hammersley, 1993, p. 439) and respond to the diversities of institutional contexts. There might be two possible factors that led to messy conceptions of pedagogical research at RTTCs. First, it was simply the working process when the curriculum developers and the implementers had been trying to re-conceptualize the concept of teacher research as well as the conception of Teachers as Researchers. Another factor was the disconnection or miscommunication between the developers and implementers of the pre-service curriculum.

This study reveals that student teachers are keen to conduct pedagogical research and that they are capable enough to do so. Unfortunately, the pre-service program fails to foster their research enthusiasm. It is perhaps not necessary to standardize the pedagogical research practices at all RTTCs, yet the current research guideline should be restructured to face the future research practices as the pre-service programs are being upgraded to university-based teacher education. The new version of PRT should therefore pay more attention to the fundamental research inputs for student teachers.

This study's findings suggest that there are some possibilities to improve the quality of PRT at RTTCs. On the one hand, a betterment of pedagogical research-environment should be reconsidered with greater attention to three aspects: 1) research-oriented training pedagogy (e.g., embedded research skills into casual training sessions as much as possible), 2) rich-research-resource facilities (e.g., enhancing the availability and reachability of local library services and data sources), and 3) pedagogical research platforms (e.g., establishing research community and regular research events). On the other hand, to respond to challenges of insufficient research inputs and heavy workloads, the current allocation of PRT should be restructured into a wider spread of implementation. More precisely, the longer process of PRT should produce better and more comprehensive research training and practice for student teachers.

References

Akyel, A. (2015). Research engagement in the EFL pre-service practicum. *Language in Focus Journal*, *1*(1), 1–14. https://doi.org/10.1515/lifijsal-2015-0001

Barócsi, S. (2015). Student teachers' research within the frame of teaching practice in TEFL. In L. Magdolna, L. Réka, & H. József (Eds.), *UPRT 2015: Empirical studies in English Applied Linguisticstudies in English Applied Linguistics* (pp. 235–247). Lingua Franca Csoport.

Beck, C., & Kosnik, C. (2017). The continuum of pre-service and in-service teacher education. In J. Clark (Ed.), *The SAGE handbook of research in and for teacher education* (pp. 107–122). The SAGE.

Bower, M. (2010). Developing pre-service teachers' research capabilities using LAMS.

Refereed Paper, 50–59.

Bullock, S. M. (2016). Teacher candidates as researchers. In J. Loughran & M. L. Hamilton (Eds.), *International handbook of teacher education: Volume 2* (pp. 379–403). Springer.

Carol, M. S., & John, L. S. (1995). Teacher as researcher. *Journal of Reading Behavior*, *27*(3), 439–451.

Castle, K. (2006). Autonomy through pedagogical research. *Teaching and Teacher Education*, *22*(8), 1094–1103. https://doi.org/10.1016/j.tate.2006.07.001

Cochran-Smith, M., & Lytle, L. S. (1999a). Relationships of knowledge and practice: Teacher learning in communities. *American Educational Research Journal*, *24*(1999), 249–305.

Cochran-Smith, M., & Lytle, S. L. (1999b). The teacher research movement: A decade later. *American Educational Research Journal*, *28*(7), 15–25.

Cochran-Smith, M., & Lytle, S. S. (1993). Learning from teacher research: A working typology. In M. Cochran-Smith & S. S. Lytle (Eds.), *Inside/Outside: Teacher Research and Knowledge* (pp. 23–40). Teachers College Press.

Corzo, Q., & Ram, O. (2009). Conducting action research projects in a teacher preparation program. *Lenguaje*, *37*(2), 415–436.

Creswell, J. W. (2013). *Qualitative inquiry & research design*. SAGE Publications, Inc.

Dy, S. S., Chhinh, N., Seak, R., Sin, N., & Men, S. (2018). *Pre-service teacher training program at provincial teacher training centers in cambodia: Case Study in four provinces*. Education Research Council.

Faikhamta, C., & Clarke, A. (2013). Thai pre-service science teachers engaging action research during their fifth year internship. *Asia Pacific Journal of Education*.

Feldman, A., Paugh, P., & Mills, G. (2004). Self-study through action research. In J. J. Loughran, M. L. Hamilton, V. K. LaBoskey, & T. L. Russell (Eds.), *International handbook of self-study of teaching and teacher education practices* (pp. 943–977). Dordrecht: Kluwer Academic Publishers.

Gitlin, A., Barlow, L., Burbank, M. D., Kauchak, D., & Tracy Stevens. (1999). Pre-service teachers' thinking on research: Implications for inquiry oriented teacher education. *Teaching and Teacher Education*, *15*(7), 753–769. https://doi.org/10.1016/S0742-051X(99)00015-3

Gurung, R. A. R., & Schwartz, B. M. (2009). *Optimizing teaching and learning: Practicing pedagogical research*. Wiley-Blackwell.

Hammersley, M. (1993). On the teacher as researcher. *Educational Action Research*, *1*(3), 425–445. https://doi.org/10.1080/0965079930010308

Hine, G. S. C. (2013). The importance of action research in teacher education programs. *Issues in Educational Research*, *23*(2 SPL), 151–163.

Hwa, C. K. (2014). Promoting collaborative action research among in-service teacher through Lesson Study: A proposed approach. *Jurnal Penyelidikan Tindakan*, *8*(2014), 49–57.

Jantarakantee, E., Roadrangka, V., & Clarke, A. (2012). Pre-service science teachers' understandings of classroom research and the problems in conducting classroom research projects. *US-China Education Review*, *1*(2012), 112–120.

Kasula, A. (2015). Conducting action research in a practicum: A student teacher's perspective. *CATESOL Journal*, *27*(2), 229–237.

Lattimer, H. (2012). Action research in pre-service teacher education: Is there value added?

I.e.: Inquiry in Education, *3*(1), 1–25.

Lovat, T., Davies, M., & Plotnikoff, R. (1995). Integrating research skills development in teacher education. *Australian Journal of Teacher Education*, *20*(1), 30–35.

Martine, P., & Nogués, F. I. P. (2015). Becoming reflective and inquiring teachers: Collaborative action research for in-service chilean teachers. *Revista Electrónica de Investigación Educativa*, *17*(3), 13–27. https://redie.uabc.mx/redie/article/view/661/1294

Medwell, J., & Wray, D. (2014). Pre-service teachers undertaking classroom research: Developing reflection and enquiry skills. *Journal of Education for Teaching*, *40*(1), 65–77. https://doi.org/10.1080/02607476.2013.864018

Merriam, B. S., & Tisdell, J. E. (2016). *Qualitative research: A guide to design and implemenation* (4th ed.). Jossey-Bass.

Niemi, H. (2012). Relationships of teachers' professional competences, active learning and research studies in teacher education in Finland. *Reflecting Education*, *8*(2), 23–44.

Odhiambo, E. (2010). Classroom research: a tool for preparing pre-service teachers to become reflective practitioners. *Journal of Instructional Pedagogies*, *4*(2010), 1–14.

Price, J. N. (2001). Action research, pedagogy and change: The transformative potential of action research in pre-service teacher education. *Journal of Curriculum Studies*, *33*(1), 43–74.

Robinson, W. (2017). Teacher education: A historical overview. In J. Clark (Ed.), *International handbook of research in and for teacher education* (pp. 48–67). SAGE.

Singh, S., & Verma, P. (2016). Teacher, education, and teacher education: An overview of teacher education in Himachal Pradesh. *An International Journal of Humanities and Social Sciences*, *3*(4), 959–972.

The World Bank. (2013). *What matters most for teacher policies: A framework paper* (No. 4).

TTD. (2013). *Quality assurance system for teacher training*. MoEYS.

TTD. (2015). *Teacher policy action plan*. MoEYS.

White, S., & Forgasz, R. (2017). The practicum: The place of experiencec? In J. J. Loughran & M. L. Hamilton (Eds.), *International Handbook of Teacher Education: Volume 2* (pp. 231–266). Springer.

Willegems, V., Consuegra, E., Struyven, K., & Engels, N. (2018). Pre-service teachers as members of a collaborative teacher research team: A steady track to extended professionalism? *Teaching and Teacher Education*, *76*(2018), 126–139.

Yin, K. R. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE.

Zeichner, M. K., & Noffke, E. S. (2001). Practitioner research. In V. Richardson (Ed.), *Handbook of research on teaching* (pp. 298–330). American Educational Research Association.

National English Textbooks and the Implementation for Cambodian Elementary Schools: A case study in Phnom Penh City

LIENGIENG CHHIT

Graduate School for International Development and Cooperation (IDEC), Hiroshima University, 1-5-1 Kagamiyama, Higashi Hiroshima, 739-8529, Japan, Email: liengieng73@yahoo.com

Received: December 22, 2020/ Accepted: May 08, 2021

Abstract

The aim of this study is to examine the appropriateness of content and the effectiveness of using English textbooks to improve the quality of English education. The study employed a mixed method involving 12 schools, 12 primary teachers, and 120 students in Phnom Penh city. It examines teachers' opinions about textbooks and textbook use. It also focuses on teacher trainers' view on textbook evaluation and students' ideas about textbook by using interview-guided questionnaires. The results revealed that teacher trainers, elementary teachers, and primary students agreed with the appearance and careful design of the textbooks which catch learners' and teachers' attention; they also approved that reading and vocabulary are important in the learning-teaching content. However, the study emphasized the need to improve the textbooks as they lacked adequate teaching materials, did not improve macro and micro skills for young learners grammar and reading contents were found to be too complicated for higher levels, and the usefulness of the textbooks were perceived to be moderate. The study also showed that teachers with English background implemented textbooks better while those without English background, especially teachers with advanced age, tended to hesitate to teach.

Keywords: National English textbook; Elementary school; Appropriateness of content; Effectiveness of textbooks

1. Introduction

It was in 1991 that English language started to attract more attention from students and teachers, particularly after the intervention of the United Nations Transitional Authority in Cambodia in 1993. This facilitated the cooperation between some 60,000 Cambodians and 20,000 peacekeepers and personnel from 34 countries around the world (Michael, 1995). Since then, the importance of the English language has truly taken hold in the country as Cambodia integrates itself into a global society where English is widely used as the language for business, communication, education and development.

In contemporary Cambodia, English is becoming increasingly popular among parents who do not mind paying for extra classes for their children in private schools which offer instruction in both English and Khmer, or in private international schools that provide instruction only in English. The English language has become more popular in Cambodian education for many

reasons, such as (1) tourism, (2) lifelong education, (3) job requirements, (4) connectivity, and (5) English-based education in primary schools.

The upper primary school in the Cambodian educational system became a significant impetus for change as seen in the introduction of new English textbooks (for Grades 4-6) by Ministry of Education, Youth and Sport since the 2013-2014 academic year, following the design of the English curriculum in 2012. However, MoEYS had conducted many workshops to train primary school teachers to use the Grade 4 English textbook as various issues have been found regarding content, lack of supporting materials, and non-suitability with young learners' needs. Moreover, the textbook was the only main tool for teachers and learners to activate their knowledge through a process of teaching and learning (Song, 2015; Hutchinson & Torres, 1994).

Against this background, this study seeks to examine the appropriateness of content and effective ways of using English textbooks to improve the quality of English education in Cambodia. The study aims to answer the following research questions:

1. *Do the primary English textbooks meet the characteristics of a good English textbook?*
2. *How are textbooks implemented? And what factors affect the way of using primary school English textbook?*
3. *To what extent do the primary English textbooks fit into the Cambodian context from the users' perspective?*

2. Literature review

Since there are few previous studies regarding textbook evaluation in the Cambodian context (see Sem, 2012), this literature review will primarily be based on related studies of English textbook evaluation for primary schools in other countries. Textbooks should be evaluated to see how they are appropriate to fit with students and teachers, and the selection of a textbook evaluation checklist was extremely significant in order to provide sufficient information in analyzing the characteristics of the textbooks. Sem (2012) conducted a study to assess English textbooks in lower secondary schools in Cambodia. The result of his study found that the textbooks have high quality in both external and internal features. His result suggested some parts to improve the textbooks such as cover page, pictures, book size, font, number of pages, durability, and glossary as the internal features, while the design and organization, language contents, grammar, vocabulary, language skills development and practicality consideration as the external features. Mukundan (2013) conducted a similar study on English language textbooks in Malaysia. The result showed that textbooks were highly useful for primary-level students while textbooks were only moderately useful for secondary-level students.

Textbooks are a really important resource in classroom teaching. Song (2015) stated that textbooks are the most useful item for teachers and learners in the Cambodian context. Hutchinson and Torres (1994) also emphasized that textbooks look worth to a universal element in language teaching classrooms. They further asserted that a process of teaching and

learning will not be complete without relevant textbooks. On the other hand, many researchers found the limitations of textbooks. Ur (1998) indicates that textbooks are appropriate to support every learner's needs in terms of topics but many textbooks are not interesting to the real classes, which makes learners experience boredom and demotivation. Besides, Richards (2001) also argued that many textbooks may not fit learners' needs because they are written for global markets.

In Turkey, Kirkgoz (2009) investigated students' and teachers' opinions about English textbooks for young learners at primary education. The findings showed that the textbooks were appropriate for young learners and they had clear explanation and usefulness in real-life situations. Abdulrahman (2008) conducted a study to evaluate the quality of Grade 6 English language textbook in Saudi Arabia. The result indicated that the new English textbook had an appropriate glossary to assist teachers and learners' integration of attractive illustration to promote critical thinking through interesting topics, more authentic themes to encourage student activeness, and the real-life interaction to encourage more flexibility of language practices. Aminuddin (2009) investigated teachers' perspectives on textbooks in language teaching classrooms and how learners respond to the usage of language textbooks in Indonesia. The result revealed that teachers used other materials instead of applying the textbook in the classroom because the textbook was not useful and did not have appropriate content to arrange the activities, structure, students' interest, and time constraints. Likewise, Srakang (2013) in Thailand examined teachers' perception of Grade 10 English textbooks. The study revealed that there were two conflictual opinions from the teachers' perspectives. Some teachers (with a pro-textbook view) posited that textbooks were extremely vital teaching material to be followed. However, some teachers (with a anti-textbook view) believed that following the textbook was useless for being exam-orientated serving more as a catalyst for students to pass university entrance exams. Osada & Tanaka (2013) conducted a research in Taiwan on teachers' concerns and students' perspectives in Taiwanese primary English education, It was found that textbooks were not interesting because most of the students attended an English cram school.

3. Methodology

This study employed a mixed method design involving the collection of both qualitative and quantitative data collected at the same time. Qualitative data was used to answer research question 1 and 2, while both qualitative and quantitative data were gathered to seek answers for research question 3. The study took place in primary schools in Phnom Penh where English is widely used in schools.

3.1 Participants

This study was conducted with 12 upper primary teachers and 120 students (Grades 4-6) through purposive sampling by using a lucky draw technique to select 10 students from each class after classroom observation was conducted. There were 164 schools with 3849 teachers and 13519 students in Phnom Penh city (MoEYS, 2017). The participants were from

government schools (public schools) supervised by the Department of Educational Youth and Sport in Phnom Penh. The sampling size was kept limited to only 12 schools, due to research time constraints, and only schools that could implement the use of English textbooks. Moreover, three raters were involved in the process of English language textbook evaluation. One rater was the researcher while the other two raters were English teacher educators who prepare trainees to be public primary school teachers**.**

3.2 Instruments

3.2.1 English textbook evaluation checklist

A checklist proposed by Nimchisalem and Mukundan (2015) was adopted in this study. This checklist has been validated and tested for its reliability. It contains two main categories: the general attributes and the learning-teaching content. There are five major components under the general attributes, which include (a) syllabus and curriculum, (b) methodology, (c) suitability to learners, (d) physical and utilitarian attributes, and (e) efficient outlay of supplementary materials. On the other hand, there are nice major components under the learning-teaching content, including (a) general content, (b) listening, (c) speaking, (d) reading, (e) writing, (f) vocabulary, (g) grammar, (h) pronunciation, and (i) exercise. The rating system for the survey is based on a 5-point Likert scale.

3.2.2 Interview-guided questionnaires

The survey was conducted to identify a source of students' perceptions and was thus aiming at eliciting students' opinions of regarding the use of English textbooks. This survey was developed based on Osada and Tanaka's (2013) questionnaire and Rashidi and Kehtarfard's (2014) questions.

3.2.3 Classroom observation checklist

The classroom observation checklist was used to see how teachers used English textbooks in the actual classrooms. It included aspects address the purpose of this study as well as the teachers' responses to the questionnaire.

3.2.4 Semi-structured interview questionnaires

A semi-structured interview questionnaire was also prepared for use during the face-to-face interviews. The data obtained from the interviews provided deeper answers and were used to cross check the accuracy of the observational data. All open-ended questions were adapted from Srakang's (2013) semi-structure questionnaire to gain in-depth understanding of the data on teachers' perceptions of English textbooks and its implementation. The interviews were tape-recorded with the permission of the participants and were later transcribed for analysis. The questionnaire consisted of two important parts: (a) background information and (b) teachers' perception on English textbooks.

3.3 Data analysis

The textbooks were analyzed using the Score Interpretation Guide adopted from Nimchisalem and Mukundan (2015) for research question 1. The data gained from classroom observations and teachers' interviews were qualitatively analyzed following Merriam and Tisdall's (2016) … for research question 2. The responses from students' interview guided questionnaires were analyzed using SPSS for research question 3.

4. Results

4.1 Textbook evaluation from Grades 4-6

The analysis of English textbooks for Grades 4 to 6 was conducted by the researcher, along with two other evaluators, and a summary of the total result and Kappa values is shown in Table 1. It can be said that the three English textbooks have their own strengths and weaknesses and each textbook received its corresponding score.

Table 1
Evaluation of the three English textbooks and reliability of results by Kappa value

	Grade 4	**Grade 5**	**Grade 6**
Total Result	2.73	2.65	2.65
Kappa value	0.879	0.819	0.846

The results show that the three textbooks were moderately useful, and the Kappa value was strong for all Grades indicating a high degree of data reliability.

In Table 2, the detailed evaluation of the textbooks for Grades 4 to 6 is presented. It covers a wide array of factors that fall into two categories which are general attributes and learning-teaching content. Each factor has been ranked from a range of 0.00 to 4.00, and the interpretation of the scores is given in Table 3. These values are explained in further detail as follows.

Table 3
Interpretation of scores

Level	**Range**	**Interpretation**
0	0.00 - 0.80	Negligible usefulness
1	0.81 - 1.60	Low usefulness
2	1.61 - 2.80	Moderate usefulness
3	2.81 - 3.60	High usefulness
4	3.61 - 4.00	Very high usefulness

The similarity among the three textbooks, brought about by the content analysis, was the high to very high usefulness of their general attributes, specifically in their good relationship between syllabus and curriculum, good methodology, suitability with learners, and physical and utilitarian attributes. However, the glaring weakness common in their general attribute was

their inefficient layout of supplementary materials because the set of these textbooks did not contain suitable supplementary materials such as workbook, audio, or multimedia in order to make teaching and learning more effective and practical.

As for the learning-teaching content, reading appeared gradually in macro skills while vocabulary had remarkable activities in micro skills, and both were regarded highly useful in all textbooks. On the contrary, grammar and pronunciation in micro skills; speaking, listening, and writing in macro skills; and general content were all not scored as highly useful. For example, the pronunciation activities on pages 49, 59, & 63 of the textbook for Grade 5 (see Appendix 1) were not interesting or useful in helping students to learn their pronunciation. Further examples were the inappropriate writing activity on pages 45, 59, & 71 (see Appendix 2) which did not reflect the reading text, and the not very useful instruction of writing sounds to improve sentence structures rather than topic sentences. For the last example, speaking activities on pages 41, 63, & 81 from the textbook of Grade 6 (see Appendix 3) were not relevant to improve language skills as students could practice this better in their real communication outside of the classroom.

4.2 Strategies to implement the textbooks

Since everything could not possibly work perfectly from the beginning, strategies of MoEYS were necessitated to find a good solution to cross the threshold of success. A good strategy would drive the mechanism to achieve the goal. Hence, The Teacher's Guide was introduced and oriented for primary school directors to employ this program successfully. The orientation of teacher's guide focused on five main parts in Khmer language, including (1) teaching English (2) teaching methodology (3) using material, (4) evaluation, and (5) teaching step.

The teaching methodology part explained precisely for teachers to follow; for example, it had guidance on how to write lower- or upper-case letters of English correctly, followed by the sound of each letter, words, phrases, sentences, conversations, and short texts to develop students' skills in listening and speaking. The Teacher's Guide in Grade 4 also emphasized that "teachers should pay attention on supporting and helping students' skills in reading and writing properly as well as using material in teaching vocabulary, sentence structure, and game in order to achieve the objective of the lesson" (p.vi). Thus, teachers could follow the textbooks and The Teacher's Guide to build their confidence in teaching English; as the result, 12 teacher participants (100% representation) confirmed that they followed the textbook. The two teachers in Grade 4 said that "I follow everything from the textbook" (No.C01 & No.C04) and others also said that "I follow the textbook, but some parts and skipped some activities" (No. C02, No. C03, No. C05, No. C06, No.C07, No. C08, No.C09, No. C10, No. C11, & No. C12). The classroom observation also clearly revealed the evidence that all teachers followed the textbooks even though they did not strictly follow them page by page due to time constraints.

Using material described on producing flashcards of the 26 letters of English, words, pictures or photos relevant to the lesson to attract learners' attention and related to their real-life situation, so students were able to remember and understand well by demonstrating or pointing

to those flashcards or pictures. According to the interviews, most of the teacher participants stated that "before teaching, I always prepare teaching material such as vocabulary, pictures, and flashcards relevant to the lesson" (No. C01, No. C02, No. C03, No. C05, No. C06, No. C08, No. C10, No. C11, & No. C12). The result of the classroom observation, however, showed that there were only a few teachers who used teaching material in their teaching classes.

4.3 Factors that affect the use of textbooks

4.3.1 Teacher factor

The teachers are the main characters who play an important role in using the textbooks smoothly and effectively. There were three teachers-related factors that affected textbook use.

4.3.1.1 Teachers with no background in English have low confidence in teaching

The truth is that, although the city was surrounded by private English schools and teeming with foreigners, most primary teachers in the capital city could not teach English. Nhem Sitha, deputy primary officer in Phnom Penh Municipal Department of Education Youth and Sports said in his 2018 speech that "Among 164 primary schools in Phnom Penh City, only 30% - 40% had teachers to support and teach the English subject."

One teacher who was teaching in Grade 5 grumbled that "the problem is I don't know English. (laughs). Sometimes, I don't understand some words in English, so I ask my colleagues to help…" (No. C09).

Similarly, another teacher said,

> The textbook is no difficult to use. The most difficult for me is that I do not know English. I am not confident enough to teach English, and I think most primary public-school teachers do not know English either. (No. C02)

Two of the teachers mentioned above are in their early 40s and were born before 1979, a dreadful period for education when Cambodia suffered under a regime of genocide which made it difficult for them to receive education, let alone learning a foreign language such as English. Probably, they did not get any chance to study English, or maybe they learnt a little bit during their training to be teachers when English textbooks were published for the first time in 1996 for Grade 7 (English for Cambodia, Book 1) for lower secondary schools (MoEYS, 1996). During the two classroom observations, the teachers hesitated while teaching students and in eliciting each word slowly from students, they seemed ambivalent to accept or reject the words from students' responses. For instance, one teacher who was teaching in Grade 5 tried to elicit the word "jam" from students by using a picture and, when some students responded [dʒæm] while others replied [dʒam] in the alternative, the teacher felt confused as to pronounce the word. Moreover, the flow from one activity to another seemed awkward, which prevented a smooth transition in their teaching. If they had more opportunity to study English from elementary school, high school, or PTTC, they would have had a better background of English, and then they could have more confidence in teaching the English subject.

4.3.1.2 Teachers with background in English use textbook as supplementary material for gaining confidence

One teacher who was teaching in Grade 4 said that "the most important thing is the teacher. Teachers who have some background in English will find it easy" (No. C04).

Meanwhile, another teacher who was also teaching in Grade 4 supported the idea and said that, "I had to follow everything in the textbook because I did not have any experience in teaching English" (No. C01).

From these comments, they tried to convey that without them having some background in English, they could not use the textbook appropriately. Certainly, as was seen during the classroom observation, they tried to appear competent in the delivery of their English lesson in the real class by following what the textbook instructed to be done for the lesson. For one teaching session, the teacher was eliciting some vocabulary, writing those words on the board, asking students to spell the words, letting them work in pairs through conversations, and allowing them to play classroom games.

4.3.1.3 Teachers with background in English use textbook as stimulus ideas for classroom activities

Most participant teachers believed that English textbooks were extremely important materials to help them in teaching effectively. Another finding that emerged from the classroom observations showed how all participant teachers used the English textbook as a main source in their class and followed the phases of the teacher's guide. The teachers considered the English textbook as their guide to demonstrate the sequence and differential activities in each unit.

Meanwhile, two teachers who were teaching in Grade 4 said, "The textbook is good. If I don't know what to teach, the book tells me what to do" (No. C04) and "the textbook is good because of its various activities which are easy for me to follow…" (No. C06).

4.3.1.4 Teachers with background in English use textbook as a source of vocabulary

Another teacher who was teaching in Grade 6 maintained that "the textbook is good especially because it has an explanation of difficult words at the back of the book" (No. C07)

In her opinion, the glossary is really helpful to teachers because it facilitates translation into Khmer language clearly, especially at time when preparing their lesson plan or designing any flashcards or posters for their activities. It was also noted during the classroom observation that the words were really trivial, and teachers concentrated on translation rather than on the function of the language use; for instance, one teacher who was teaching in Grade 5 confirmed that "sometimes, I teach more words outside of this textbook to my students" (No.C09).

4.3.2 Students factors

4.3.2.1 Students have different levels of English proficiency

Even though English is a mandatory subject that begins from Grade 4, some schools could not deal with the subject properly because they "have no English teachers." The core issue comes to light when students start English classes in Grade 5 or 6 and begin learning the unit related to sentence structures, phrases, grammar, or reading texts, but they find it difficult as they have not learnt even basic letters or consonants yet. One teacher teaching Grade 6 complained, "the levels of proficiency of students are not the same so that I cannot go forward" (No. C12)

Grammar, the basic rule in using English correctly, is an area where most students were most challenged. One teacher who was teaching in Grade 6 said that "grammar in the textbook of Grade 6…and students don't like to study grammar…" (No. C11). As noted from the classroom observation, it was only in one class that grammar was explained to the students because grammar was believed to be implicit in these textbooks.

4.3.2.2 Students were satisfied with the textbook design

The English textbooks were written by a local writer committee who localized the context to meet the learners' needs and to motivate them in their new language learning. The textbooks were printed with colorful pictures and distributed to all libraries of public primary schools around Cambodia, so students could borrow them from the library, study in class and return them at the end of the academic year. From the classroom observation, it was clear that both teachers and students looked delighted by having the gorgeous textbook in their hands.

One teacher who was teaching in Grade 4 said that, "the textbook is fine and uses local names, so it is easy for me and my students, and the textbook is suitable to our context with a design that is appropriate for the students' level" (No. C01). Another teacher who was teaching in Grade 5 agreed with this and said, "I think the textbook has a very good design to attract the learners' attention" (No. C08). Similarly, two more teachers shared the same idea that "the textbook is good to have such colorful pictures that attract the learners' attention" (No. C02 and No. C07).

4.3.3 Textbook factors

The textbook was really a helpful resource for teachers who followed its prescribed teaching steps and, even though they did not follow it page by page, they used most of the activities in sequence in each lesson. The textbook also provided unambiguous ideas for the teachers to develop and deliver the lesson to their students.

4.3.3.1 The level in the textbooks was unequal for all students

Although the textbook provided great support for teaching, it was difficult for the teachers to effectively carry out the lesson and meet its objectives.

Sometimes, the textbook set some limitations in view of divide in the students' ability which led to teachers not being able to manage well in teaching class. The classroom observation also helped to show that most teachers (especially those teaching Grades 5 and 6) were resigned to follow every single activity in the textbook rather than support and assist students who were poor at the lesson by repeating reading texts to them.

Two teachers who were teaching in Grade 5 complained that "the textbook is too deep for students to understand and learn…" (No. C09) and another teacher said "the textbook is good, but in this grade, it seems at a higher level compared to the level of my students, especially in reading texts which I can't teach any faster" (No. C10).

Another teacher who used to teach in Grade 5 but was currently teaching in Grade 6 also said, "for Grades 5 and 6, if students have experience in learning English before, they will have an easier time; but if students have not learnt English before, they will need help from the teacher." (No. C11).

Two teachers who were teaching in Grade 5 complained how "the text in the textbook is too long and the time for teaching is short, and I have to spend about 6 hours to finish one lesson" (No. C10) and "there are a lot of texts which are difficult to teach" (No. C12).

4.3.3.2 The gradation and selection of the textbook

In the textbooks, a sequence of topics in every lesson was the bridge linking one lesson to another. In this sense, prior knowledge was useful to activate new comprehensible input without which it was not easy to design appropriate linkages from one lesson to the next. Most teachers could do well in connecting one lesson to another by eliciting the link from the previous to the new lesson as was discovered during classroom observations.

One teacher who was teaching in Grade 6 opined that, "There is a connection from one lesson to another" (No. C02). Another teacher who was teaching in Grade 4 also confirmed this, saying that "the topics in the textbook move in gradation from one to another unit" (No. C04)

4.4 Assessment of English textbooks in a Cambodian context

4.4.1 Textbooks assessed by students

Figure 1 shows that, among all student participants, there were 44 male students (36.7%) and 76 female students (63.3%) while female students are 76 (63.3%). Figure 2 indicates 20 students participated in Grade 4 (16.7%), 50 students in Grade 5 (41.7%); and 50 students in Grade 6 (41.7%). Figure 3 shows only 13 students (10.8%) did not study English in part-time class while 107 students (89.2%) studied. As shown in Figure 4, that 78 students (65%) really like English, 35 (29.2%) like English, 5 (4.2%) feel so so, and 2 (1.7%) do not like. On the other hand, Figure 5 gives an insight on the importance of English placed by students that 83 students (69.2%) strongly agree that English is important, 32 (26.7%) agree, 4 (3.3%) feel so so, and 1(0.8%) do not agree that English is important. With regard to the English language

skills set, Figure 6 shows that 54 students (45%) like reading skill, 25 (20.8%) like speaking, 25 (20.8%) like writing, and 16 (13.3%) like listening.

As responding to questions about the importance of teaching vocabulary and grammar and gave their further opinion on the textbooks. Figure 7 points out that 91 students (75.8%) thought that teaching vocabulary is very important, 32 (19.2%) thought it is somewhat important, and 5 (4.2 %) thought it is slightly important. Relatedly, the figure 7 showed that 92 students (76.7%) thought that teaching grammar is very important, 26 (21.7%) thought it is somewhat important, and 2 (1.7%) thought it is slightly important.

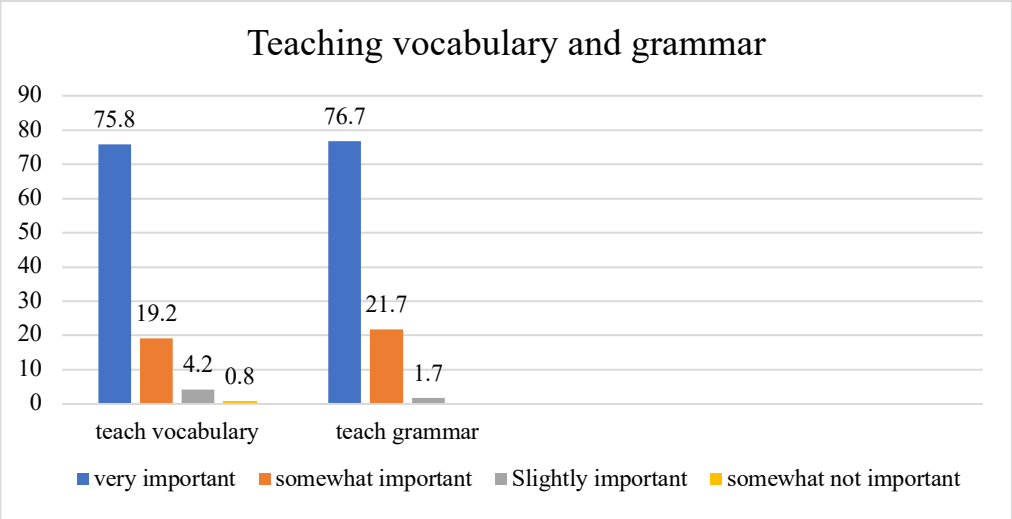


Figure 7. Importance of Teaching Vocabulary and Grammar

Figure 8 shows that 91 students (75.8%) strongly agree to liking the textbook, 18 (15%) agree to like the textbook, and 11 (9.2%) felt so so. This general preference is explained more in details given in Figure 9. On whether or not the textbook is interesting, 96 students (80%) strongly agreed, 19 (15.8%) agreed, 3 (2.5%) felt so so, and 2 (1.7%) disagreed. The figure also revealed that 98 students (81.7%) strongly agreed that the textbook is funny to study, 14 (11.7%) agreed, 6 (5%) felt so so, and 2 (1.7%) disagreed. As to whether or not the textbook related to real life, 64 students (53.3%) strongly agreed, 24 (20%) agreed, 24 (20%) agreed, and 8 (6.7%) disagreed. Finally, the survey showed that 2 students (1.7) strongly agreed that the textbook is easy to study, 99 (82.5%) agreed, 3 (2.5%) felt so so, 14 (11.7%) disagreed, and 2 (1.7%) strongly disagreed.

As can be seen from the results of the students' survey and textbook analysis above, the textbooks can fulfill the students' needs in terms of reading in macro skills and vocabulary in micro skills. In Figure 6, the value attached to reading skills was the highest (45%) among other skills, and when related to content analysis shown in Table 2, reading was rated 3.00, which indicated the high usefulness of the three textbooks. Meanwhile, Figure 7 revealed that a total of 95% students thought that teaching vocabulary is either somewhat important (19.2%) to very important (75.8%), while Table 2 in content analysis, vocabulary in the textbook was rated 3.00 for being highly useful. Moreover, the students' survey also made it clearer that 65%

of the students liked to study English and 75.8% liked the English textbooks. Through the classroom observation, it was ascertained how students felt passionate and excited to study the English subject, and probably, their background of private tutoring on this subject bears some relation. The data showed that 107 students (nearly 90%) have studied the English subject at private school. Finally, 95.83% of the students said that the textbooks were interesting, which is in sync with the rating for general attributes which found the books were well-designed to attract students' attention. The characters' names, activities, and situational themes were in a Cambodian context, which was convenient for the students who found the activities in the lesson more familiar.

In Figure 7, a remarkable 99.2% of students thought that teaching grammar is important. Unfortunately, the grammar received a score of 2.33 for moderate usefulness which echoed one teacher's negative comment who said "the grammar in the textbook of grade 6…and students don't like to study grammar…." (No. C11). From these results, it has become clear that the grammar item needs critical reconsideration for better contextualization and frequent repetition throughout the textbooks. For example, the grammar item on page 102 in Grade 6 textbook (see Appendix 4) could be simplified into the Cambodian context for ease of explanation to students who are 11 years old. In addition, 93.4 % of the students thought that the textbook was funny to study and 73.3% of the students believed that the textbooks were related to real life. However, the general content under learning-teaching content was scored 2.80 for only moderate usefulness.

4.4.2 Textbooks and teachers

The textbooks were designed in a Cambodian context which motivated local teachers who appreciated the convenience and familiarity in using them. As to its physical appearance, it models a Khmer family, schools and students in order to attract teachers' and students' attention. In the textbook evaluation, the physical and utilitarian attributes was scored 3.33 for high usefulness. Some teachers have similar ideas related to the three textbooks and narrated that, "the textbooks have colorful pictures in the Cambodian context to hook teachers' and learners' attention" (No. C02, No. C07, and No. C08). Moreover, the activities under methodology in content analysis was scored 3.00 for high usefulness, which was parallel with one teacher's view, "The textbook is good with various activities which are easy for teacher to follow" (No. C06). From A-G activities for the English textbook Grade 4, from A-E activities for the textbook Grade 5, and from A-G activities for the textbook in Grade 6, the teachers could follow easily from one activity to another, making the lesson flow more smoothly.

Though the raters and teachers agreed that activities could be exploited more fully and work well in most classroom situations, most teachers could not afford to deal with all activities in one session as became obvious during the classroom observation. Most of them could teach only two or three activities per hour in one lesson instead of spending time on games or revising the lesson. One teacher who taught in Grade 5 mentioned that "I spend four to six hours for one lesson" (No. C10).

On the matter of listening skills, one teacher complained that, " For conversation, there is no audio for media which would have been useful instead of using the teacher's voice for the listening part" (No.C1). Another teacher who taught in Grade 5 similarly said, "it is better if we have the audio sound" (No. C05) while yet another teacher who was teaching in Grade 6 added how "it will be great if most conversations can be provided with audio from media" (No.C11). This was reflected in the textbook analysis where the rating of 2.67 for moderate usefulness was given to note the ineffective layout of the supplementary material.

As confirmed from the classroom observation, the conversation, pronunciation, and listening parts were really necessary to confirm the English sounds. All teachers could have played some audio and pronounced the words correctly considering that the language competency between teachers was so different that they would pronounce one word differently. It is also worth noting how most teachers commented on the physical appearance and superficial characteristics of the textbooks when they should have said more about the methodology, techniques of teaching and learning, macro skills, or micro skills which were the major aspects to make the use of the textbook successful. Probably, they were not very aware of these matters or they did not care about the textbooks. In fact, one teacher who was teaching in Grade 6 gave a negative critique about "the grammar in the textbook of Grade 6… and students don't like to study grammar…." (No. C11). Based on the classroom observations, only one teacher explained grammar to her students because of the notion that grammar was implicitly taught in these textbooks.

5. Discussion

5.1 Problems about English textbooks

Textbooks are one of the most common resources in the classroom and are viewed differently depending on the aims of the curriculum. The learning outcome of the English textbooks for upper primary school is to meet the requirement of A1 CEFR in the Cambodian context. The result from textbook evaluation showed that the three English textbooks were moderate usefulness which conform with the result of a previous study by Mukundan (2013) who found that "primary level textbooks are of high usefulness while secondary level textbooks are of moderate usefulness" (p. 42). The results of the textbook evaluation in the current study are in the line with the secondary level. This feedback is valuable for analyzing the scope of improvement in these textbooks. According to Sultana, Khan, Ali, and Rehman (2007), textbook evaluation is extremely significant as well for decisions about choosing future textbooks.

Furthermore, the three textbooks were made in Cambodia to satisfy the users' needs, and previous studies found that the textbooks written by local authors, normally attracted the most attention in terms of physical appearance. Chao (2009), for example, found that textbooks filled with colorful photos helped learners develop language and interaction skills. Some teachers also praised the textbooks for including colorful and local pictures related to the Cambodian family context. Ruan and Miekley (2005) and Abdulrahman (2008) also found that pictures and illustrations could help to promote learners' understanding of the meaning of the text and

the topic. It is absolutely crucial to compile real and colorful pictures of humans and the environment that they could evoke new feeling among teachers and learners (Fredrisson & Olsso, 2006; Nemati, 2009). Therefore, the result of this study seemed to be contrasted with Richards (2001) who states that textbooks may not suit learners' needs because they are often written for global market.

In addition, through the result of the textbook evaluation, the four macro skills except reading and micro skills except vocabulary were thought to have moderate usefulness because the local authors had a tendency to promote reading and vocabulary skills. To reach the A1 goal, students should have strong vocabulary of 5000 words. This can be achieved by providing several reading texts to students so that they can learn plenty of words. Vocabulary also helps students communicate in real life, which is the main objective of upper primary education. The result looked similar to a study conducted in Turkey which found that the textbooks had well-presented vocabulary for young learners (Kirkgoz, 2009). Certainly, one of the most exciting aspects of language development is vocabulary growth. Children enter school with the ability to understand and produce several thousand words, and more will be learned at school depending mainly on how much children read (Nagy, Herman, & Anderson 1985). Gardner (2004) also stated that reading a variety of texts is an important part of building vocabulary. Nation (1997), McCath (1998), and Meara (1995) had similar positive ideas, arguing that learning a large number of words at the beginning of the language learning process is extremely important for students. However, studies by Nation and Na showed that a vocabulary of about 3,000 words is needed to understand a simplified text for efficient learning from context (Nation, 1997, p. 11). However, Meara (1995) denied the importance of learning too much vocabulary, stressing that grammar rules should be mastered in language learning. Indeed, grammar in micro skills is an important part of language acquisition, but focusing too much on grammar at the basic English language stage can create obstacles in the language acquisition of young learners. As Copland, Galton, and Burns (2014) reported, teaching grammar is considered complicated among 145 counties in Asia.

Furthermore, the findings of this study highlight an issue among secondary schools in Cambodia. Sem's (2012) study assessment of English textbooks similarly found that textbooks were not equipped with a pack of CDs or cassettes for students to practice listening. However, reading is not the only macro skill, there are also listening, writing, and speaking skills. Listening is useful for articulation, pronunciation, and is a model for the controlled and free practice of speaking in basic English. Supporting materials are the key resources to help novice teachers and learners. The teachers interviewed in the current study also complained about the lack of audio aids in practicing listening skills and pronunciation.

Weddle cited Parrish (2004), stated that it was helpful for new teachers and learners to get relevant sources which could help them with different teaching and learning approaches. Masuhara and Tomlinson (2008) also stated that textbooks are normally accompanied by other materials such as workbooks, teachers' book or multimodal texts to make up a textbook package. However, there are several issues that local publishers could consider, such as the fact that many schools, especially those in rural areas, cannot afford audio aids, which results in the

unequal implementations of the textbooks in Cambodian schools. Another important issue is related to time constraints. A teaching session is only about 40 minutes, which puts too much pressure on teachers, who are forced to follow the textbook instead of selecting methods of their own choice in practice.

5.2 Problems with the implementation of English textbooks

Song (2015) mentioned that textbooks are really important for teachers and students to follow in the Cambodian context. It is really hard for English teacher to teach this subject without the textbook because some of them are in advanced age and English illiterate. Two teachers shared similar ideas, expressing their opinions that "the textbook is no problem and the problem is I don't know English". The result from this study is different from some previous studies Perhaps the English proficiency of the teachers who participated in the previous studies were better, allowing them to seek for the sources or materials to teach in their classroom. For example, Srakang (2013) showed that some teachers believed that the textbooks were useless for classroom teaching because they thought that the supplementary material was useful in helping and guiding the students to achieve success in national exams. Those teachers used teaching materials instead of the textbooks, as the latter did not contain useful and appropriate content with respect to learning activities and structures, students' interest, and time constraints (Aminuddin, 2009).

On the other hand, some teachers [in this study?] pointed out that level of students are different match with the level of language input in the textbooks. Moreover, having large classes was another possible problem in using textbooks. These findings are supported by Richards (2001), Ur (1998) and Sheldon (1998)'s views. They assert that textbooks cannot meet the varied needs of learners and language classes around the world. One of the reasons for this could be that primary teachers have multi subjects to focus on. Thus, elementary English teachers have low English competence and language teaching knowledge and skills. Therefore, textbooks are extremely useful for teachers since they cannot spend more on time looking for other materials to support for their teaching.

Indeed, the findings of the current study indicates that teachers with an English background have better teaching methods. Through the classroom observation, it can be said that "the younger teachers are better at teaching." They had better preparation in terms of lesson plans, flashcards, posters, and teaching materials.

5.3 Conclusion

The study intended to evaluate the national English textbooks from Grades 4 to 6 and understand the implementation of these textbooks through students' and teachers' perceptions. The findings from textbook evaluation indicated that the three primary English textbooks were perceived to have only moderate usefulness since MoEYS chose the textbooks written by local authors not those from global market to fill the needs of learners and teachers in Cambodia. Even though the results of some parts of the textbooks seemed low, the textbooks were in general believed to fit the Cambodian situational context. To achieve the ultimate goal of

teaching English at primary school, which is is A1 (CEFR), the local writers designed the textbooks by focusing on vocabulary and intensive reading skills. The study's results showed that students and teachers really appreciated the textbooks. The results from the teachers' perceptions and classroom observation about the English textbook was used indicated that most of the teachers could follow the textbook although they were not able to follow every single step of the teachers' book guidelines. Young and less experienced teachers tended to implement the textbooks in their classroom teaching better than those who had no English background.

5.4 Limitations

This study was designed as a case study, with data collection spanning only over a period of eight weeks. Considering that English classes were conducted only on Thursdays, this presented an obstacle for the researcher to interview and conduct classroom observations with as many teacher participants as possible. With this limited data, this study is not generalizable to the implementation of the English textbooks in other schools across Cambodia.

5.5 Implications

The results of this study are really important to inform MoEYS to properly plan and design the future English textbooks. These results also inform the PTTC and PTEC to evaluate the curriculum of the English training program for primary teacher education. Moreover, the English subject should be made compulsory for the national high school exam so that students can become industrial learners of English from the beginning until passing the entrance exam to be student teachers.

References

Abdulranhman, A. M. (2008). An evaluation of six grade English textbook for Saudi' boy school. KingSaud University: Deanship of Higher Education. Kingdom of Saudi Arabia.

Aminuddin, M. (2009). Analysis of teachers' use of English instructional materials: From preparation to implementation. UPI: Unpublished Paper.

Ministry of Education, Youth and Sport [MoEYS]. (2012). *English Curriculum for primary school grade 4, 5, and 6*. Phnom Penh: MoEYS

Ministry of Education youth and sports [MoEYS]. (2014). *Student's Book English Grade 4*. Phnom Penh: MoEYS.

Ministry of Education youth and sports [MoEYS]. (2016). *Student's Book English Grade 5*. Phnom Penh: MoEYS.

Ministry of Education youth and sports [MoEYS]. (2016). *Student's Book English Grade 6*. Phnom Penh: MoEYS.

Chao, T.C.A. (2009). Retrospective Evaluation of Local College English Textbook from an Intercultural Perspective. Studies in English for Professional Communications and Application, 89.

Copland, F. Garton, S & Burns, A. (2014). Key themes and Future directions in Teaching English to Young Learners: Introduction to the Special Issue ELT Journal. ResearchGate.

Fredriksson, C. & Olsson, R. (2006). English Textbook Evaluation: An Investigation into Criteria for Selecting English Textbook. MamoHoscholar: Sweden.

Gardner, D. (2004). Vocabulary input through extensive reading: A comparison of words Found in Children's Narrative and Expository Reading Materials. DOI: 10.1093/applin/25. 1.1.

Huthison, T. & Toreres, E. (1994). The Textbook as Agent of Change. *ELT Journal, 48(4*), 351-28.

Kırkgöz, Y. (2009). Evaluating the English textbooks for Young Learners of English at Turkish Primary Education. *Procedia-Social and Behavioral Sciences*, 1(1), 79-83.

Machael, D. (1995). *UN peacekeeping in Cambodia*: UNTAC's civil mandate. Boulder, CO: Lynne Rienne.

Masuhara, H. & Tomlinson, B. (2008). Materials for General English. In B. Tomlinson (Ed), *English Teaching Materials: A Critical Review* (pp. 17-37). London: Continuum.

Meara, P. (1995). The Importance of an Early Emphasis on L2 Vocabulary. *The Language Teacher*, 19 / 2, 8- 10.

McCarthy, M. (1998). *Principles and Practice in Vocabulary Teaching*. Presentation at JALT' 98 Conference in Omiya, Japan.

Miekley, J. (2005). 'ESL textbook evaluation checklist'. *The Reading Matrix*, 5/2: 1-9. Retrieved on 16.12.2019, from http://www.readingmatrix.com/reading_projects/miekley/project.pdf.

Mukundan, J., & Rezvani Kalajahi, S. A. (2013). Evaluation of Malaysian English Language Teaching Textbooks. *International Journal of Education & Literacy Studies*, 1(1):38-43.

Mukundan, J., Nimehchisalem, V., & Hajimohammadi, R. (2011). Developing an English Language Textbook Evaluation Checklist: A Focus Group Study. *International Journal of Humanities Developing an English Language*, 1(12), 100-105.

Na, L, & Nation, P. (1985). Factors Affecting Guessing Vocabulary in Context. RELC journal.

Nagy, W. E., Herman, P., & Anderson, R. C. (1985). Learning words from context. *Reading Research Quarterly, 20(2)*, 233–253.

Nation, P. (1997). Vocabulary size, text coverage and word lists. In Schmitt, n. and McCarthy, M.(Eds). *Vocabulary description, Acquisition and Pedagogy*. Cambridge: Cambridge University Press, 6- 19.

Nemati, A. (2009). *Evaluation of an ESL Course Book: A Step towards Systematic Vocabulary Evaluation.* University of Mysore: Department of studies in linguistics. Karnataka: India.

Nimehchisalem, V. & Mukundan, J. (2015). Refinement of the English Language Teaching Textbook Evaluation Checklist. *Pertanika Journal of Social Sciences and Humanities*. 23(4), 761-780.

Osada, E., & Tanaka, M. (2013). Exploring Taiwanese primary English education: Teachers' concerns and students' perceptions. Kokugakuin University, *JALT2012 Conference Proceedings*. Tokyo: JALT.

Rashidi, N & Kehtarfard, R. (2014). A Need Analysis Approach to Evaluation of Iranian Third Grade High school English Textbook. SAGE Open: 1-9.

Ruan, Y. (April, 2005). *CeleaJoural*. My View on Textbook in Middle School. (V.28). (N.2). Communication University of China.

Richards, J. C. (2001). *Curriculum Development in Language Teaching. Cambridge*: Cambridge University Press.

Sheldon, L. (1988). Evaluating ELT Textbooks and Materials. *ELT Journal, 42*(4), 237-246.

Sem, S. (2012). An Assessment of English for Cambodia Textbook Used in Cambodian Secondary School. Master Thesis. RUPP.

Srakang, L. (2013). *A study of Teachers' Perceptions Toward Using English Textbooks*: *A case study of 10th grade English Teachers in Maha Sarakham province* (Master Thesis).

Song, S. (2015). Cambodian teachers' responses to child-centered instructional policies: A mismatch between beliefs and practices. Teaching and teacher education (50), 36-45.

Sultana, R., Khan, R., Ali, U., & Rehman, A. (2007). Evaluation of textbooks of English for secondary school students. *Gomal University Journal of Research*.

Ur, P. (1998). *A Course in language Teaching: Practice and Theory*. UK: Cambridge University Press.

Weddle, K.S. (2009). How to Choose a Good ESL Textbook: for Adult Education and Family Literacy learners; Colorado Adult Education and Family Literacy Independent Study Course. Northern Colorado Professional Development Center. Retrieved from *ncpdc@stvrain.k12.co.us*.

Appendixes

Table 2
Textbook evaluation in detail

		Grade 4	Grade 5	Grade 6
NA	**I. General attributes**			
☐	A. <u>The book in relation to syllabus and curriculum</u>			
	1. It matches the specifications of the syllabus.			
	2. Overall, the book has a nice feel.	3.00	3.00	4.00
		3.00	3.00	3.00
NA	B. <u>Methodology</u>			
☐	3. The activities can be exploited fully.	3.00	3.00	3.00
	4. The activities can work well in most classroom situations.	3.00	3.00	3.00
NA	C. <u>Suitability to learners</u>			
☐	5. It is compatible with the background knowledge and level of students.	3.33	2.67	2.00
	6. It addresses learning targets.	3.33	3.00	3.00
NA	D. <u>Physical and utilitarian attributes</u>			
☐	7. It is appropriately priced.	4.00	4.00	4.00
	8. Its layout is attractive.	3.00	3.00	3.00
	9. It indicates efficient use of text and visuals.	3.00	3.00	3.00
NA	E. <u>Efficient layout of supplementary materials</u>			
☐	10. The book is supported by suitable materials like a workbook, audio, or multimedia.	1.00 2.00	1.00 2.00	1.00 2.00
	11. The book is supported by other materials like review and test units.	3.00	3.00	3.00
	12. There is a useful teacher's guide to aid the teacher.			
NA	**II. Learning-teaching content**			
☐	F. <u>General content</u>			
	13. Tasks move from simple to complex.	3.00	3.00	3.00
	14. Tasks are varied.	2.00	2.00	2.00
	15. Tasks support teaching objectives.	3.00	3.00	3.00
	16. The language in the textbook is natural and real.	3.00	3.00	3.00
	17. The material is fairly recent.	3.00	3.00	3.00
NA	G. <u>Listening</u>			
☐	18. The book has appropriate listening tasks with well-defined goals.	2.00	2.00	2.00

	19. Tasks are authentic or close to real language situations.	2.00	2.00	2.00
	20. Various listening contexts such as formal vs. informal contexts are considered.	2.67	2.33	2.00
NA	H. Speaking			
☐	21. Activities are developed to initiate meaningful communication.	3.00	3.00	3.00
	22. Individual, pair and group work are given equal emphasis.	2.00	2.00	2.00
NA	I. Reading			
☐	23. Length is appropriate.	3.00	3.00	3.00
	24. Difficulty level is appropriate.	3.00	3.00	3.00
	25. Texts are interesting.	3.00	3.00	3.00
NA	J. Writing			
☐	26. Tasks have achievable goals and take into consideration learner capabilities.	3.00	2.00	2.00
	27. Tasks are interesting.	2.00	2.00	2.00
NA	K. Vocabulary			
☐	28. The load (number of new words in each lesson) is appropriate to the level of students.	3.00	3.00	3.00
	29. There is a good distribution (simple to complex) of vocabulary load across chapters and the whole book.	3.00 3.00	3.00 3.00	3.00 3.00
	30. New words are sufficiently repeated and recycled across the book.	3.00	3.00	3.00
	31. Words are contextualized.			
NA	L. Grammar			
☐	32. Grammar is contextualized.	2.00	2.00	2.00
	33. Grammar items are repeated throughout the book.	2.67	2.67	2.67
NA	M. Pronunciation			
☐	34. Tasks are useful.	2.00	2.00	2.00
	35. Tasks are interesting.	2.00	2.00	2.00

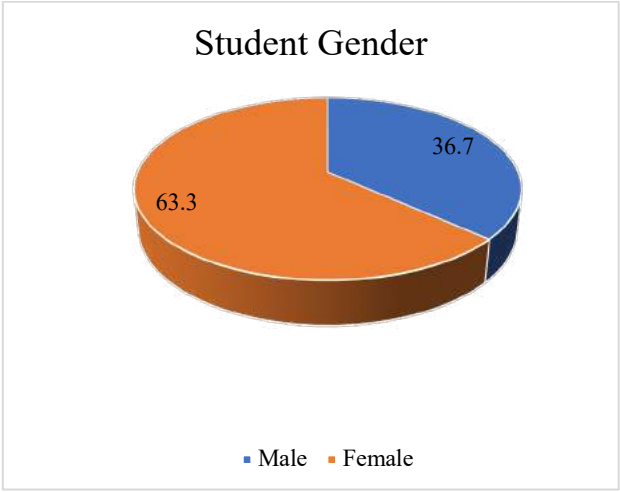


Figure 1. Participation by Gender

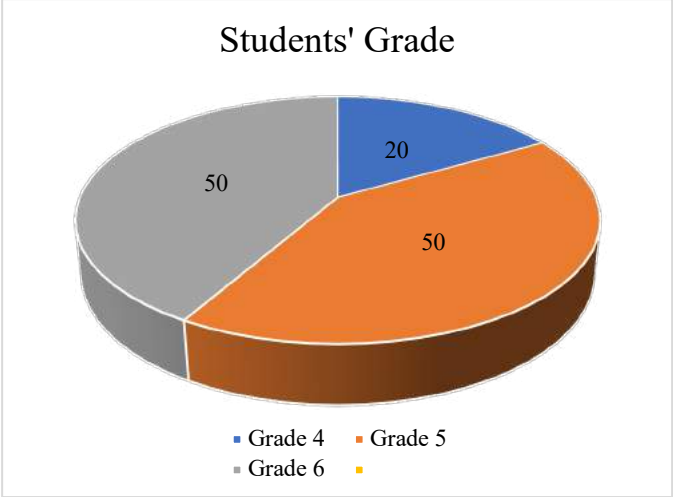


Figure 2. Participation by Grade Level

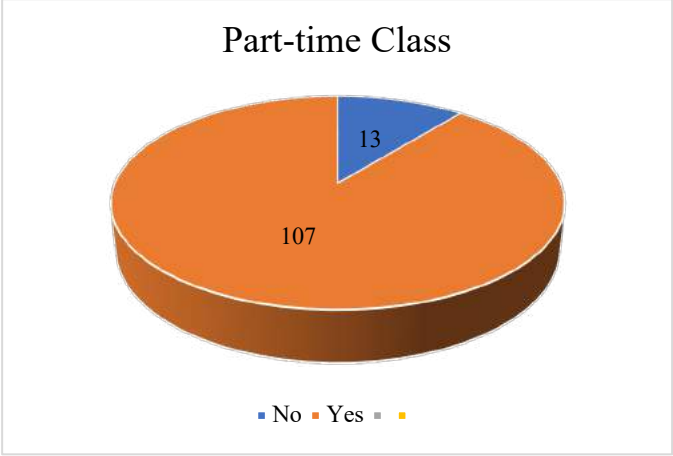


Figure 3. Attendance in Private School English Classes

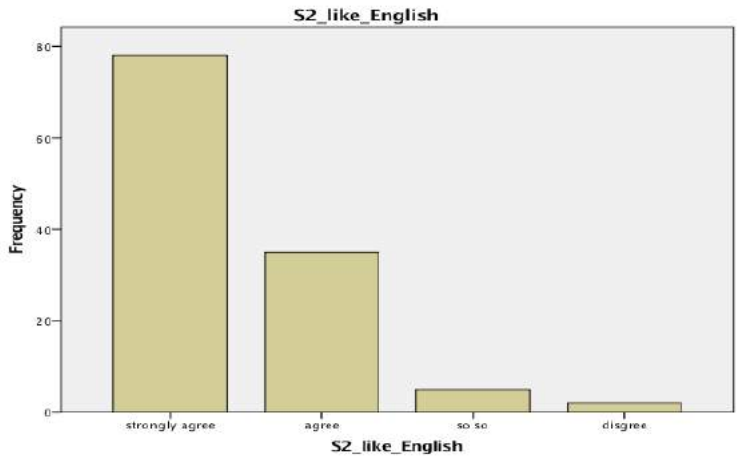


Figure 4. Students who Like English

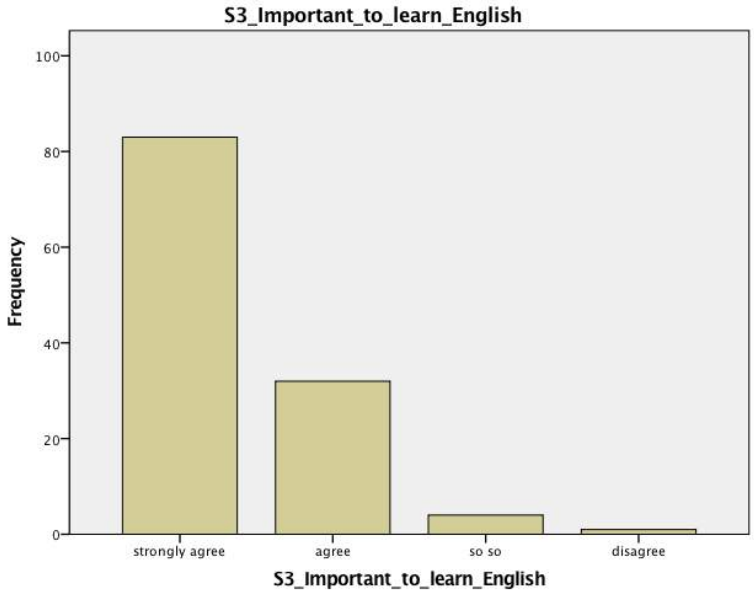


Figure 5. Number of Student who Value Learning English

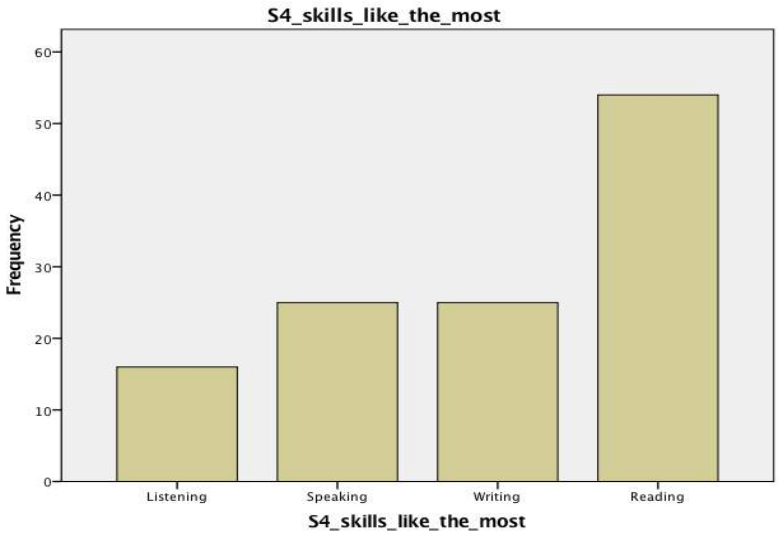


Figure 6. Skills that Students Like the Most

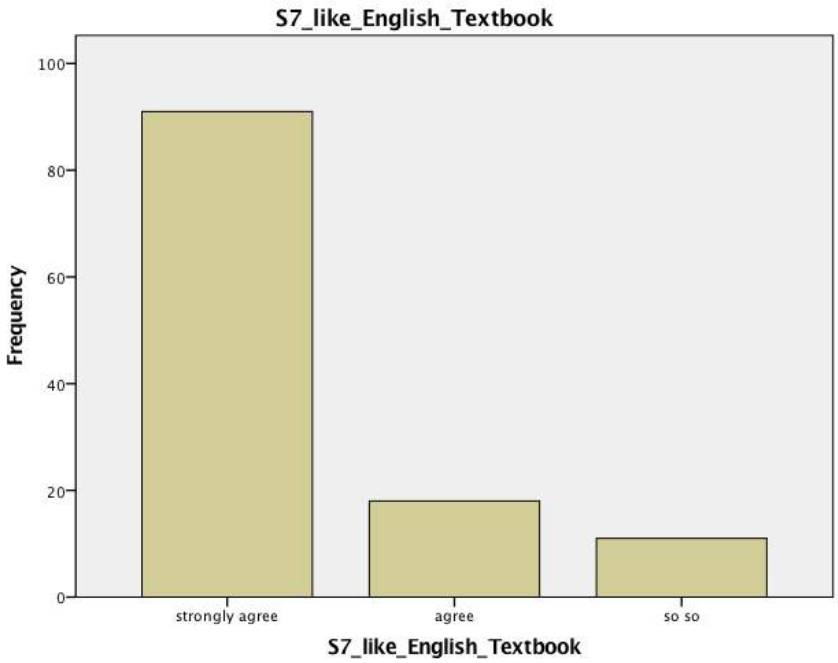


Figure 8. Students who Like English Textbook

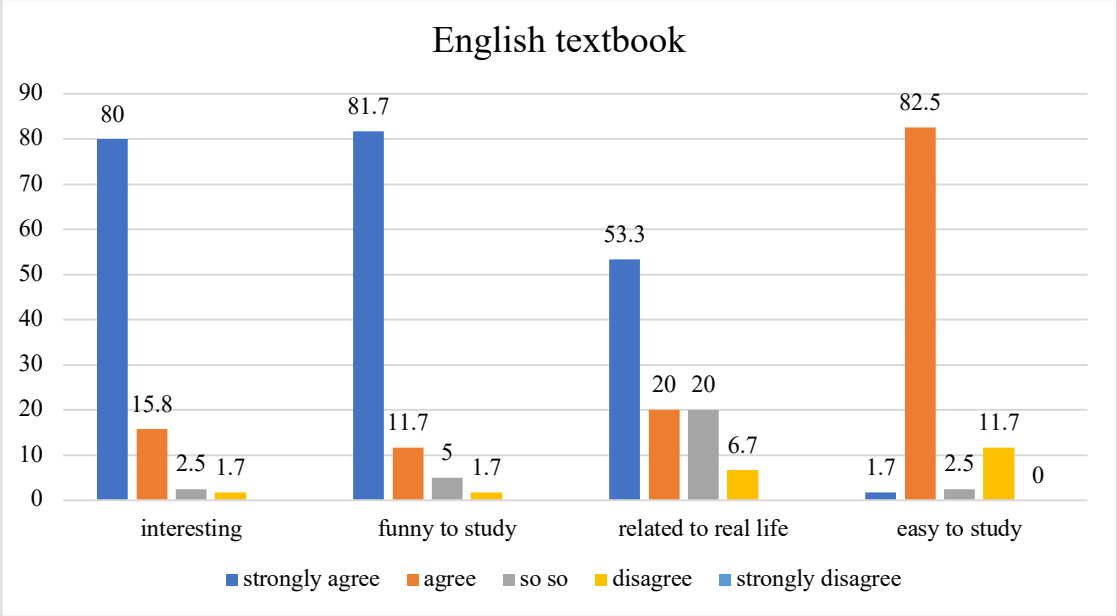


Figure 9. Impression on the Textbook

Cambodian Non-English Major Trainees' Perceptions of English Learning at National Institute of Education

VUTHEAVY CHIM

National Institute of Education, Phnom Penh, Cambodia, Email: chimvutheavy@gmail.com

Received: December 22, 2020/ Accepted: May 08, 2021

Abstract

This intrinsic case study aimed to investigate the perceptions of Cambodian non-English major trainees (hereafter N-ETs) towards English learning and their perceived challenges during their training at the National Institute of Education. A multi-method qualitative approach was employed for data collection. Stratified random sampling was used to select N-ETs from different majors for questionnaire survey (n = 42) and focus group interviews (n = 9). As a result, the study found that the majority of N-ETs changed their perceptions of learning English owing to the syllabus, teaching strategies, class size and insufficient facilities. They encountered two key challenges – mixed level and too many subjects, in learning English. The findings of this study largely echoed previous findings on perceptions of trainees and university students whose majors are not English towards learning English.

Keywords: Perceptions of English leaning; Non-English major trainees; Student teachers; Trainees; Cambodia

1. Introduction

The National Institute of Education (NIE) is the only institute which trains teachers for upper secondary schools across Cambodia. University graduates as well as experienced teachers at primary schools and lower secondary schools are eligible to participate in the training at NIE if they are bachelor's degree holders. NIE recruits its trainees through an entrance examination. The successful candidates attend a one-year training at NIE before they are certified as upper secondary school teachers and sent to their assigned school. During this training program, trainees are required to study three specialized courses and eight common courses, as well as undertake teaching practicum. This training program aims to provide them with concrete foundational knowledge of their specialties and teaching pedagogies of their major.

The Cambodian teacher-training program has been reformed for several times to improve its training quality and ensure the betterment of its impacts on the trainees. Notably, English was included in the Cambodian teacher training curriculum for all levels to equip future teachers with English ability to meet the fast growth of education and economy in the country and the region. Prior to this, English was embedded into the national curriculum for lower and upper secondary schools in 1990 (Neau, 2003), and it was added to the curriculum of the primary education level in 2014 (MoEYS, 2014). English has gained its popularity among Cambodian learners since the 1999s although it was banned for more than one decade. Clayton (2007)

pointed out two primary reasons for the fast growth of English learning in Cambodia, namely the presence of the United Nations Transitional Authority in Cambodia in the early 1990s and the admission of Cambodia into the Association of Southeast Asian Nations (ASEAN) in 1999.

Previous studies pointed out that Cambodians viewed English as a bridge for scholarship abroad, academic life and career growth (Igawa, 2010; Chan, 2018), as well as for improving their lifestyle (Keuk, 2009). Additionally, English is generally known as a main language used in online documents and websites which can be accessed for teaching and learning benefits. However, it is generally believed that non-English major trainees (N-ETs) do not seem to prefer to learn English during their training program, although English is one of the compulsory subjects for teacher trainees whose major is not English. Since this concern has attracted little attention by the local researchers and scholars, this paper aims to explore the perceptions of upper-secondary schoolteacher trainees in learning English after being selected for their training program at NIE in order to kindle better the quality of English learning and training in the Cambodian context by attempting to answer the following questions:

1. *What changes non-English major trainees' perceptions of English learning?*
2. *What do non-English major trainees perceive as challenges in learning English during their training?*

2. Review of literature

2.1 Defining perceptions in language learning

The 1969 pioneer work by Eleanor Jack Gibson on perceptions in the education field defined the concept of perception as a function of collecting information about one's surrounding and what one perceiver can do with it (Adolph & Kretch, 2015, p. 128). This definition is served as the conceptual foundation in many later studies. For example, in language acquisition, Ellis (2015) defined 'perception' as the way in which learners perceive the language being learned. Tse (2000)also defined 'perception' as a thought or point of view, which arises due to learning experiences (i.e., instructional activities and approaches), satisfaction with their progress in the classroom, or interactions with teachers and other learners.

Since this study focused on perceptions of English learning, it adapted Tse's definition for its conceptual design. Additionally, the definition was not restricted to integrate insights of perception in general as the importance of perception can be associated with understanding senses (Samovar, Porter, & Jain, 1981; Samovar, Porter, & Stefani, 1998; Gudykunst & Kim, 2003; Samovar & Porter, 2003) and motivation (Williams & Burden, 1997).

2.2 Main determinants for perceptual studies

The remarkable concept about studies on perceptions was noted in the 1980s. Marx (1983) showed in a systematic review on perceptions of learning in the classroom that two main characteristics which captured the attention of many studies of perceptions were *'task demand'* and *'classroom organization'*. The task demand was referred to *instructional activities*, and *teacher behavior* in assigning and facilitating learning activities. Previously, the task demand

was used to refer to learners' achievement. An empirical study by Zhang, Kuusisto and Tirri (2017) indicated that there was no association between perceptions and achievement scores. Yet, the researchers did not seem to deny that perceptions could be viewed as learners' learning outcome. Meanwhile, low achievers tend to have lower perceptions in doing tasks than their high achieving peers (Stipek & Hoffman, 1980). Bossert (1979, as cited in Marx, 1983) defined the *classroom organization* as any organizing tasks, such as designing the structure of the task/activities in a classroom to create a learning environment in which the teacher and students could interact with one another during the learning process.

These two main characteristics of perceptions were later found to have an influence on learners' perceptions by Rosenholtz and Wilson (1980), Rosenholtz and Rosenholtz (1981) and Tammivaara (1982). Cray and Currie (1996) argued that to effectively understand about one individual classroom, the pedagogy as well as the social and personal interaction in the classroom should be integrated into the design. This concept was known as learning environment or psychosocial environment in later studies (Henderson, Fisher, & Fraser, 2000). Evidently, by employing a multi-method qualitative approach, Barkhuizen (1998) discovered that learners and teachers had different perceptions on most of the applied activities of communicative language teaching (CLT). Learners reported to prefer learning grammar and writing, but teachers tended to focus primarily on reading. Additionally, a teacher-oriented approach was not what the learners like; however, it was frequently used by teachers in the classroom. This created as unpleasant learning environment. It also created low motivation in both learning and teaching. Similar findings were also reported in the Turkish context by Bulut and Uguten (2003).

2.3 Trainees' perceptions of English learning

A mixed method study by Ulla (2017) in Myanmar showed that pre -service trainees' challenges in learning English were related to the communicative learning approach and the teaching style of English trainers. The trainees were, moreover, not familiar with these kinds of learning environment. They admitted that they needed more time to transform their conventional learning environment to which they get used to student-centered teaching and learning. More than participating in the class activities, the trainees hope to gain not only English knowledge but also teaching strategies from their language class. However, those techniques could not be applied in any subjects except in English. Ulla and Winitkun (2018) found similar findings with in-service trainees in Thailand. Likewise, a study using self-administered questionnaires and interviews with Lebanon pre-service trainees showed that trainees usually had expectations to learn more than the contents of the subject matter (Goff-Kfouri, 2013). However, this group of trainees felt that the syllabus and course evaluation were the source of their concerns and should be revised. In an Ethiopian context, it was found that trainees had positive perceptions towards the teaching strategies (action learning) used by their trainers. They were willing to employ them in their classes later (Engidaw, 2014). Ulla and Winitkun (2018) suggested that to make English class effective for trainees, trainers should engage them with classroom workshops and activities that could assist them to gain experience

in what and how to use teaching strategies/techniques in their real classroom setting after the training.

There were very few studies on the perceptions of N-ETs in the Cambodian context. Although the findings of the previous studies in other contexts shed light on trainees' perceptions of English training and learning, they tended to focus much on trainees' perceptions of one particular teaching method (e.g., CLT, student-centered approach, action learning) or classroom management rather than on understanding the causes of changes in their perceptions. Additionally, previous studies did not seem to include any effect from training institute.

3. Methodology

3.1 Research context and design

It is worth acknowledging that English plays a crucial role in future success and career growth in the Cambodian context. However, it widely believed that N-ETs who graduated their bachelor's degree from various universities in Cambodia did not seem to prefer to learn English during their teacher training program. Similarly, English trainers have faced various challenges in teaching English to N-ETs, causing inefficiency and ineffectiveness in teaching and learning English. This concern should have been investigated and addressed on time, or it spawns unwanted role models for young students at upper secondary schools. Therefore, this study conveniently chose NIE – the only institute which trains teachers for upper secondary schools in Cambodia – to understand the central phenomenon of the issue. To realize this aim, an intrinsic case study design was employed to explore this unique issue (Crowe, et al., 2011) by adapting a multi-method qualitative approach for data collection and interpretation (Barkhuizen, 1998; Bulut & Uguten, 2003). Understanding learners' perceptions is proved to be complex by many researchers (Denzin & Lincoln, 1994). Therefore, to develop a deeper and stronger understanding of such a complex phenomenon, the use of multiple data sources and/or multiple methodologies was used (Denzin & Lincoln, 1994) to describe a complex phenomenon in the classroom (Geertz, 1973).

3.2 Participants and tasks

Table 1 precisely illustrates how the samples were recruited from the entire NIE's N-ETs population (N = 773*)*, and how data for this study were collected. To achieve more reliable information, a stratified random sampling method was used. First, 5% of N-ETs were selected from each major except English. The total selected samples (n = 42; female (F) =16, male (M) = 26) per major were manually divided into each achievement level, namely poor (P), average (A) and good (G). The real samples were randomly chosen from each major's achievement lists which were made based on their first semester results prior to the data collection process. Before starting the second step, three new achievement lists were made regardless of their majors. Then, 20% out of the real samples were selected. As a result, nine participants were selected in this stage. These numbers were divided into three achievement levels, so there were three participants from each achievement level (P = 3, A = 3, G = 3).

Table 1
Stratified sampling and data collection methods

Majors	Total Pop.	1st Sampling *(5%)*			By achievement level		
					Poor	***Average***	***Good***
		Questionnaires			*Focus-group interviews*		
French	10	0.5	*1 (not limited to achievement)*		-	-	-
Mathematics	117	5.9	*6 (2P, 2A, 2G)*		-	*1*	-
Khmer Literature	95	4.8	*5 (2P, 1A, 2G)*	2nd	-	-	*1*
Information Technology	50	2.5	*3 (1P, 1A, 1G)*	Stage *(20%)*	*1*	-	-
Physical Education	6	0.3	*1 (not limited to achievement)*		-	*1*	-
Social Science	191	9.6	*10 (3P, 4A, 3G)*		*1*	-	*1*
Science	304	15.2	*16 (5P, 6A, 5G)*		*1*	*1*	*1*
Total N:	773		*P = 13, A = 16, G = 13*		*3*	*3*	*3*
*Samples **(n)** per approach:*			**(n = 42)**			**(n = 9)**	

Note[1]*: ≤ 6.00 (poor); ≥ 6.25 - <8.00 (average); ≥8.00-10.00 (good)*

Survey questionnaires were distributed to 42 participants in Stage 1. They were given one week to complete this task, and all questionnaires were collected by the due date. The questionnaire consisted of three parts – selected responses, composition writing and open-ended questions. The selected responses comprised two questions to seek for their perceptions of English learning before *(do you like learning English before participating in this training program?)* and after *(Do you like learning English after one semester in your current training?)* joining the NIE course. Participants were asked to select one of the choices (i.e., *definitely, quite a bit, just a little, and not at all*) that applied to their perceptions. Additionally, they were asked to write one composition about '*What I like and dislike about English class at NIE? Please finish your composition writing with recommendations for improving the English teaching at NIE*'. In the third part, there were four open-ended questions such as (a) *What challenges have you faced learning English at NIE?* (b) *Have you done somethings to deal with your challenges?* (c) *Do you think you trainers helps you learn/improve English?* and (d) *Do you think learning English at NIE will be useful to you one day when you completed your training?* All questions were mainly adapted from Barkhuizen (1998) and Bulut and Uguten (2003). The questionnaire was used to collect N-ETs' perceptions of English learning before and during their training at NIE, their learning experiences and learning environment, the challenges they face and their views on how to improve English training.

[1] According to NIE's scale guideline, the original scale *(out of 10)* is divided into four grade levels: *poor* (<5.00), *average* (5.00 – <6.50), *fairly good* (6.50 – <8.00), *good* (8.00 – 10.00). However, the scale is purposively adjusted to realize the research objective owing to the fact that trainers tend to pass their trainees to minimum of original scale in their real practice.

After creating sub-themes and themes through reading the responses in questionnaires, questions for the next data collection phase were developed using a guideline for the focus-group interview suggested by Anderson (1990). The interviewing length was adapted from Dilshad and Latif (2013) and Rice and Ezzy (1999). Dilshad and Latif (2013) recommended that the number of informants for focus group interview should be between six to nine; however, this study purposively created groups with smaller size – 1st group = 5 participants (F = 3) and 2nd group = 4 participants (F = 2) – by considering gender and the achievement level in each group. The focus group interviews provide participants with more time to express their viewpoints and interactively discuss with other members as well as to allow the moderator to probe into the bottom line of each concerned point. Both questionnaires and interviews were conducted in participants' native language, Khmer, to make it easier for the participants to express their points of view (Rice & Ezzy, 1999).

To analyze the data, conceptual content analysis by grouping information according to words, word sense, phrases, sentences was first employed. Manual coding was also used for identifying themes and subthemes. Then the rational analysis was used to investigate the relationship between concepts and identified thematic issues (Busch, et al. 2012).

The focus-group interview was employed not only to probe for the central phenomenon or any unique findings but also to triangulate the answers obtained from the questionnaires in order to ensure the reliability and validity of the obtained information.

4. Results and discussion

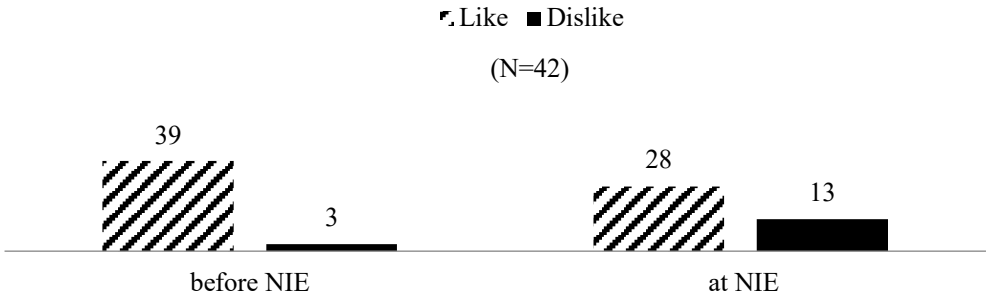


Figure 1. Comparison of trainees' perceptions of English learning

According to the results from the selected responses, Cambodian N-ETs seemed to change their perceptions of English learning after joining the training course at NIE for one semester. Figure 1 illustrates that almost all trainees (92.9%) preferred learning English prior to joining English classes at NIE while only three (P = 2, A = 1) did not. However, the number of trainees who disliked learning English increased from three to 10 trainees after they started their course at NIE. Precisely, twelve of them (30.8%) who used to like English changed their mind after taking a course at NIE. Two (P = 1, A = 1) out of three trainees who disliked English turned to like learning it in NIE. It should be noted that the majority of trainees who switched their mind from 'like' to 'dislike' were good achievers (6), following by 4 and 2 in average and poor

achievers, respectively. This showed that English learning at NIE was, on the one hand, not good enough to attract its learners across different achievement levels. On the other hand, it provides some trainees with some benefits (i.e., teaching strategies).

4.1 Determinants of changes in trainees' perceptions

This current study found four main determinants that made N-ETs changed their perceptions of learning English after joining the training program at NIE. Two were embedded in the first input of learning experience such as *teaching strategies* and *English syllabus*. Other two determinants, namely *class size* and *insufficient facilities*, were in the second input of the classroom learning environment.

4.1.1 Teaching strategies

Teaching strategies were the only determinant found to inspire N-ETs to enjoy and participate in classroom learning activities and encouraged some of them to prefer learning English at NIE. Trainees from across achievement levels expressed their preference to learn various teaching strategies used by their trainers during English classes. They were willing to apply those strategies in their real classroom later. However, it is worth highlighting that imparting teaching strategies is not the aim of the English subject at NIE.

> I really like the ways my trainer teaches and leads learning activities. It is absolutely learner-based approach […]. (Q.P10)

> I think what I've learned the most from my English class is teaching strategies and [learning] games. I noted [the steps] and I will use it with my students. (Int.A04)

This finding was in line with Engidaw's (2014) study in the Ethiopian context. However, it seemed to contradict Ulla's (2017) findings in Myanmar and Ulla and Winitkun's (2018) findings about trainees in Thailand. Cambodian N-ETs were also trained by the same teaching methodologies – a learner-based approach – in their teaching pedagogy classes for their major. Therefore, they may be familiar with a variety of teaching strategies which were being used in their English classes. Thus, the trainees might feel that they could extend their ability to use those strategies during the English lesson beyond what they could learn in their teaching pedagogy classes. Despite the time required to adjust themselves, N-ETs enjoyed practicing the activities with peers.

> I met different teaching techniques in my class that I have never seen in my major class especially task-based, and cooperative-learning approach. This is what the only benefit for me. Also, my trainer is always on time and kind. He is my idol [role model]. (Q.G06)

This empirical study revealed that N-ETs did not play a role as English learners, but as so-called *'teaching-strategies compilers'*- who participate in activities and take notes of how each

activity was conducted. Moreover, they tended to view their trainers as a *'methodology-using role model.'* This role was like being a 'coach' or 'mentor teacher' as suggested by (Lunenberg, Dengerink, & Korthagen, 2014, p. 44).

> […] we take note [each step of] how our trainer leads and introduces lesson or activities. Then we share and note in our notebook for future use [when we teach our students]. (Int.P04)

4.1.2 English syllabus

English syllabus was another key determinant which contributed towards the perceptual change of the majority of N-ETs, especially those who were high achievers. The NIE syllabus, to them, seemed to overlap with what they had learned at their universities. The level of English was lower than their university level. Therefore, they felt the English syllabus could not provide them with any benefits that they expected. Although average achievers' perceptions of the English syllabus were similar to their high achieving peers, they named this syllabus as a 'revising syllabus.' They humbly admired that English at NIE could help them revise what they had learned, or they may forget.

> I think English at NIE does not provide me with any benefits […]. However, it helps revise what I have learned at university. (Q.A04)

> […] helps me remember what I have learned, or I may forget it as I have no time to learn on my own […]. (Int.A13)

However, poor achievers thought the English syllabus was not friendly to them although the NIE syllabus was at A2 level[2] of the Common European Framework of Reference for Language (CEFR). Consistently, all N-ETs thought that the English syllabus should be re-evaluated and revised for the sake of future trainees' benefits. This finding was similar to the English training in Lebanon by Goff-Kfouri (2013) and in Pakistan by Tasdemir, Asghar and Tahir (2019). It should be highlighted that the overall goal of the NIE English syllabus is to build foundation of English knowledge for N-ETs in order to assist them to develop themselves to understand and communicate in English in their lives and future professional development (NIE, 2017).

4.1.3 Class size

Class size showed negative effects on N-ETs' perceptions of English learning at NIE in this study. Regardless of their achievement, trainees felt that studying English in a large class size was so distractive and even more demotivating in the learning process. N-ETs who were

[2] A2 level of CEFR = TOEIC (255 – 400), TOEFL PBT (397 – 433), TOEFL IBT (30 – 40), IELTS (3.0 – 3.5) retrieved January 18 2019
http://www.englishcollege.pl/userfiles/file/TOEFL%20Equivalency%20Table%20-%20TOEIC,%20TOEFL,%20IELTS%20Score%20Comparison%20Chart.pdf

studying in a large class pointed out that the trainers did not seem to pay more attention to the classroom discipline. This distracted them from hearing the trainer's instructions or explanation and made them feel demotivated in learning English.

> My trainer does not seem to care much about the classroom rules. S/he never blames my classmates who misbehaved (i.e., chatting) during the class. I felt frustrated sometimes because I could not hear trainer's voice [explanation or instruction]. I sometimes got lost. […]. They worked [on assigned tasks or exercises] so fast and started to chat. This is very annoyed to other [classmates who are still working] including me. (Q.P10)

This finding was in line with Al-Jarf's (2006) study on large class in Saudi Arabia. Although the size of class – whether large or small – varies according to the context and the individuals' perceptions (Hayes, 1997; Ur, 1996), in the context of the Cambodian teacher training college/center/institute, the maximum class size is 25 (MoEYS, 2018). However, the size of the class at NIE is flexible in the real practice owing to the shortfall of English trainers. Unexpectedly, some trainees especially the average achievers complained about the small class size (5 or 6). They said that they had less motivation in learning since the class is so quiet. They thought that learning in larger class could help them learn from their peers whose English was better than them.

> I get tired of working with the same peers in both groups and pair work. The class is so quiet. I prefer to learn in a larger class so I can learn from other students. I think the class will be more active and enjoyable. (Int.A07)

4.1.4 Insufficient facilities

N-ETs in the current study expressed their negative perceptions of learning facilities at NIE. They referred to the library, language lab and reliable internet connection. Evidently, good achievers felt that these facilities could help them become independent learners and learn more than what was taught in the class. N-ETs in other achievement levels thought that these facilities could help reduce class size and promote effective monitoring and positive attitudes towards pair and group work. This could be implied that when the training institute could not offer enough facilities that support learning and teaching, the learners did not feel to be part of learning, and they felt restricted to actively participate in the learning process (i.e., pair/group work) (Hang, 2015; Köksal & Çöğmen , 2013).

> […] it will be helpful if NIE has [language] lab to practice exercises such as grammar, reading, and listening rather than keep us (good achievers) in class when the syllabus is for elementary level. (Q.G09)

> There are many trainees in the class. So, any trainees whose English is better should be doing the tasks in library. So, there is enough space for trainers to monitor during doing [pair or group] work. If the trainer cannot walk around, some trainees will not focus. So, this [pair or group] works are boring. In fact, this [pair or group] works are good

> because we can learn from each other. Thus, if some trainees (good achievers) can do self-study in the library or language lab like at IFL [Institute of Foreign Languages], the learning environment will be even better." (Int.A11)

4.2 Perceived challenges

This study found that N-ETs paid less attention to the English subject than their major subjects. This finding was similar to the study in the Vietnamese context on non-English major university students (Hang, 2015). N-ETs in this study faced two common challenges – *mixed ability* and *many subjects* in their entire training program, in learning English at NIE. Their primary purpose in the English class was to obtain the passing mark in this subject to gain an eligibility to sit for their final examination by the end of the training program rather than to accumulate knowledge of English for future and professional development benefits. This could suggest that English learning at NIE was for the sake of examination only. Soeung (2020, p. 326) suggested that to increase participation in learning English, the '*exam-career balance*' syllabus should be developed to ensure learners' success in both examination and prospective careers. The following quotes illustrate the trainees' attitudes towards the English subject.

> This one-year training program is very essential for my future career as a(n) [upper] high school teacher. I expect that NIE will train and coach me specifically on my major because I am going to spend the rest of my life with it. […]and for English, I just learn some to ensure that I can pass in every examination. (Q.A12)

> […] First, I have to pass this [English] subject, and second, I cannot miss class more than twenty times, otherwise I cannot sit in the final exam. (Int.G01)

> There is limited time during this training program. I think we should focus on our major. Every subject has its importance, but I have to be better in my major. Getting better grades in the major must be a better record than on others because it is our specialty. (Int.G03)

These findings showed that mixed ability class affected the trainees' commitment to learn, as it was the case with the findings by Lee (2007) in South Korea. The current study found that learning in a mixed ability class caused boredom to learn especially for good achievers. It was also a barrier for N-ETs in either average or poor achievers to express their viewpoints during discussions as well as to participate in any learning activities. They felt ashamed or were afraid of being mocked. Regardless of any teaching strategies, none of the trainees raised the benefits from learning in this heterogenous learning environment (Ur, 1996).

Moreover, having too-many subjects in their training program was a burden for them because every subject had its assessment tasks. Trainees had to spend most of their time to fulfill the requirements of their major subjects rather than to invest their time to improve their English. Despite the English subject, none of the other subjects affects the results of their final examination.

5. Conclusion

The intent of this study was to discover the perceptions of Cambodian non-English major trainees towards learning English at NIE by attempting to understand reasons of change in their perceptions and the challenges they perceived. This study found that English learning at NIE could not provide N-ETs with as many benefits as they expected. This caused many trainees to change their mind from 'like' to 'dislike' learning English after participating in their training at NIE. This change was caused by the English syllabus, class size and insufficient facilities. However, the majority of the trainees tended to gain more benefits through picking up teaching strategies during their English classes which was not the aim of the English syllabus in this institute. In addition, mixed ability in the English class was seen to be a main challenge for them to learn or to improve their English competency. Furthermore, trainees thought that NIE should minimize the number of learning subjects during the training course and revise the English syllabus to increase enjoyments and benefits for future N-ETs.

The study also found that the trainees' crucial role in the classroom is no longer as learners who are curious about the contents, but as someone who collects teaching strategies/techniques (*teaching-strategies compliers*) for future benefits in their teaching career. Additionally, they viewed their trainers as *methodology-using role models*. This is like one of the six roles of teacher educators, namely a 'coach' or 'mentor (teacher)'. This suggests that English learners who are future teachers put their concentration on what can contribute towards their professional career rather than unrelated contents/subjects.

Moreover, it was found that English learning at NIE did not seem to provide trainees with English competence as stated in its training program. The study found that the English syllabus was one of the main causes among other determinants. When the syllabus does not match with its learners' proficiency level, learners tend to focus only on passing a grade rather than improving their English knowledge and skills as expected by the ultimate syllabus goal. This suggests that the NIE English syllabus should not be designed from the perspectives of a 'one-size-fits-all' but that of an 'exam-career balance'.

The findings of this study largely echoed previous findings on perceptions of teacher trainees and university students whose majors are not English, although they also indicate the context-specific pattern of determinants of N-ETs' perceptions. However, this study is not without limitations. First, the trainers' and administrators' perceptions of English learning and syllabus should have been obtained for triangulation purposes. Second, the results would contribute even more towards English courses at NIE or other teacher training institutes/colleges in Cambodia if this study could expand its investigation into the perceptions of N-ETs who were from different streams (i.e., experienced teachers – primary and secondary school teachers and students from state and private universities). Future research, therefore, should address these limitations.

References

Adolph, K. E., & Kretch, K. S. (2015). Gibson's theory of perceptual learning. *International Encyclopedia of the Social & Behavioral Sciences, 10*, 127-134.

Al-Jarf, R. (2006). Large student enrollments in EFL programs: challenges and consequences. *Asian EFL Journal, 8*(4), 8-34.

Anderson, G. J. (1990). *Fundamentals of educational research.* London: The Falmer Press.

Barkhuizen, G. P. (1998). Discovering learners' perceptions of ESL classroom teaching/learning activities in a South African context. *TESOL Quarterly, 32*(1), 85-108.

Bulut, T., & Uguten, S. D. (2003). The importance of student perceptions in language teaching. *Cukurova University: Institute of Social Science Journal, 11*(11), 90-99.

Busch, C., De Maret, P., Flynn, T., Kellum, R., Le, S., Meyers, B., Saunders, M., White, R., & Palmquist, M. (2012). *Content Analysis.* Retrieved July 2020, from Writing@CSU Writing Guide: https://writing.colostate.edu/guides/pdfs/guide61.pdf.

Chan, H. (2018). Cambodian EFL students' investment in learning English: perspectives and practices. *TEFLIN Journal*, 29(1), 45-71.

Clayton, T. (2006). *Language choice in a nation under transition: English language spread in Cambodia.* New York, The United States: Springer Science and Business Media.

Clayton, T. (2007). Transition, culture, and language in Cambodia. In A. B. Tsui, & J. W. Tollefson, *Language Policy, Culture, and Indentity in Asian Contexts* (pp. 95-120). New York, The United States: Routledge.

Cray, E., & Currie, P. (1996). Linking adult learners with the education of L2 teachers. *TESOL Quarterly, 30*(1), 113-130.

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A., & Sheikh, A. (2011). The case study approach. *BMC Medical Research Methodology, 11*(1), 1-9.

Denzin, N. K., & Lincoln, Y. S. (1994). *Handbook of qualitative research.* Thousand Oaks: CA: SAGE.

Dilshad, R. M., & Latif, M. I. (2013). Focus group interview as a tool for qualitative research: an analysis. *Pakistan Journal of Social Science (PJSS), 33*(1), 191-198.

Ellis, R. (2015). *Understanding second language acquisition (2nd Ed.).* Oxford University Press.

Engidaw, B. (2014). Teacher trainers' and trainees' percveptions, practices, and contraints to active learning methods: The case of English department on Bahir Dar university. *Academic Journals: Educational Research Reviews, 9*(20), 981-990.

Geertz, C. (1973). *The intepretation of culture: selected essays.* New York: Basic Books.

Goff-Kfouri, C. A. (2013). Pre-service teachers and teacher education. *Procedia: Social and Behavioral Sciences, 93*, 1786-1790.

Gudykunst, W. B., & Kim, Y. Y. (2003). *Communication with strangers: a approach to intercultural communication (4th ed.).* London: McGraw-Hill.

Hang, N. T. (2015). Effectiveness of pairwork and groupwork activities in teaching and learning English for non-English majors at Buang Binh University. *The Second International VIETTESOL Conference* (pp. 216-255). Hanoi: University of Education Publishing House.

Hayes, D. (1997). Helping teachers to cope with large classes. *ELT Journal, 51*(2), 106-116.

Henderson, D., Fisher, D., & Fraser, B. (2000). Interpersonal behavior, laboratory learning environments, and student outcomes in senior biology classes. *Journal of Research in Science Teaching, 37*(1), 26-43.

Igawa, K. (2010). The impact of English language education on Cambodian elementary school chilrend: perceptions of EFL teachers in Cambodia. *Shitennoji University Bulletin*, 147-165.

Köksal , N., & Çöğmen , S. (2013). Pre-service teachers as lifelong learners: university facilities for promoting their professional development. *Eurasian Journal of Educational Research, 53*, 21-40.

Keuk, C. N. (2009). How intelligible is Cambodian English variety? A look from foreigners' perspectives. *CamTESOL Conference on English Langugae Teaching: Selected Papers, 5*, 23-35.

Lee, S. (2007). Perservice EFL teachers' perceptions of their student-teaching experiences. *English Teaching, 62*(4), 355-371.

Lunenberg, M., Dengerink, J., & Korthagen, F. (2014). *The professional teacher educator: roles, behaviour, and professional development of teacher educators.* Rotterdam, The Netherland: Sense Publishers.

Marx, R. W. (1983). Student perception in classroom. *Educational Psychologist, 18*(3), 145-164.

MoEYS. (2014). *Teaching and learning English at primary education level.* Phnom Penh: MoEYS.

MoEYS. (2018). *Regulatory instruction on standard use of teaching staff (No. 20MoEYS.s.n.n).* Phnom Penh: MoEYS.

National Institute of Education [NIE], (2017). English syllabus and teaching guideline for non-English majoring trainees. Phnom Penh: NIE.

Neau, V. (2003). The teaching of foreign language in Cambodia: Historical perspectives. *Langugage, Culture and Curriculum, 16*(3), 253-256.

Rice, P. L., & Ezzy, D. (1999). *Qualitative research methods: a health focus.* Oxford: Oxford University Press.

Rosenholtz, S. J., & Rosenholtz, S. H. (1981). Classroom organization and the perception of ability. *American Sociological Association, 54*(2), 132-140.

Rosenholtz, S. J., & Wilson, B. (1980). The effect of classroom structure on Shared perceptions of ability. *American Educational Research Journal, 17*(1), 75-82.

Samovar, L. A., & Porter, R. E. (2003). *Intercultural communication: A reader (10th ed.).* Belmont, California: Wadsworth/Thomson Learning.

Samovar, L. A., Porter, R. E., & Jain, N. C. (1981). *Understanding intercultural communication.* Belmont, Califonia: Wadsworth Pub Co.

Samovar, L. A., Porter, R. E., & Stefani, L. A. (1998). *Communication between cultures (3rd ed.).* Belmont, California: Wadsworth Publish Co.

Soeung, S. (2020). Cambodian twelfth graders' choice for English private tutoring: Quit or not to quit? *TEFLIN Journal, 31*(2), 322-341.

Stipek, D. J., & Hoffman, J. M. (1980). Children's achievement-related expectations as a function of academic performance histories and sex. *Journal of Educational Psychology, 72*(6), 861-865.

Tammivaara, J. S. (1982). The effects of task structure on beliefs about competence and participation in small groups. *American Sociological Association, 55*(4), 212-222.

Tasdemir, M., Asghar, M. Z., & Tahir, A. (2019). Factors of pre-service teacher education affecting the elementary school teachers' preparedness in Punjab. *Journal of Elementary Education, 29*(2), 15-36.

Tse, L. (2000). Student perceptions of foreign language study: a qualitative analysis of foreign language autobiography. *The Modern Language Journal, 84*(1), 69-84.

Ulla, M. B. (2017). Teacher training in Myanmar: teachers' perceptions and implications. *International Journal of Instruction, 10*(2), 103-118.

Ulla, M. B., & Winitkun, D. (2018). In-service teacher training program in Thailand: Teachers' beliefs, needs, and challenges. *Pertanika Journal: Social Sciences & Humanities, 26*(3), 1579-1594.

Ur, P. (1996). *A course in language teaching: practice of theory.* Cambridge: Cambridge University Press.

Williams, M., & Burden, R. L. (1997). *Psychology for langugae teachers: a social constructivist approach.* Cambridge: Cambridge University Press.

Zhang, J., Kuusisto, E., & Tirri, K. (2017). How teachers' and students' mindsets in learning have been studied: research findings on mindset and academic achievement. *Psychology, 8*, 1363-1377.

Teachers' Knowledge and Perception in Implementing Critical Thinking Skills Practice in Chemistry: A Case of Upper Secondary Schools in Kampong Chhnang Province, Cambodia

LINDA SEANG

Graduate School for International Development and Cooperation (IDEC), Hiroshima University, 1-5-1 Kagamiyama, Higashi Hiroshima, 739-8529, Japan, Email:lindaseang999@gmail.com

Received: December 22, 2020/ Accepted: May 08, 2021

Abstract

The general focus of this study is to identify the level of chemistry teachers' knowledge and how they perceive the prospect of teaching critical thinking skills (CTS). The study used an explanatory sequential mixed-method design involving 50 teachers from 16 upper secondary schools in Kampong Chhnang province. Descriptive statistics were used for quantitative analysis, while coding, content and thematic analysis were employed for qualitative analysis. The results revealed that upper secondary chemistry textbooks have a low level of CTS; they offer only a minor reference to help students reach the level of analysis present in the cognitive domain of Bloom's taxonomy. Moreover, although these teachers had an accurate level of knowledge of CTS, they seemed to have an uncertain understanding of a few items related to CTS knowledge. In addition, most of the teachers had positive opinions and strong agreement on the perception of CTS teaching, but they had a limited or moderate level of transferring CTS to their students due to some crucial factors. Further studies need to focus on investigating the factors that influence teachers' knowledge and perception of teaching CTS.

Keywords: Critical thinking skills; Perception; Knowledge, Upper secondary school teachers; Chemistry textbooks

1. Introduction

Generally, having the ability to think critically is viewed as a necessary skill for people in society. This is especially true in the case of the fast and dynamic socio-economic development that would necessitate the young adult population to compete in a diverse job market. In addition, as information and communication technology in the 21st century is constantly evolving, the work done by people and the work done by machines tend to be in opposition. The future work will possibly be automated by artificial intelligence and robotics (Dede, 2009; Vincent-Lancrin et al., 2019). Taking the case of changes in the field of education as an example, with the help of diverse sources of information and advanced social media platforms, students can get information as well as learning materials and content related to any subjects easily through their smartphones or personal computers. As a result, it now seems less interesting to attend an actual physical class. These changes have profound implications for

teachers' competency development and emphasize the necessity for teachers to equip themselves with new skills to effectively teach students the much-needed 21st-century skills such as critical thinking, problem-solving, decision making, collaboration, creativity, and communication skills (Assessment and Teaching 21st Century Skills, 2012; Klassen & Tze, 2014; Schleicher, 2012).

Critical thinking (CT) is one of the most significant skills that students must acquire to solve problems and make correct judgments on a variety of aspects arising in this rapidly changing world (AAC&U, 2011; Butler, 2012). According to a series of studies conducted by researchers at Stanford University, countries that excelled on the Programme for International Student Assessment (PISA), a test used to measure 21st-century skills, particularly critical-thinking and problem-solving skills, had a higher increase in GDP growth than the countries that did not perform well in PISA (Partnership for 21st Century Skills, 2008). However, critical thinking skills (CTS) cannot be easily acquired only through technology; it requires more extensive guidance and instruction, through practical activities, from instructors or teachers in an actual class. Moreover, CTS has become an essential skill for meeting the needs of employers who are seeking solutions to the problems arising within a competitive global business market (Alazzi, 2008; Bataineh & Alazzi, 2009; Butler, 2012). In line with that change, the Cambodian Ministry of Education, Youth and Sport (MoEYS) has extensively worked on formulating a curriculum framework reform for general and technical education in which the development of self-study, research, critical thinking, communication, and problem-solving skills is the primary purpose for all learners (MoEYS, 2015).

However, the statistics of the Grade 12 National Exit Examination in 2015 show that the level of the cognitive domain of the different test items was relatively low; that is, the items were only at the levels of remembering and understanding (Chey & Khieu, 2017), and this did not satisfy the three upper levels (i.e., analyzing, evaluating, and creating) of Bloom's taxonomy of educational objectives, which are often considered as a definition of CT (Ennis, 1993). Against this background, this study aims to examine the knowledge and perception of CTS of upper secondary school chemistry teachers in Kampong Chhnang province, Cambodia. In order to achieve this objective, the study attempts to answer three research questions as follows:

1. *To what extent is critical thinking skills included in the upper secondary school chemistry textbooks?*
2. *What is the extent of upper secondary school chemistry teachers' knowledge of critical thinking skills?*
3. *How do upper secondary school chemistry teachers perceive teaching critical thinking skills?*

2. Review of literature

2.1 Defining critical thinking

There is an increase in the number of studies examining the meaning of the term *critical thinking skills*. Historically, the concept of CT was originated by the American philosopher, John Dewey, who called it "reflective thinking" (Dewey, 1910, p. 6). Eventually, the meaning

of CT evolved with variations in its definition from one researcher to another in their respective field of study. However, the most common definition was developed by Robert Ennis (1985, p. 46), who defined CT as "reasonable reflective thinking that focuses on deciding what to believe or do." Several other studies conceptualized CT as a process in which high-level cognitive skills of analysis, synthesis, and evaluation are supposed to be used to assess truth or mistake associated with a situation (Celikkaya, 2012 as cited in Aybek & Aslan, 2016). Given that the objective of the study is to examine teachers' knowledge and perception of implementing CTS in teaching chemistry, the researcher believes that the definition of CT provided by Celikkaya (2012) is more appropriate for this study.

2.2 The role of critical thinking skills

Considering the discussion on the importance of CTS, several questions arise: "Why do students need to learn CTS?"; "Are there any applicable strategies to teach learners CTS?"; and/or "How do teachers help students in learning CTS?" These questions promote eagerness among researchers to find answers and justify them. Basically, learners need to be armed with 21st- century skills to be able to function as global citizens, operate effectively in schools, and compete in the global economy (Carlgren, 2013). CTS is one of the skills in the 21st-century which learners must acquire in order to define and solve problems, devise strategies, shift focus, and consider alternatives (Lee, 2005). CTS is viewed as a tool that helps develop a high academic setting in which students need to reach their goals established by academic sources or teachers (Ennis, 1962).

Additionally, acquiring CTS can lead to mental independence and help in accomplishing greater productive tasks with others. It also helps in revealing the working of people's minds and sharing ideas with others, recognizing and directing the inner processes related to understanding issues, communicating ideas and beliefs, and analyzing and making decisions to solve a problem (Mayfield, 2007). Studying CTS benefits the learners not only in the context of the classroom and workplace but also daily life (Bassham et al., 2005). For instance, in classrooms, students can learn a variety of skills related to CT such that they can better understand the arguments and beliefs of others and help critically evaluate those arguments and beliefs and develop well-supported arguments to defend their own opinions and beliefs. Furthermore, in workplaces, using CTS, individuals can solve problems effectively, think creatively, gather and analyze information thoughtfully, draw appropriate conclusions, communicate clearly and efficiently, and avoid making biased decisions. Duron et al. (2006) also supported the idea that CT is required in the workplace, as it can help people to deal with mental and spiritual questions and evaluate people, policies, and institutions, thereby avoiding social problems. In daily life, CT can help people make decisions more carefully, clearly, and logically. It can also free them from unexamined assumptions and bias and help promote democracy in society (Bassham et al., 2005).

2.3 Studies on teachers' perceptions of critical thinking skills

Regarding how CT is perceived, Kenney (2013) claimed that CT is not an inherent skill, rather it is a skill that can be learned and enhanced with educational progress, from school to college

and then to university. However, a qualitative study on the perceptions of CT among social studies teachers at a Jordanian secondary school revealed that teachers have little familiarity with the meaning of and the teaching strategies for CTS (Alazzi, 2008). The result of the study also showed that according to the Ministry of Education of Jordan, Jordanian secondary school teachers need to teach CT only to a small extent.

Similarly, a study on the attitudes toward CTS among 72 high school teachers of a Hong Kong secondary school in China indicated that they had a narrow conception of the meaning of CTS (Stapleton, 2011). The teachers expressed strong support for the inclusion of CTS in the curriculum and the desire to be trained on how to teach it and to provide a more vivid definition of CT in educational documents. Another study using a semi-structured questionnaire conducted by Choy and Cheah (2009) on teacher perceptions of CTS among students and their influence on higher education in Malaysia revealed that teachers were aware that they taught CTS to their students and expected that CTS would provide the intellectual stimuli needed to develop students' critical thinking ability. Yet, the participants of this study did not understand the requirements for cultivating CT among students, and they concentrated more on ensuring subject matter comprehension.

A study conducted by Bezanilla et al. (2019) attempted to identify what teachers understand by CT and how they apply it in their teaching by examining 230 university teachers from Spain and Latin America. The study results indicated that the teachers believed that oral and written reflection and argumentation, reading, analysis, synthesis of resources, and case studies were the most effective ways to teach and develop CT. Moreover, Gashan (2015) conducted a quantitative study with 29 male pre-service teachers involved in a teacher education program in Saudi Arabia to explore their knowledge and perceptions of CTS. The results demonstrated that pre-service teachers were optimistic about the importance of teaching CTS, but they had underdeveloped knowledge of CTS and wondered whether they have the skills necessary to promote CTS among students within the classroom setting. The study suggested a need for further investigation on exploring CTS knowledge among college teachers in order to better understand the extent to which college teachers are prepared to teach CTS. The present study responds to this call, by examining Cambodian upper secondary school chemistry teachers' knowledge and perception of CTS.

3. Methodology

This study employed an explanatory sequential mixed-methods design, involving a quantitative data collection and analysis conducted in the first phase, followed up by a qualitative data collection and analysis in the second phase. This method provides a more insightful understanding of the problem due to the integration or mixing of the quantitative and qualitative data (Creswell & Creswell, 2018). According to Creswell (2014), using only one type of data collection has strengths and weaknesses; however, blending or mixing data can provide a stronger view by addressing the weaknesses of each type of data to develop a more comprehensive understanding of a research question or a problem. Basically, the quantitative results determined the types of respondents to be purposefully selected and the types of

questions that the respondents will be asked in the qualitative phase. In the second phase, the qualitative data was collected using a semi-structured interview guide and classroom observation scoring sheet. The participants were asked to give consent to being audiotaped and videotaped during the interview and classroom observation, respectively. In this study, the quantitative statistical results are presented first, followed by a discussion of the qualitative findings. Finally, an interpretation of the results from both types of data was made by using qualitative data to explain the quantitative data.

3.1 Participants

A total of 50 respondents (32 males and 18 females) from 16 upper secondary schools in Kampong Chhnang province participated in the survey. Among the 50 respondents, 8 respondents (one from each district in the province) were purposively selected for interviews and four out of eight respondents were purposively selected for classroom observation based on their perception, teaching experience, and major.

3.2 Questionnaires

The sources of information for data collection that have been included in this study are public chemistry textbooks. These textbooks were published by MoEYS for the upper secondary level. The first textbook (grade 10) was published in 2007, the second textbook (grade 11) in 2008, and the third textbook (grade 12) in 2009. These textbooks are the essential sources that all the teachers across the country rely on for teaching chemistry. Therefore, they have been considered as the vital sources for data collection and analysis in this study. The purpose of using these textbooks is to analyze the extent to which CTS has been included in the textbooks of grades 10–12. The researcher used the questions in each chapter as a unit of analysis and compared it with the checklist of the verb forms using the Revised Bloom's taxonomy (2001). A self-reported survey questionnaire developed by Gashan (2015) was adapted for this study. This questionnaire was used because the digested components of the survey questionnaire are strongly related to the concept and objective of this study, where knowledge and perception are considered to be important variables. Another important justification for the adaptation of this questionnaire is that it was mainly developed for evaluating teachers' knowledge and perception of CTS, which is in line with the objective of this study. To evaluate teachers' knowledge, codes such as 0 for inaccurate (0 = inaccurate), and 1 for accurate (1 = accurate) were used. Moreover, a five-point Likert-type scale (ranging from 1 = strongly disagree to 5 = strongly agree) was used to measure teachers' perception of implementing CTS. Furthermore, the internal consistency of the questionnaire (Cronbach's alpha = 0.93) is highly reliable and thus is appropriate for this study. Specifically, this questionnaire was employed as an example in measuring the teachers' knowledge of CTS, as seen below.

Skill	**Yes**	**No**
1. Examining relationships among statements.		
2. Interpreting the meanings from variety of data or experiences.		
3. Assessing the quality of ideas or data.		
4. Identifying alternative claims and drawing conclusion.		

Regarding teachers' perception, the following statement was used as an example which ranged from 1 to 5 (1= Strongly Disagree, 5= Strongly Agree).

Statement	SD	D	N	A	SA
1. Critical thinking engages students' higher order thinking (analyzing, evaluating, and creating).	1	2	3	4	5
2. Critical thinking encourages students to become independent thinkers.	1	2	3	4	5
3. Critical thinking encourages students to become active learners.	1	2	3	4	5
4. Critical thinking can be used to achieve better learning outcomes.	1	2	3	4	5

3.3 Interviews

To gain more insights into the result of the quantitative analysis, a semi-structured interview guide was adopted from Alazzi (2008) and modified by the researcher to garner a comprehensive understanding of the survey questionnaire results. The interview protocol for determining teacher perceptions consisted of eight items, followed by sub-questions for each one. The questions focused mainly on the four critical viewpoints regarding the importance of CTS (2 items), the support they have received from the various stakeholders (3 items), the difficulties they have encountered while teaching a lesson in the classroom (2 items), and their CTS teaching practice (1 item). The interviewed participants were chosen based on their demographic information (age, teaching experience, gender, and major) and their perception from the quantitative result (i.e., strong perception). Due to time constraints, the researcher did not interview the respondents who had a weak perception

3.4 Classroom observations

Additionally, the researcher observed the teaching practice of the four selected respondents based on their level of perception (strong perception), experience, and major (chemistry and others). The purpose of classroom observations was to see how the participants implemented their knowledge and perception of CTS in their teaching practice. This method was used to triangulate the results of the survey questionnaire and the interview. A classroom observation scoring sheet was developed by the researcher following guidelines from Stevens and Levi (2013) who provided the rubrics to evaluate the CTS teaching. From the scoring sheet, four main themes were identified, namely communication with students, questions to students, discussion guidance to students, and teaching materials for students' understanding of the subject. There were three questions that corresponded to the meaning of each main theme. The researcher rated the classroom observation on a scale of 1–5 (1 = not at all, 2 = poor, 3 = moderate, 4 = good, and 5 = very good). In addition, for more qualitative evidence, a classroom observation timeline was created following Stigler and Hiebert's (1999) suggestions to explain how the four teachers used their lesson time.

3.5 Data analysis and interpretation

The quantitative data from the survey was entered into a Microsoft Excel spreadsheet and later imported into the Statistical Package for Social Science (SPSS) version 23.0 for analysis. The demographic characteristics of the participants were analyzed using descriptive statistics. Each demographic characteristic was computed to determine the frequency and percentage. Descriptive statistics were also used to evaluate the teachers' knowledge of CTS by calculating frequencies, percentages of the respondents who got the answers, mean score, and standard deviation for the three sections of knowledge of CTS. These descriptive statistics were also used to compute teachers' perception of CTS, scaling from strongly disagree to strongly agree. This calculation was used to check to what extent was each item in the questionnaire rated by the respondents. The same calculations of the descriptive statistics were also done for the textbook analysis. Additionally, another rater in the field of chemistry helped rate the verbs from the questions in each textbook in comparison with the verbs from the Revised Bloom's taxonomy (2001). Then, the interrater reliability was measured using SPSS to check the level of agreement between the researcher and another rater using Cohen's Kappa value. This process helped the researcher to ensure the data reliability from different raters (McHugh, 2012).

4. Results and discussion

4.1 The extent to which critical thinking skills were included in upper secondary school chemistry textbooks

As shown in Table 1 below, only a small proportion of the questions in each chemistry textbook reached the level of analyzing (level 4). However, the upper two levels (evaluating and creating) could not be found in any of the questions in each textbook. It was found that only 59 questions (7.9%) out of a total of 749 questions in the three upper secondary chemistry textbooks required a higher level of CTS. However, 690 questions (92.1%) only demanded a lower level of CTS. This result was consistent with Lau et al.'s (2018) study which indicated that most of the textbooks among the 100 textbooks used in their study were not appropriately designed to stimulate advanced cognitive processes, such as evaluating and creating, but for basic and intermediate learning that is based on the revised Bloom's taxonomy.

Furthermore, the result of this study slightly corroborated the findings of Upahi and Jimoh (2015) who had conducted a similar study on the classification of end-of-chapter questions in the senior school chemistry textbooks used in Nigeria. Upahi and Jimoh found that 24% of the end-of-chapter chemistry questions required higher-order cognitive skills, while the percentage of questions at the understanding level was the highest at 41% among the remaining 76%. The percentage of questions in the categories of evaluating and creating were found to be low. In contrast, the results of the current study showed that there was no questions that fell into the categories of evaluating and creating.

In the current study, the percentage distribution of the questions found across the chemistry textbooks indicated that 7.9 % of the total questions required in the *analyzing* category. This result is different from the finding of Thote and Gowri (2020), who found a higher proportion

(30%) of the questions falling in the analyzing category. Thus, the upper secondary chemistry textbooks provided by MoEYS tended to require low levels of CTS.

Table 1
Results of Chemistry Textbook Analysis

Grade	Number of Questions	L1		L2		L3		L4		L5		L6	
		Qs	%	Qs	%	Qs	%	Qs	%	Qs	%	Qs	%
10	143	78	54.5	21	14.7	33	23.1	11	7.7	0	0.0	0	0.0
11	295	110	37.3	81	27.5	83	28.1	21	7.1	0	0.0	0	0.0
12	311	107	34.4	121	38.9	56	18	27	8.7	0	0.0	0	0.0
Total	**749**	**295**		**223**		**172**		**59**		**0**		**0**	

Note: **(L1:** Remembering, **L2:** Understanding, **L3:** Applying, **L4:** Analyzing, **L5:** Evaluating, **L6:** Creating**)**

4.2 The extent to which chemistry teachers possess the knowledge of critical thinking skills

The second question intended to identify the level of CTS knowledge of the chemistry teachers. The question was answered through a review of individual responses to the second part of the questionnaire which had three sections—skills, concepts, and nature. The first section of this part examined the upper secondary school chemistry teachers' knowledge regarding the skills and sub-skills of CT.

Table 2
Sum, Mean and Standard Deviation (SD) for Skills of CT

Skill	Sum	M	SD
1. Examining relationships among statements.	36	.72	.45
2. Interpreting the meanings from a variety of data or experiences.	46	.92	.27
3. Assessing the quality of ideas or data.	45	.90	.30
4. Identifying alternative claims and drawing conclusion.	48	.96	.20
5. Presenting results of one's reasoning.	39	.78	.42
6. Generating original and new insights.	42	.84	.37
7. Delivering information that committed to memory.	17	.34	.48
8. Generating questions from a particular topic.	46	.92	.27
9. Confirming, validating, or correcting one's reasoning procedure.	36	.72	.45
10. Working from specific facts to general principles.	47	.94	.24
11. Storing, retaining, and recalling information.	25	.50	.51
12. Separating relevant from irrelevant data.	41	.82	.39
13. Moving from a question or a problem toward one correct answer or a solution.	50	1.00	.00
14. Making a prediction of what will happen in the future from given information.	40	.80	.40
15. Summarizing an article in one's own words.	29	.58	.50
16. Analyzing an argument through sketching a graph or drawing a picture.	42	.84	.37

In this section, the participants were required to select the skills that they thought were related to CT. The results presented in Table 2 showed that the mean score of 13 out of 16 items fell in the range of 0.66–1, which indicated that the majority of the participants had accurate CTS knowledge; in particular, all the participants correctly identified item number 13 which is represented by the statement: "Moving from a question or a problem toward one correct answer or a solution." Moreover, the mean scores of two statements (items 11 and 15) were in the range of 0.36–0.65, which suggested that the respondents have an uncertain understanding of CTS. Furthermore, only one item "Delivering information that committed to memory" was in the low range of 0–0.35, as it was correctly answered by only 17 out of 50 participants. This result indicated inaccurate CTS knowledge.

In the second section (Table 3), there were a total of six statements that examine whether the upper secondary school chemistry teachers were familiar with the concept of CT. According to the data, almost all the participants answered four out of six statements correctly, which were in the range of 0.66–1. However, only two items were in the range of 0.36–0.65, which indicated that more than half of the participants were uncertain about the CT concept presented by the statements: "Fair-minded thinking is connected with the accurate assessment of one's own reasoning" and "An important fact that supports the need for an analytic dimension of CT is that the analysis of thinking is presupposed in every subject."

Table 3
Sum, Mean and Standard Deviation (SD) for the Concept of CTS

Statement	Sum	M	SD
1. It is important to clarify thinking whenever you are explaining something to someone; whenever someone is explaining something to you; and whenever you are analyzing an article or chapter.	49	.98	.14
2. Fair-minded thinking is connected with the accurate assessment of one's own reasoning.	32	.64	.49
3. Depth in reasoning best relates to complexities in the issue; logical interpretations; clarifying the issue.	43	.86	.35
4. One main requirement of critical thinking is to analyze thinking into its most basic components.	49	.98	.14
5. Critical thinkers assess thinking in order to determine what thinking to accept and what to reject.	48	.96	.20
6. An important fact that supports the need for an analytic dimension of critical thinking is that the analysis of thinking is presupposed in every subject.	32	.64	.49

The last section for evaluating the knowledge of CT consisted of nine statements which were about the nature of CT (Table 4). In this section, the respondents were required to identify

whether the statements reflected the nature of CT or not. Consequently, it was found that seven out of nine items were correctly answered and within the high range of 0.66–1. Among these statements, only one item with the statement, "Critical thinking enables one to think more deeply" was correctly chosen by 49 out of 50 respondents. The last two items with the statements, "One should not analyze sympathetically the points of view that are disgusting, and obviously false" and "Critical thinkers use subjective standards to assess thinking" were ranged low at 0–0.35, as they were answered correctly by less than half of the respondents. This suggested that the teachers had uncertain knowledge of the nature of CTS.

Table 4

Sum, Mean and Standard Deviation (SD) for the Nature of CTS

Statement	Sum	Mean	SD
1. As people grow older, they naturally develop as critical thinkers.	42	.84	.37
2. Critical thinking is self-disciplined.	39	.78	.42
3. Critical thinking enables one to think more deeply.	49	.98	.14
4. One should not analyze sympathetically points of view that are disgusting and obviously false.	16	.32	.47
5. If a statement is unclear, we benefit by asking what our purpose is in saying it.	35	.70	.46
6. Implications are conclusions you come to in a situation.	40	.80	.40
7. Critical thinking is important in learning to read well.	44	.88	.33
8. Critical thinkers use subjective standards to assess thinking.	17	.34	.48
9. Critical thinkers learn to ignore their emotions when making important decisions.	39	.78	.42

Upper secondary chemistry teachers were surprisingly found to have an accurate knowledge of CTS. There were only a few items related to CTS about which the respondents seemed to have an uncertain understanding. Almost all the items drawn from the questionnaire for investigating the knowledge related CTS in the study were answered correctly by most of the respondents, generating a high mean score (M = .78, SD = .12). This result is in contrast with Alazzi (2008), Gashan (2015), and Stedman and Adams (2012) who found that teachers had unsure knowledge about CT. Similarly, teachers were found to have little familiarity with the meaning and the teaching strategies of CTS (Alazzi, 2008). Gashan (2015) argued that teachers were uncertain as to whether they have the skills necessary to promote CTS among students in the classroom. Educated college teachers might also think that they were appropriately teaching CTS to their students when they were not; moreover, teachers might have insufficient CTS education themselves. The reason behind the lack of knowledge of teachers as mentioned in Stedman and Adams (2012) is the teachers themselves. They might not have had formal education for acquiring CTS; therefore, naturally, if teachers do not understand CT, it is almost impossible for them to teach it to their students.

However, the present study provided results that are noticeably different from those of the previous studies. The rationale behind teachers having accurate knowledge of CTS might originate from their educational level, as most (92%) of the teachers in this study had a bachelor's degree, which they spent four years acquiring, and one year of pedagogical education. Only after attaining these qualifications were they able to become a public school teacher. They experienced both academic and social lives while studying, during which they might have developed their thinking skills.

4.3 The perception of upper secondary school chemistry teachers towards teaching critical thinking skills

The results obtained from the questionnaire analysis indicated the chemistry teachers' perception toward the importance of CTS and the support as well as the difficulties which they encountered while teaching CTS to students. To understand the teachers' perception of CTS, they were asked to determine the level of agreement and disagreement about seventeen statements related to the importance of CTS, the support from relevant stakeholders, and the challenges they faced, as shown in Table 4.5. The results revealed that the mean score of all the seventeen statements was in the high range of 3.5–5, indicating agreement.

The present study found that most of the chemistry teachers strongly agreed on and had a positive perception (M=3.94, SD=.54) toward teaching CTS, which was mainly related to the importance of teaching CTS, the support system built by the relevant stakeholders, and the challenges they face during their teaching practices. These results are consistent with the study by Gashan (2015) which found that pre-service teachers held positive opinions about the value of teaching CT. They strongly agreed that CT engages students in higher-order thinking and encourages them to become independent thinkers and active learners.

In the present study, most of the respondents (88%) agreed that it is their responsibility to promote CT in their course with a high mean score (M = 4.04, SD = .76). This result could be associated with the finding of Stedman and Adams (2012) which found favorable perspectives from the respondents on statements about the need to develop students' CTS. On the other hand, the participants in their study provided a variety of responses that focus on the role of teachers' instruction in promoting CTS.

Furthermore, the findings observed in this study mirror those of Choy and Cheah (2009) who examined teachers' perceptions of CT among students and its influence on their higher education. The study indicated that although teachers believed that they were teaching CT to their students and encouraging CT in the classroom, they were only focusing on explaining the subject matter for the purpose of comprehension. Moreover, they found that the teachers did not understand how to cultivate CTS among students in a classroom environment.

This finding of this study also somewhat corroborates with the idea put forwarded by Stapleton (2011) who suggested that high school teachers had narrow conceptions regarding the concept of CT. They extended strong support for the inclusion of CT in the curriculum and conveyed the desire for the promotion of relevant training on how to develop CT in students along with

Table 5

Sum, Mean and Standard Deviation (SD) for Teachers' Perceptions of CTS

Statement	Sum	Mean	SD
1. Critical thinking engages students' higher order thinking (analyzing, evaluating, and creating).	215	4.30	.84
2. Critical thinking encourages students to become independent thinkers.	193	3.86	1.09
3. Critical thinking encourages students to become active learners.	207	4.14	.90
4. Critical thinking can be used to achieve better learning outcomes.	214	4.28	.76
5. Critical thinking will allow students a better understanding of course topics.	214	4.28	.78
6. Critical thinking is a method of thinking which would help students enjoy the learning process.	195	3.90	.89
7. The Ministry of Education guidelines require me to teach critical thinking.	183	3.66	.85
8. The teacher's manual explains how to teach critical thinking.	181	3.62	.99
9. I used to take a course related to how to teach critical thinking to students during pre-service training.	184	3.68	.87
10. My professors address how to teach critical thinking during the class.	183	3.66	.82
11. I think that students have barriers to critical thinking, regardless of the strategies I use.	204	4.08	.97
12. I find some difficulties (school facilities, parents, material, time…) when I involve student in critical thinking.	199	3.98	.85
13. I have the skills necessary to promote critical thinking by students in my course.	177	3.54	.93
14. I look for specific evidence of critical thinking by students in my course.	181	3.62	.78
15. I believe that it is my responsibility to promote critical thinking in my course.	202	4.04	.76
16. If required, I could implement critical thinking into my course.	203	4.06	.65
17. In order for me to fully implement critical thinking into my course, I would need additional support.	214	4.28	.83

a suggestion to present more precise definitions of CT in educational documents. Regarding their suggestions, to some extent, the participants in the current study showed a strong desire to receive trainings for learning proper CTS teaching methods to fully promote CTS in their classrooms as well as to enhance the subject matter.

Moreover, the qualitative findings of this study also suggested some similarities with those of previous studies regarding the barriers to promoting CTS teaching practice (Almulla, 2018; Alwadai, 2014). The main barriers identified in the present study were insufficient teaching materials, the lack of basic knowledge related CTS among the students, the lack of teacher motivation, difficulties in teacher instruction method for promoting CTS, and too much content in chemistry textbooks. These findings are aligned with Almulla (2018) who found that limited school resources and traditional curricula were key barriers to implementing CTS. The finding from another study by Alwadai (2014) has also reported similar results, outlining seven obstacles to the teaching of CTS such as student ability, classroom structure, teaching methods, pre-service teacher preparation programs and in-service teacher professional and developmental programs, Islamic studies curriculum, the Saudi society, and the school community. However, the finding of the current study differs from that of Aliakbari and Sadeghdaghighi (2013) who found that the major obstacles in practicing critical thinking in the Iranian context were the lack of critical thinking knowledge among teachers, students' attitudes and expectations, and self-efficacy constraints.

Given the discussion on the perception of teaching CTS, the results of this study exhibited strong consistency with those of previous studies, showing positive opinions and strong agreement with the statements used in the questionnaire. Nevertheless, the results generated from the actual practice observed during classroom observations contradicted the results from the reported questionnaire and the interview notes. During their teaching practice, the teachers who were observed seemed to have faced obstacles that were similar to those presented found in previous studies discussed above.

6. Conclusion

The qualitative findings of this study suggest that upper secondary chemistry textbooks provide a minor reference to CTS and include questions only up to the *analyzing* level of the Bloom's taxonomy. Additionally, the quantitative results indicate that chemistry teachers' knowledge is accurate and their perception is positively related to the importance of CTS and the support from policymakers and other relevant stakeholders. However, the teachers have emphasized the existence of some difficulties such as insufficient teaching materials, particularly chemical substances and laboratory instruments, the lack of students' basic knowledge of CTS, the lack of teachers' motivation, limitations in the teachers' instruction methods for CTS implementation, and too much content in textbooks. They also requested policymakers to address these issues. The results indicate that teachers need to fully understand and adequately use CTS in their teaching.

Considering all these results together, there are some possible implications for curriculum developers, policymakers in MoEYS, and teachers themselves. Curriculum developers or textbook designers should re-examine the content of chemistry textbooks and conduct a more detailed analysis of the constraints and potential consequences—positive and negative—by including all the cognitive levels of thinking from Bloom's taxonomy in the chemistry textbooks of upper secondary schools. While incorporating a high level of cognitive skills in

chemistry textbooks may result in some adverse effects, offering more questions that reach three upper levels of thinking to provide learners with CTS as well as comprehensive subject matter knowledge is of utmost importance, not only for the classroom interaction between students and teachers but also for the future work and daily life of students.

Another practical implication that needs to be considered is the promotion of CTS teaching at the school level. The policymakers should provide clear guidelines to foster CTS teaching in the upper secondary education as well as tackle all the barriers that prevent teachers from implementing CTS in their teaching practice. Furthermore, the pre-service and in-service teacher training programs should provide clear instructions on how to cultivate CTS in the teaching practice. Most importantly, the teachers should not depend only on the standard textbooks; they should do more research and gather any available documents that can enrich their knowledge of the subject matter and improve their teaching method to promote the teaching of CTS in the classroom as it is a crucial skill students need to success in their study and life. The current research was not specifically designed to examine the factors affecting teachers' knowledge and perception toward teaching CTS, so future studies could consider assessing the factors that might affect teachers' knowledge about and perception of CTS.

References

Alazzi, K. F. (2008). Teachers' perceptions of critical thinking: A study of Jordanian secondary school social studies teachers. *The Social Studies*, *99*(6), 243–248.
https://doi.org/10.3200/tsss.99.6.243-248.

Aliakbari, M., & Sadeghdaghighi, A. (2013). Teachers' perception of the barriers to critical thinking. *Procedia-Social and Behavioral Sciences*, *70*, 1–5.

Almulla, M. (2018). Investigating teachers' perceptions of their own practices to improve students' critical thinking in secondary schools in Saudi Arabia. *International Journal of Cognitive Research in Science, Engineering and Education*, *6*(3), 15–27.

Alwadai, M. A. (2014). Islamic teachers' perceptions of improving critical thinking skills in Saudi Arabian elementary schools. *Journal of Education and Learning*, *3*(4), 37–48.

Anderson, L.W. (Ed.), Krathwohl, D.R. (Ed.), Airasian, P.W., Cruikshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* (Complete edition). New York: Longman

Association of American Colleges and Universities. (2011). The LEAP vision for learning: Outcomes, practices, impact, and employers' view. Washington, DC: Author.

ATC21S. (2012). *Assessment and teaching for 21st century skills*. http://www.atc21s.org/

Aybek, B., & Aslan, S. (2016). An examination of teachers' views regarding the conformity of social studies textbooks to the critical thinking standards. *Journal of Education and Training Studies*, *4*(11), 12-20.

Bassham, G., Irwin, W., Nardone, H., & Wallace., J. M. (2005). *Critical thinking: A student's introduction* (2nd ed.). USA: McGraw-Hill.

Bataineh, O., & Alazzi, K. F. (2009). Perceptions of Jordanian secondary school teachers towards critical thinking. *International Education*, *38*(2), 4.

Bezanilla, J. M., Nogueira, F. D., Poblete, M., & Domínguez, G. H. (2019). Methodologies for teaching–learning critical thinking in higher education: The teacher's view. *Thinking Skills and Creativity, 33*, 100584.

Butler, H. A. (2012). Halpern critical thinking assessment predicts real-world outcomes of critical thinking. *Applied Cognitive Psychology*, *25*(5), 721–729.

Carlgren, T. (2013). Communication, critical thinking, problem-solving: A suggested course for all high school students in the 21st century. *Interchange, 44*(1–2), 63–81. https://doi.org/10.1007/s10780-013-9197-8

Chey, C. O., & Khieu, V. (2017). Cognitive domain, level of difficulty and topic distribution of the science stream in the national exit examination in Cambodia. *Cambodia Education Review*, *1*(1), 33–48.

Choy, S. C., & Cheah, P. K. (2009). Teacher perceptions of critical thinking among students and its influence on higher education. *International Journal of Teaching and Learning in Higher Education*, *20*(2), 198–206.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Thousand Oaks, CA: Sage.

Creswell, J.W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage.

Dede, C. (2009). *Comparing frameworks for "21st century skills*." 1–16.

Dewey, J. (1910). *How to think.* Boston: DC Heath & Co.

Duron, R., Limbach, B., & Waugh, W. (2006). Critical thinking framework for any discipline. *International Journal of Teaching and Learning in Higher Education*, *17*(2), 160–166.

Ennis, R. H. (1985). A logical basis for measuring critical thinking skills. *Educational Leadership*, *43*(2), 44–48.

Ennis, R. H. (1993). Critical thinking assessment. *Theory into practice*, *32*(3), 179–186.

Ennis, R.H. (1962). A concept of critical thinking: A proposed basis for research in the teaching and evaluation of critical thinking ability. *Harvard Educational Review*, *32*, 81–111.

Gashan, A. K. (2015). Exploring Saudi Pre-service Teachers' Knowledge of Critical Thinking Skills and their Teaching Perceptions. *International Journal of Education and Literacy Studies*, *3*(1). https://doi.org/10.7575/aiac.ijels.v.3n.1p.26

Kenney, J. (2013). Fostering critical thinking skills: Strategies for use with intermediate gifted readers. *Illinois Reading Council Journal*, *41*(2), 28–40.

Klassen, M. R., & Tze, M. C. V. (2014). Teachers' self-efficacy, personality, and teaching effectiveness: A meta-analysis. *Educational Research Review*, *12*, 59–76.

Lau, K. H., Lam, T., Kam, B. H., Nkhoma, M., Richardson, J., & Thomas, S. (2018). The role of textbook learning resources in e-learning: A taxonomic study. *Computers & Education*, *118*, 10–24.

Lee, K. S. (2005). Enhancing critical thinking in online learning. *Academic Exchange Quarterly*, *9*(4), 43–49.

Mayfield, M. (2007). *Thinking for yourself: Developing critical thinking skills through reading and writing* (7th ed.). Boston, MA: Thomson Wadsworth.

McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochem. Med.*, *22*(3), 276–282.

https://www-ncbi-nlm-nih-gov.ezpprod1.hul.harvard.edu/pmc/articles/PMC3900052/

Ministry of Education, Youth and Sport [MoEYS]. (2015). *Curriculum Framework of General Education and Technical Education.* https://drive.google.com/file/d/0B1ekqZE5ZIUJY0FoY25EZzZRSWM/view

Partnership for 21st century skills. (2008). 21st century skills, education, & competitiveness.

Schleicher, A. (Ed.). (2012). *Preparing teachers and developing school leaders for the 21st century: Lessons from around the world*. OECD Publishing. http://dx.doi.org/10.1787/9789264174559-en

Stapleton, P. (2011). A survey of attitudes towards critical thinking among Hong Kong secondary school teachers: Implications for policy change. *Thinking Skills and Creativity*, *6*(1), 14–23.

Stedman, N. L., & Adams, B. L. (2012). Identifying faculty's knowledge of critical thinking concepts and perceptions of critical thinking instruction in higher education. *Nacta Journal*, *56*(2), 9.

Steven, D. D., & Levi, A. J. (2013). *Introduction to rubrics: An assessment tool to save grading time, convey effective feedback, and promote student learning* (illustrated ed., vol. 2). Stylus Publishing, LLC.

Stigler, W. J., & Hiebert, J. (1999). *The teaching gap. Best ideas from the world's teachers for improving education in the classroom.* A Division of Simon & Schuster, Inc.

Thote, P., & Gowri, S. (2020). Analysis of senior secondary examination questions according to revised blooms taxonomy complexity. *International Journal of Research-GRANTHAALAYAH*, *8*(3),119–127.

Upahi, J. E., & Jimoh, M. A. (2015). Classification of end-of-chapter questions in senior school chemistry textbooks used in Nigeria. *The Electronic Journal for Research in Science & Mathematics Education*, *19*(7).

Vincent-Lancrin, S., et al. (2019). *Fostering students' creativity and critical thinking: What it means in school, educational research and innovation*. Paris: OECD Publishing. http://doi.org/10.1787/62212c37-en.

Examining Cambodian Pre-service Primary School Teachers' Mathematical Knowledge for Teaching (MKT) on Fractions

Sokunthea Sin

Graduate School for International Development and Cooperation (IDEC), Hiroshima, University, 1-5-1 Kagamiyama, Higashi Hiroshima, 739-8529, Japan, Email: sokuntheasin23@gmail.com

Received: December 22, 2020/ Accepted: May 08, 2021

Abstract

Primary school students in Cambodia lack basic skills in mathematics, especially in fractions—the poor performance related to teachers' instruction. Many primary school teachers still have inadequate Pedagogical Content Knowledge (PCK) regarding instructional strategies and representations. Therefore, this study aims to examine Cambodian pre-service primary school teachers' (PPSTs) Mathematical Knowledge for Teaching (MKT) on fractions. This study employed an explanatory sequential mixed-method design involving pre-service primary school teachers from two teacher education institutions. 18 items of MKT, which focused on the five sub-constructs of fractions, were administered to 206 PPSTs, and 45 PPSTs were selected for interviews. This study found that PPSTs' performance varied by sub-construct of fractions. Among the five sub-constructs, the part-whole sub-construct received a poor result. PPSTs considered part-whole as an equal shape and struggled to provide different types of representation. Moreover, PPSTs also had inadequate Specialized Content Knowledge (SCK); they could not explain the reason behind the procedure of their answers. The limitation of SCK causes a limited PCK. They were difficult to explain students' misconceptions and utilize the representations of fractions. However, they were familiar to utilized part-whole sub-construct for posing examples in teaching fractions.

Keywords: Pre-service primary school teachers; Mathematical knowledge for teaching; Pedagogical content knowledge; Subject matter knowledge; Five sub-constructs of fractions

1. Introduction

In Cambodia, education is a priority area that aims to develop human capital for national competitiveness and economic growth and to meet the economic goal of the Association of Southeast Asian Nations (ASEAN) to transform the country from a lower-middle-income to an upper-middle-income country by 2030 (Royal Government of Cambodia [RGC], 2014). The road map of Cambodia's Sustainable Development Goal (SDG) 2030 sets up the strategies for meeting the education goal of improving teachers' quality, which is stated as the main objective in the Education Policy. To achieve this objective, Cambodian teachers have been provided with opportunities to attend the appropriate training to develop their professional competence. They have also been motivated and supported to develop sufficient academic content

knowledge and pedagogical skills (Ministry of Education Youth and Sports [MoEYS], 2019). To improve teachers' quality, MoEYS has made an effort to attract and motivate recent high school graduates who are strongly committed and have the required competencies to be involved in teacher education. Moreover, the curriculum of the pre-service teacher education program has been upgraded from 12+2 to 12+4 programs. Currently, two Teacher Education Colleges in Cambodia implement the 12+4 program for pre-service teacher training. This is the first step for the expansion of the teacher education system (MoEYS, 2015; JICA, 2017).

Pre-service teacher education plays a significant role in improving teachers' quality for a more extended period (Prigent, 2016). Studies by Ma (1999) and Wright (2008) in mathematics education also showed that the pre-service teacher education programs need to emphasize conceptual understanding of mathematics and subject matter knowledge (SMK) for future teachers. The researchers also acknowledged the primary concern of connecting the pre-service teachers' mathematics competence with the teaching and learning in school mathematics (Ma, 1999; Wright, 2008). In 2012, The study of Teacher Education and Development Study in Mathematics (TEDS-M) provided evidence for understanding how pre-service mathematics teachers gain content knowledge and pedagogical content knowledge during their study in the teacher education colleges. The TEDS-M study also noted that the study of pre-service teachers' knowledge regarding content knowledge and pedagogical content knowledge (PCK) could be a crucial indicator for measuring the success of the teacher education program (TEDS-M, 2012).

A recent study by Van, Moa, and Cnudde (2018) suggested that improving the teacher preparation program with a focus on subject matter knowledge (SMK) and pedagogical content knowledge (PCK) of future teachers is in critical demand in Cambodia In the educational system, the teacher quality is considered as a core element as it is significantly related to students' performance (Phin, 2014; Sem & Hem, 2016; Song, 2012). PCK is at the core of teachers' professional knowledge and it is recognized as a type of knowledge that helps transfer subject matter knowledge to the students (Shulman, 1986; Hill, Rowan, & Ball, 2005; Kilic, 2011). Moreover, PCK has emerged as a crucial topic that has been significantly linked to students' achievement (Ball, Thames, & Phelps, 2008; Hill, Rowan, & Ball, 2005; Ngo, 2013).

The World Bank report (2015) on Improving Teacher Quality in Cambodia revealed that teacher trainers, practicing teachers, and pre-service teachers have inadequate pedagogical content knowledge (PCK) in diagnosing and remedying students' misconceptions (Tandon & Fukao, 2015). Moreover, a study by Van et al. (2018) found that although teacher trainers in Provincial Teacher Training Centers (PTTCs) had improved their content knowledge (CK) and PCK after the intervention, they still struggled with PCK, implying the ineffectiveness of instructional strategies and representations.

Furthermore, the results of the Early Grade Mathematics Assessment (EGMA) indicated that first-grade students lagged behind in building the basic mathematics competencies for primary school students. They could read the given numbers, yet their conceptual knowledge of number sense was insufficient (MoEYS, 2016). According to the Cambodian National Assessment of

Mathematics conducted by the Education Quality Assurance Department in 2013, sixth-grade students lacked basic skills in the mathematics domain (MoEYS, 2015). They had better procedural knowledge but insufficient conceptual comprehension (MoEYS, 2015, 2016). For instance, although the Number domain was the main content at the primary level, students attained a poor result in solving fraction problems. The percentage of correct answers to questions on operations of fractions and mixed numbers was on average 38.1 percent. Surprisingly, the percentage of correct answers to the addition and subtraction of fractions was merely 13.5 percent. The report revealed that students' poor performance was related to teachers' instructions. It noted that teachers put more emphasis on theories and abstract concepts of mathematics and demonstrated the lesson of the content with insufficient teaching aids (MoEYS, 2015). Therefore, it was suggested that it is crucial to enhance early grade fundamental skills with respect to the fraction concept (MoEYS, 2016).

In the number domain, fractions has been recognized as a complicated topic for learning and teaching at the primary level because of the diverse meanings of fractions, especially in the early grades (Van Steenbrugge et al., 2014). Research has shown that students tended to lack conceptual understanding of fractions; thus, they learned fractions without understanding the meaning of fractions (Hansen, Jordan, & Rodrigues, 2017; Siegler & Lortie-Forgues, 2015). Meanwhile, pre-service teachers had a limited understanding of the fractions concept and the explanation of the rationale behind the procedure of doing fractions problems (Kilic, 2015; Newton, 2008; Wright, 2008).

Thus, to understand what Cambodian pre-service primary school teachers' (PPSTs) have learned in their training college regarding Subject Matter Knowledge (SMK) and Pedagogical Content Knowledge (PCK), this study is conducted. It aims to examine PPSTs' Mathematical Knowledge for Teaching (MKT) on fractions. The specific research question is: What is Cambodian pre-service primary school teachers' Mathematical Knowledge for Teaching (MKT) on fractions?

2. Literature review

2.1 The concept of Mathematical Knowledge for Teaching (MKT)

Shulman (1986) introduced the notion of pedagogical content knowledge (PCK), referring to the knowledge of how to teach and make a particular subject comprehensible for students. The notion of PCK is linked between content knowledge and practice (Kilic, 2011; Hill, Rowan, & Ball, 2005;Shulman, 1986). Shulman and his colleagues began the study with prospective teachers on "*knowledge that grows in the minds of teachers, which focus on the content*." They distinguished three categories of content knowledge, such as subject matter content knowledge, pedagogical content knowledge, and curricular knowledge (Shulman, 1986).

In 2008, Ball and her colleagues argued that the Shulman framework presented an inadequate relationship between theoretical and empirical perspectives Ball, Thames, & Phelps, 2008). The term PCK was widely used, but it is still underspecified. The insufficient definition and practical foundation limited the benefit of PCK. To improve the foundation of PCK more

comprehensively, the connection between knowledge and practice need to be investigated (Ball, Thames, & Phelps, 2008). Ball et al. (2008) project interconnected teachers' knowledge, teaching, and students' learning (Chua, 2018). To develop their conceptual framework, Ball et al., (2008) reviewed Shulman's ideas as the foundation. They utilized the bottom-up approach, which started by exploring the knowledge that is required in teaching mathematics to students. The main question was emphasized on the knowledge employed in teaching rather than the teachers, which focused on "*what teachers need to know the content, determine what else teachers need to know about mathematics, and how and where teachers might use such mathematical knowledge in practice*" (Ball et al., 2008, p.394-395). The framework of Mathematical Knowledge for Teaching (MKT) was then developed, which referred to the mathematical knowledge that is needed to carry out teaching work. The study about teachers' mathematical knowledge for teaching provided a positive association between teachers' knowledge and students' learning outcomes (Ball et al., 2008; Depaepe et al., 2013).

The MKT model consists of two components: Subject Matter Knowledge (SMK) and Pedagogical Content Knowledge (PCK), each of which has three categories of knowledge. Subject Matter Knowledge (SMK) is split into common content knowledge (CCK), which refers to the knowledge used in teaching, and it is used in many other tasks and professions that also employed mathematics (simply calculating an answer, correctly solving mathematics problems) ; for example, write fractions correctly based on the representation and ability to calculate the fractions operations. Specialized Content Knowledge (SCK) refers to the knowledge that allows the teachers to engage in specific teaching tasks, including how to represent mathematics ideas accurately. Moreover, teachers can provide mathematics explanations for common rules or procedures as well as examine and understand unusual solutions or problems. For example, teachers can explain the meaning of fractions by using the representations and understand the reason behind the calculation. The third component, Horizontal Content Knowledge (HCK), refers to teachers' awareness of how mathematical topics are related to the curriculum span included in the curriculum such as the ability to consider which topic relates to Simplify Fractions. Moreover, The component of Pedagogical Content Knowledge (PCK), is divided into the knowledge of content and students (KCS), which refers to teachers' knowledge of students' conceptions and misconceptions and possible difficulties about a particular topic and the ability to diagnose misconceptions. For instance, teachers can identify students' misconceptions about learning fractions concepts. Knowledge of Content and Curriculum (KCC) refers to knowledge of learning goals for different grades and knowledge of instructional materials. For example, teachers can understand students' prior knowledge and content based on the curriculum. Knowledge of Content and Teaching (KCT) refers to teachers' ability to choose appropriate tasks, examples, or representations for a particular group of students and the ability to eliminate students' misconceptions. For instance, teachers can utilize a variety of examples and representations for teaching fractions concepts. According to Depaepe et al. (2013), the concept of MKT has three clear merits.

> First, "MKT is the result of the empirical study on the knowledge that teachers need for and apply in teaching mathematics". Second, "MKT furthers the operationalization of Shulman's concept through the development of a valid measure of teachers' mathematical knowledge for teaching". Third, "the concept of MKT provides empirical

evidence for a positive relationship between teachers' PCK and student learning outcomes" (Depaepe et al., 2013).

Based on the existing literature, if was found that mathematics teachers and pre-service teachers had inadequate pedagogical content knowledge. They had difficulties in diagnosing and determining students' misconceptions about fractions. Moreover, their subject matter knowledge regarding the specialized content knowledge also insufficient (Ball et al., 2008; Depaepe et al., 2015; Newton, 2008; Purevdorj & BABA, 2009; Turnuklu & Yesildere, 2007; Van et al., 2018; Wright, 2008;).

2.2 Primary school students and pre-service teachers' knowledge of fractions

Fractions were invented when the whole number cannot fully describe a mathematical situation. There are various ways to represent fractions useful to develop children's understanding of fractions concepts utilizing the visual representation of the linear model, area model, and set model (Musser, Peterson, & Burger, 2003, pp. 215-223). Kieren (1993) distinguished five sub-constructs of fractions for developing students' understanding as follows:

- Part-whole: A number of equal parts of a unit out of the total number of equal parts into which the unit is divided.
- Measure: A distance, a position in a number line that fractions as an abstract number. Fractions as the quantity, which helps the student to see fractions as the number with magnitude.
- Quotient: Fractions are regarded as the result of the division, which helps students understand the relative size of fractions.
- Operator: Comprises the application of a function to a number, an object, or a set.
- Ratio: Fractions is a comparison between two quantities, it can be a part-part or part-whole relationship based on the context. (Kieren, 1993)

The different meanings of fractions occurred in different situations and contexts (Van Steenbrugge et al., 2014). It is necessary to teach students to understand the various and interrelated meanings of fractions and the integration of these facets. Fraction knowledge is useful in everyday skills. Notably, knowledge of the fractions concept is extremely important because it linked to fractions achievements, algebra, and other advanced mathematics in the higher grades (Jordan et al., 2013; Mohsin & Baba, 2007).

However, in the early grades of the primary level, students tend to have some difficulties in learning fractions. Primary school students face hardship in understanding the notation of fractions and misread fractions. Their prior knowledge of whole numbers also has influenced and confused their learning of fractions (Hansen et al., 2017; Lortie-Forgues & Siegler, 2015; Nguyen et al., 2017). Lamon (2012) noted that shifting from the whole number into fractions creates the variety and complexity of the situation. Moreover, fractions were understood as a difficult topic in teaching and learning because of its various meanings (Van Steenbrugge et al., 2014). The various meanings of the fractions symbol were concerning. In 2013, the

Cambodian National Assessment of Mathematics found that the 6th-grade students could not solve fractions problems properly. The majority of the students were confused with the numerator and denominator in solving addition and subtraction of fractions (MoEYS, 2015). To teach the operations of fractions, we need to understand the fractions' sense and the broad range of the phenomena that form the meaning underlying the fractions symbol (Lamon, 2012, p. 32).

Previous studies have shown that pre-service teachers had inadequate conceptual knowledge; on the contrary, they performed better in procedural knowledge of fractions, especially in fraction multiplication and division (Ball, 1990; Kilic, 2015; Van Steenbrugge et al., 2014). They lacked the ability to explain the rationale of a procedure or the underlying conceptual meaning of fractions. Moreover, it was found that pre-service teachers have limited understanding of the particular meaning of fractions; for instance, they were more familiar with the part-whole sub-construct than the other sub-constructs. A challenge of the PCK they encountered was to identify students' misconceptions and instructional representation (Kolar et al., 2018; Lee, Son, & Arabeyyat, 2015; Reeder & Utley, 2017; Van Steenbrugge et al., 2014; Wright, 2008).

A quantitative study by Van Steenbrugge et al. (2014) investigated pre-service teachers' knowledge of the five sub-constructs of fractions. They utilized the fraction test items to measure pre-service teachers' fractions knowledge. The study found that pre-service teachers had better procedural knowledge performance; however, their specialized content knowledge received a low result. Among the five sub-constructs of fractions, the participants accomplished a better result in doing part-whole and ratio sub-construct problems but were deficient in the measure sub-construct. The ratio sub-construct was strongly related to the two proportions and part-whole sub-construct (Van Steenbrugge et al., 2014).

3. The development of the fractions concept in Cambodian mathematics textbooks

In the Cambodian context, textbooks are considered an important resource material for teaching and learning. Teachers utilize textbooks as the main source for classroom activities and homework that emphasize the computation tasks (Song, 2015). Chan (2015) raised some common issues related to mathematics textbooks at the primary level. For example, mathematics textbooks often contained some errors, which novice teachers cannot recognize, and therefore they ended up teaching incorrect mathematics to students. The content in mathematics textbooks employed less modern psychological and pedagogical approaches. The content and its applications also provided little evidence related to real-life activities (Chan, 2015).

Fractions are recognized as an important topic that is related to daily life. Understanding fractions and its meaning encourage students to understand the operations of fractions (Jordan et al., 2013; Kilic, 2015; Mohsin & Baba, 2007). However, the multifaceted constructs of fractions are challenging for students who need to learn to acquire a deep understanding of the nature of fractions. In the case of primary school students in Cambodia, it was found that they

could attain better procedural knowledge but had insufficient conceptual knowledge. In addition, they struggled in doing fractions tasks in the national examinations (MoEYS, 2015, 2016). This study analyzed the Cambodian mathematics textbooks at the primary level focusing on various meanings of fractions. The five sub-constructs of fractions and their representation were analyzed based on Lamon's (2012) framework, which represents Part-whole, Measure, Quotient, Operator, and Ratio. The textbook analysis aimed to understand the development of the fraction concept regarding the multi-aspects of fractions and integration of these aspects in each grade and identify how fractions were introduced regarding the representations of fractions concept in each example. The textbook analysis resulted that each grade at the primary school focused on the part-whole sub-construct of fractions. In the Cambodian textbook, the part-whole sub-construct is commonly used to develop the understanding of fractions concept. The operator sub-construct is utilized, but, in this part, just focused on the multiplication of fractions and whole numbers. The other sub-constructs of fractions were not presented in the textbook. The table below summarizes the analysis results, from grade 1 through grade 6, that focused on examples of teaching and learning fractions. Sixty examples were posed as examples to introduce fractions.

Table 1
Result of textbook analysis on fractions sub-construct and representations

	Sub-constructs of Fractions					Representation of fractions			
	P-W	Meas	Quot	Oper	Ratio	Area	line	set	number
N (60)	40	4	0	1	0	36	0	4	39
%	66.66	6.66	0	1.66	0	60	0	6.66	65

Mathematics textbooks tended to provide examples of the part-whole sub-construct (66.66%) and utilize the area model (60%) to introduce the fractions. Moreover, 65 percent of the examples have written in numbers, which focuses on the demonstration of fraction calculations. There were limited examples used area of fractions as the part-whole sub-construct; it leads teachers and students with a constrain in developing their knowledge or understanding of fractions.

4. Methodology

4.1. Research design

This study employed an explanatory sequential mixed-method design to obtain reliable and valid data to answer the research questions (Creswell & Clark, 2011). The explanatory sequential mixed-method design is a two-phase method that uses qualitative data to explain the result of the quantitative data. In this study, the participants for the qualitative study were purposively selected based on the quantitative result. However, the qualitative data in this study were not only used to explain the quantitative result, but it was utilized to answer the research question regarding the pre-service primary school teacher' pedagogical content knowledge (PCK) and subject matter knowledge (SMK).

4.2. Research setting and participants

The study was conducted in Phnom Penh Teacher Education College (PPTEC) and Svay Rieng Provincial Teacher Training Center (SVPTTC). PPTEC is located in Phnom Penh city, the capital of Cambodia. Currently, PPTEC is reforming pre-service training programs from 12+2 to 12+4 programs (JICA, 2017; MoEYS, 2015). SVPTTC is not on the list of reforms for Teacher Education College (JICA, 2017; MoEYS, 2015). At present, SVPTTC is the institution that trains primary school teachers for the 12+2 program with a small number of pre-service teachers who participated in a survey designed for this study. In the survey, all second-year pre-service teachers (a total of 206 pre-service primary school teachers), who have attended the mathematics method courses about fractions based on the written curriculum in PPTEC and SVPPTC, were encouraged to join the study.

Among the 206 teachers, there are 123 pre-service teachers (78 female) who are being trained in the 12+4 program, and 41 pre-service teachers (26 female) in the 12+2 program in PPTEC. There are 42 pre-service teachers (29 female) who are attending the 12+2 training program in SVPTTC. All these 206 teachers participated in this study.

In the next phase of the mixed-method design, 45 (26 female) pre-service primary school teachers (PPSTs) were purposively selected for interviews through clustered and systematic sampling methods. They were selected based on their performance of the MKT test. After getting the MKT test result, the PPSTs score was grouped based on their training institutions and training programs. The results showed that there were three groups, from the lowest to the highest of the MKT test result. The researcher then selected the participants in every interval based on the formula of a systematic sampling method $f=\frac{N}{Sn}$ (that f =frequency interval; N= the total number of the sample; Sn= the required number in the sample) (Cohen, Manion, & Morrison, 2007).

4.3. Research instruments

The MKT questionnaire contained two parts. The first part required participants' demographic information about gender, age, math grade, and education qualification. The test items in the second part were developed to measure PPSTs' mathematical knowledge for teaching focusing on the five sub-constructs of fractions, which was adapted from previous studies (Depaepe et al., 2015; Kilic, 2015; Kolar, Čadež, & Vula, 2018; Peruvdorj, 2009; Tanaka, 2019; Van Strenbrugge et al., 2014;). The researcher checked the correspondence of the test items with the Cambodian mathematics curriculum and textbook at the primary school level and teacher education programs. As a result of the pilot survey, 18 items of MKT have been retained, in which 17 items were SMK (15 CCK items and 2 SCK items) and 1 item which intended to measure PCK focused on KCT. The Cronbach Alpha estimated the reliability of the questionnaire at .610, which was considered as moderate reliability. Meanwhile, in the interview sessions, the questions were utilized to measure PPSTs' knowledge about students' difficulties in solving this item (KCS) and how to utilize this item as the representation and appropriate examples for teaching and learning fractions (KCT) in primary school.

4.4. Data collection procedure

A pilot survey was conducted to validate the questionnaire items. There were 24 pre-service teachers who involved in the pilot survey. After completing the pilot survey questionnaire, they were asked to check the statements and questions' spelling and meaning. For the MKT test, there were 34 items on subject matter knowledge (SMK) and pedagogical content knowledge (PCK) of fractions. As a result of the pilot survey, 16 items were removed, and most of the items related to SCK and PCK required more written explanation. However, most of the participants did not complete these questions because it took time to write and explain in handwriting. The researcher removed the items which were not completed by more than 60 percent of the participants. After removing the items, the MKT test was revised based on comments from the participants and senior mathematics educators. As a result, 18 items were retained in the main survey, and the removed items were examined again in the interviews.

In the survey, participants were given enough time and a brief explanation of how to respond to the questionnaires was provided. The MKT test result was used to select the participants who completed the questionnaire for the interviews. The interviews were conducted approximately two weeks after the survey. The interviews were conducted face-to-face using a semi-structured interview protocol, which was developed to identify PPSTs' SCK and PCK. The interviews were audio recorded with handwriting notes and memos.

4.5. Data analysis procedure

Before starting the data analysis, data cleaning was conducted to screen the missing data of the quantitative analysis. The PPSTs' responses from the MKT questionnaire were analyzed based on the rubric that considered the correctness of the responses. The quantitative data was analyzed using SPSS software. This study employed descriptive statistics that focus on the frequency and the central tendency of the data. Chi-square and one-way ANOVA were employed to examine the significant difference of the data. Moreover, the normality of the MKT result was analyzed using a Shapiro-Wilk test, a widely used test, that has a strong ability to detect the normality of the data.

The data derived from the interviews were analyzed based on the steps of analyzing the qualitative data suggested by Creswell (2014). The first step started with organizing and preparing the data for analysis that included transcribing the interview data and sorting the data into different types based on the information sources. Then, the researcher read all the data and code the data to generate major themes. Finally, the data were interpreted (Creswell, 2014). After transcribing and coding the interview data, each interviewee's data was utilized to verify the result of the MKT questionnaire. Lastly, after confirming both types of data, the researcher generated key themes reflected in the components of the MKT model.

5. Results

5.1. General performance of PPSTs' subject matter knowledge on fractions

In the SMK part of the MKT questionnaire, as shown in Table 2, the highest expected score was 17. The descriptive statistics indicated that the mean score (M) of the PPSTs was 7.56, and standard deviation (SD) was 2.72 with 95% confidence interval for the mean (lower bound = 7.19, upper bound = 7.94). These results revealed that pre-service teachers' general performance is quite low. The result of the Shapiro-Wilk test (statistics .987 and the statistically significant values p = .056) revealed that the p value is not significant (p > .05) (See Table 2). This result showed that the PPSTs' performance is normally distributed.

Table 2
The general performance of the MKT questionnaire

Number of items	Mean	SD	Range	Shapiro-Wilk Test			Cronbach's alpha
				Statistics	df	Sig.	
17	7.56	2.72	16 (0-16)	.987	206	.056	α = .610

The detailed evidence of each item is shown in Table 3 which describes the PPSTs' responses to the SMK items in the questionnaire.

As seen in Table 3, PPSTs faced challenges in solving the tasks that focus on the various representation types in the part-whole items (Q1, Q3.2, Q3.3). Moreover, PPSTs struggled to respond to the measure sub-construct questions and struggled to explain the reason for their answers (Q2.2, Q6.1, Q6.2). However, they performed better in the measure sub-constructs, which referred to place fractions on the segment and number line (Q4.1, Q4.2, Q5). PPSTs received better scores in solving fractions problems of ratio and quotient sub-constructs than other sub-constructs, which required computation rather than explanation (Q7, Q8, Q9).

Table 3
Descriptive results of PPSTs' responses to the SMK items in the questionnaire

Items	SMK-Fractions	Max	Mean	SD	N	Percentages
Q1	CCK part-whole	1	.03	.18	7	3.4
Q2.1	CCK measure and operator	1	.35	.47	72	35
Q2.2	SCK measure and operator	1	.30	.45	61	29.6
Q3.1	CCK part-whole, operator	1	.67	.47	139	67.5
Q3.2	CCK part-whole, operator	1	.13	.33	26	12.6
Q3.3	CCK part-whole, operator	1	.16	.36	33	16
Q4.1	CCK measure	1	.74	.44	152	73.8
Q4.2	CCK measure and operator	1	.41	.49	85	41.3
Q5	CCK measure	1	.64	.48	131	63.6
Q6.1	CCK measure	1	.24	.42	49	23.8

Q6.2	CCK and SCK measure	1	.20	.40	41	19.9
Q7.1	CCK Ratio	1	.71	.45	146	70.9
Q7.2	CCK Ratio	1	.67	.47	137	66.5
Q8.1	CCK quotient	1	.74	.43	153	74.3
Q8.2	CCK quotient	1	.39	.48	80	38.8
Q9.1	CCK quotient	1	.86	.34	178	86.4
Q9.2	CCK quotient	1	.33	.47	68	33

5.2. Characteristics of PPSTs' MKT on fractions

This section describes PPSTs' performance in each sub-construct of fractions. By utilizing the result from Table 3, the items referred to each sub-construct of fractions were calculated to identify the mean scores and percentages of the correct answers. However, the operator sub-construct items, which were integrated into the other sub-constructs, were treated equally. For instance, part-whole sub-construct items (Q1, Q3.1, Q3.2, Q3.3) were calculated to determine the average scores and percentages of the items. Items Q2.1, Q2.2, Q3.1, Q3.2, Q3.3, Q4.2 were considered as the operator sub-constructs. Table 4 below presents the result of each sub-construct of fractions after calculation.

Table 4

Descriptive statistics of fractions sub-constructs

Fractions sub-constructs	Part-whole	Measure	Operator	Ratio	Quotient
Mean	.25	.41	.34	.69	.58
SD	.2	.25	.21	.45	.25
Percentages (%)	24.87	41	33.67	68.7	58.13

MKT on part-whole sub-construct

For the CCK part-whole, the majority of the PPSTs' responses in the questionnaire and interview considered the part-whole construct as the equal shape, and they were confused with the figures that divided into 4 parts as fractions. Only 3.4 percent of the participants were able to distinguish the unequal shape figures from the equal area figures. Moreover, they had insufficient knowledge to extend the different representations for improper fractions.

Regarding the SCK part-whole in item Q1, PPSTs provided an explanation of the rationale in choosing part-whole representation. However, the responses were limited based on their CCK; they explained based on the chosen answer from the questionnaire. A majority of them shaded the figures that were divided into equal shapes. Besides, PPSTs considered fractions as the figures that were divided into 4 parts as the reason for choosing fractions $\frac{1}{4}$. They chose all figures which were divided into 4 parts, both equal and unequal. For instance:

because the first figure has 4 parts too. Then, we want to take $\frac{1}{4}$ the denominator is 4, so we shade 1 part from 4 parts too. For the other figures, even though they are divided unequally, they still take 1 part among 4 parts as well. (3S211)

Question1: Which shape is divided into $\frac{1}{4}$?
Please ✓, in the box of the correct number. In cases you ✓ , color one quarter $\frac{1}{4}$.

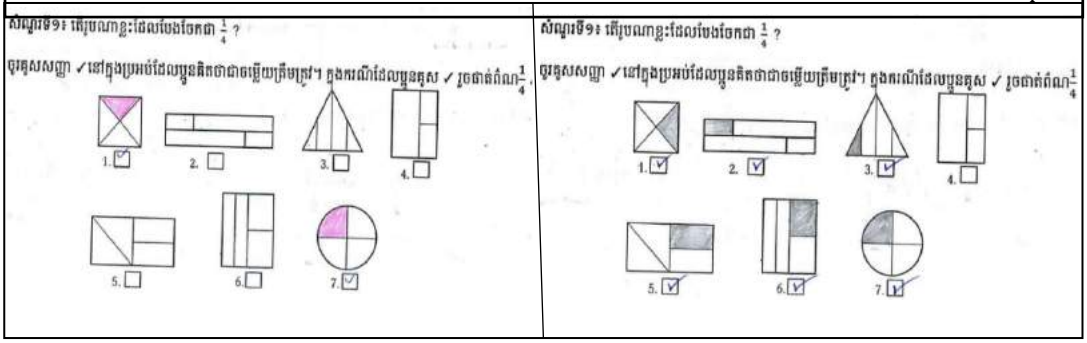


Figure 1. Example of PPSTs' responses for item Q1 in the questionnaire

Meanwhile, for KCS part-whole, PPSTs seemed to have proper knowledge in anticipating students' difficulties and misconceptions in part-whole representation which referred to the misconception regarding the figures that were divided into 4 parts, including equal and unequal parts. For instance, the following statements highlight the participants' responses:

> Students have difficulties because some figures are divided into unequal parts. Some figures have a circle that is divided equally. So, students fine it difficult to recognize which figures are fractions.(1P29)

> Students might consider the figures which are divided into 4 parts as the answers because they don't consider the unequal parts. (2P43)

For the KCT part-whole, PPSTs provided precise explanations, which considered to choose simple figures to make students easy to understand. They also expanded the examples with the unequal shape figures, which helped students recognize and distinguish the divided parts of figures. For instance, the following statements are the participants' responses:

> For teaching, I will choose numbers 1 and 7 because these figures are correct, then students will find it easy to understand. This figure is also divided into 4 parts, but it might confuse the students. So, for teaching, if we teach the confusing figures, it will make students confused as well. For figure 5, it is equal in shape and area, but for primary school students, they are hard to recognize it. (2S22)

> For teaching, I will choose the tricky figure. I will choose the correct and incorrect figures. If we use only correct figures, then we will get only the correct answer. So, we utilize some incorrect figures as well. (1P21)

MKT on measure sub-construct

In terms of the CCK measure, the results showed that PPSTs had inadequate knowledge regarding measure sub-constructs. PPSTs solved the problems correctly regarding placing fractions on the number line with 1 cm segment. However, they faced challenges in solving the problems and placing fractions on the segment, which the whole is more than one centimeter. For instance, in Figure 2 below, PPSTs found it challenging to place the improper fractions on the segment

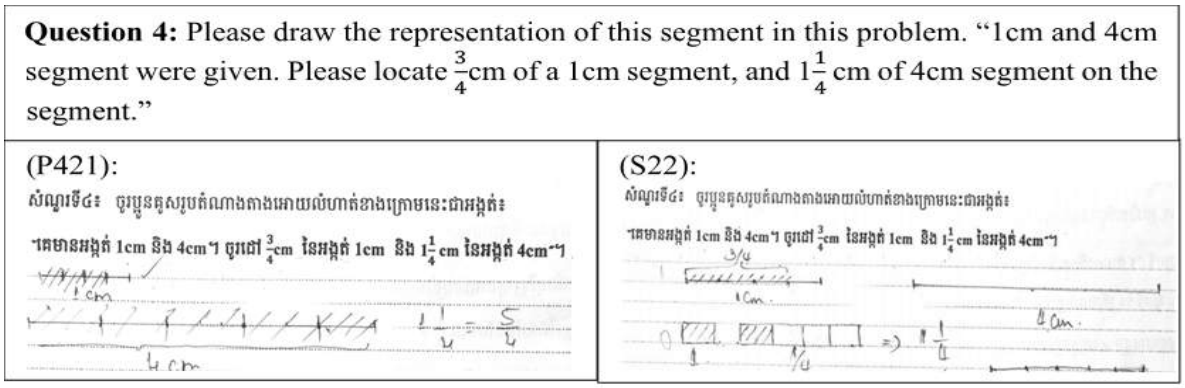


Figure 2. Example of PPSTs' marking mixed-number on the segment

For the SCK of measure sub-constructs, PPSTs' responses to the items indicated some limitations of their knowledge. PPSTs had difficulties determining fractions in which the whole is greater than 1 and solving the item Q2 utilizing part-whole sub-constructs. The part-whole sub-construct here means that they were aware that each part or taken part was $\frac{1}{3}$ of the 3 total parts of the rope, but they did not understand that this part was $\frac{1}{3}$ of 2m. Moreover, they placed fractions on the segment and the number line without understanding the specific reason and also applied decimal numbers to measure the length of the segment before placing fractions.

Regarding the KCS and KCT on measure sub-constructs in item Q2, PPSTs could anticipate students' difficulties with their limited understanding and superficial ideas. Moreover, for the KCT on measure sub-constructs, PPSTs attempted to utilize the linear model to explain the concept of the question, which focused on the $\frac{1}{3}$ *of 2 meters* to the students. However, PPSTs' responses were constrained by their SCK and KCS. The linear representation that they utilized to explain their students helped PPSTs realize their mistake in solving item Q2.

> students might get confused that 2m is the denominator, they might answer $\frac{1}{2}$ m. (2P43)
>
> students don't understand that the rope is 2m. They simply think the answer is $\frac{1}{3}$. But $\frac{1}{3}$ of 2m. So, students might be confused to choose $\frac{1}{3}$ m. (4P422)

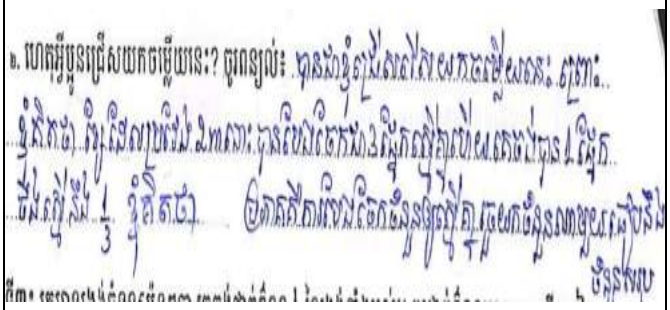
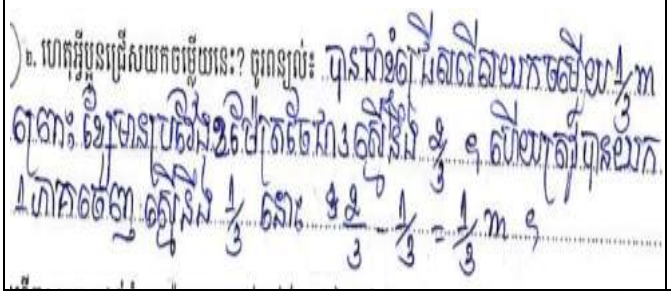
Q2.2 (take one part from 3 equal parts) 	*"because I thought the rope is 2m and is divided into 3 equal parts and she wants to take 1 part equal to* $\frac{1}{3}$*. I think fractions refer to dividing one whole equally, then compare the taken part with the total parts."*
Q2.2 (using subtraction operation) 	*"because the rope is 2m and is divided into 3 parts which equals to* $\frac{2}{3}$*m. It was taken 1 part equal to* $\frac{1}{3}$*. So,* $\frac{2}{3} - \frac{1}{3} = \frac{1}{3}$*."*

Figure 3. Examples of commonly incorrect answers in responding to Q2.2

MKT on operator sub-constructs

The operator sub-construct involves the application of the multiplication function, which is related to the calculation. The operator sub-construct in this study was indirectly investigated through the questions. The operator problems were utilized with the other sub-constructs questions that could include the operator sub-construct. For instance, in item Q2, because PPSTs were overfamiliar with the part-whole sub-construct, they did not consider multiplying the taken by the whole length of the rope. Furthermore, the operator sub-construct was less frequently mentioned in item Q10 proposed as an example for teaching fractions (see Table 5).

MKT on Ratio sub-constructs

For the CCK on ratio sub-constructs, PPSTs seemed to have proper knowledge in solving ratio problems, This was recognized as the highest performance in the questionnaire. The ratio sub-construct involves the concept of part-to-part and part-to-whole. As this study utilized a comparison of the part-to-part concept, PPSTs could write fractions or ratios of two quantities correctly. For the SCK on ratio sub-constructs, PPSTs could explain how they wrote the ratio-fractions, but they encountered challenges in comparing fractions with different denominators. To compare fractions, they employed the decimal number concept or just explained the way how they evaluated it in determining the larger amount. For the KCS on ratio sub-constructs, PPSTs emphasized the comparison fractions rather than writing ratios or fractions notation. Thus, this result showed that they had a superficial knowledge of content and students' ability. Furthermore, PPSTs could propose various instructional strategies to help students to overcome the difficulties in solving the ratio problems. However, these ideas did not

correspond to the reality. They posed the ideas based on their theoretical knowledge, which was acquired from the teacher education program. They explained in words and followed the problem-solving strategy which was considered as an oral explanation. But for the "follow problem strategy", the explanation just repeated the rule in solving the problems, which involved reading the problem, noting the hypothesis, solving the problems, and concluding the answers. Thus, they had theoretical and shallow knowledge of KCT on ratio sub-constructs. The following statement illustrates this point.

> for teaching, I allow the students to solve the problem and estimate the given hypothesis. After solving it, I ask them to compare by dividing the two numbers, then they will find out which one is bigger. (1P29)

MKT on quotient sub-constructs

The result indicated that PPSTs had proper knowledge of quotient sub-constructs. They were conscious that the result of the division or sharing could be written in fractions notation. The majority of the PPSTs answered correctly in quotient sub-construct problems.. In the interviews, PPSTs could explain how they solved the Q9 problem. They were able to utilize the concept of quotient to write fractions. However, they face challenges in comparing fractions. PPSTs converted fractions to decimal numbers, and then they compared them. Moreover, they could write the fractions correctly, but they did not utilize them for comparison. They just considered sharing pizzas and estimated the amount of pizza for each person to answer the questions (see Figure 4). For the KCS on quotient sub-constructs, PPSTs focused on students' difficulties in sharing the pizza parts because of the number of pizzas and the number of people were different, which made students write fractions incorrectly. However, pre-service teachers failed to draw the representations to explain how to share the pizzas among girls and boys. Some of the participants who answered correctly also had difficulties drawing the representation, especially in sharing the pizzas for girls. This result revealed the pre-service teachers' limited knowledge of utilizing the representation model, especially for sharing objects with more than one.

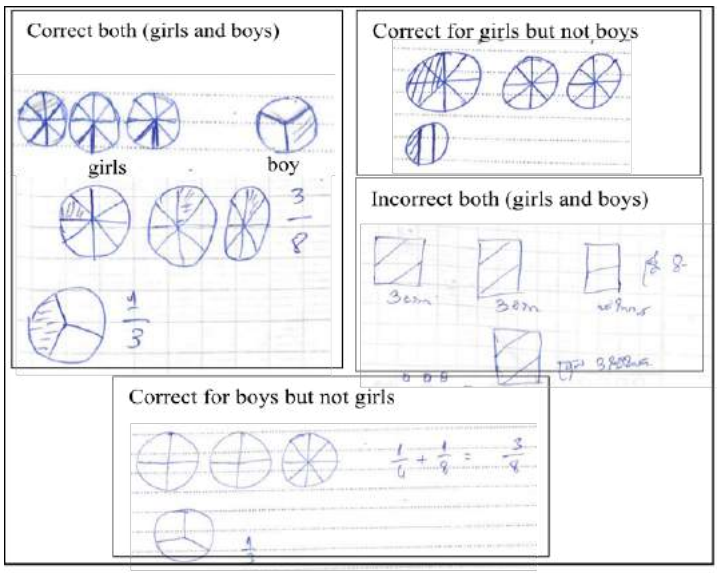


Figure 4. Common representations in item Q9

Additionally, for the KCT based on the result of item Q10 (see Table 5), PPSTs could pose examples for teaching fractions to primary school students. However, the examples of the part-whole sub-construct were mostly applied. This result revealed the participants' limited knowledge of utilizing various contexts or meanings of fractions in teaching fractions, which considered a particular meaning of fractions as part-whole representation.

Table 5
Characteristic of posed examples by PPSTs using fractions

Examples	**Frequency**	**Percentage (%)**
No answer and no meaning	63	12.7
Measure	34	6.9
Measure-subtraction	9	1.8
Measure-addition	1	0.2
Part-whole	214	43.2
Part-whole-subtraction	27	5.5
Part-whole-addition	2	0.4
Quotient	86	17.4
Quotient-subtraction	1	0.2
Operator	20	4
Ratio	8	1.6
Others (using operations of fractions)	30	6.1
Total	**495**	**100**

5.3. PPSTs' performance based on their background

The backgrounds of PPSTs were utilized for the data analysis, which referred to the teachers' educational background, training institutions pursuing in the university, math grade, and genders. Regarding the result of the Common Content Knowledge (CCK) in the questionnaire, PPSTs' performance varied based on their diverse backgrounds, excepted their genders.

Table 6
PPSTs' performance based on the teachers' education programs in each institution

	PP TEC		**SV PTTC**			
Programs	**12+2**	**12+4**	**12+2**	**F**	**df**	**Sig.**
Mean	6.54	7.61	8.43	5.28	(2, 203)	.006
SD	2.70	2.71	2.27			

Based on the result from each institution (see Table 6), PPSTs in Svay Rieng PTTC performed better than PPSTs in PPTEC, and there was a statistically significant difference between PPTEC and SVPTTC.

Meanwhile, among the 206 PPSTs, the majority of them hold grades C (24.3%), D (20.4%), and E (30.6%) in the national mathematics examination. Based on the result of their math grade, it is revealed that the PPSTs who hold high grades performed better than those with lower grades. Moreover, the result of the one-way ANOVA revealed a statistically significant difference between PPSTs' math grades and their performance of MKT test items (F (5, 200) = 7.26, $p < .001$).

By clustering the numbers of PPSTs in each institution, 54.8% of the PPSTs in SVPPTC hold higher grades (grade A, B, and C), while the score for PPSTs in PPTEC was 43.9%. For each teacher education program, the number of PPSTs who hold higher grades (grade A, B, and C) in the 12+2 program in PPTEC was 46.4%, while in the 12+4 program was 43.1%. The score for the 12+2 program in SVPPTC was 54.8%.

Table 7
PPSTs' performance based on their math grades

Math Grades	**A**	**B**	**C**	**D**	**E**	**F**
Mean	9.12	9.24	7.98	7.14	6.57	5.16
SD	2.72	2.6	2.14	2.71	2.66	1.72
N (Total 206)	16	29	50	42	63	6

As seen in Table 8, there were more PPSTs at SVPTTC who were enrolled in other universities than PPSTs at PPTEC. 69% of the PPSTs in SVPTTC are pursuing their study in other universities. For PPTEC, only 12.8% of the PPSTs are pursuing in their study at other universities. The result of Chi-square test revealed the significant difference between PPSTs who are pursuing their study in other universities and those who are not ($X^2(1, N = 206) = 57.54$), $p < .001$).

Table 8
PPSTs' performance based on their gender, pursuing other university and institutions

		Mean	***t***	**df**	**Sig**
Gender	Male	7.96	1.55	204	$p = .122$
	Female	7.35			
PPSTs pursuing other universities	Yes	8.64	3.29	204	$p = .001$
	No	7.22			
Training institutions	PPTEC	7.34	-2.23	204	$p = .02$
	SVPPTC	8.43			

6. Discussion

The results of this study showed that the general tendency of PPSTs' MKT on fractions is quite low. The results was interpreted by each component of the MKT model and five sub-constructs of fractions. In the CCK component, PPSTs struggled to solve the part-whole sub-construct questions. This revealed the inconsistency with previous studies showing that the participants performed better and had an insight about understanding of part-whole than the other sub-constructs (Kolar, Čadež, & Vula, 2018; Lee, So & Arabeyyat, 2015; Reeder & Utley, 2017; Van Steenbrugge et al., 2014; Wright, 2008). The results about the ratio sub-construct revealed PPSTs' high performance, a finding that paralleled Van Steenburgen's (2014) study which found that the pre-service teachers understand the comparison or proposition of two quantities that the ratio concept strongly connects to the part-whole sub-constructs. However, the low performance of the part-whole sub-construct did not necessarily mean that PPSTs did not understand this subconstruct. Based on the analysis of the items and the interview data regarding part-whole sub-constructs, PPSTs considered fractions as a whole divided into equal parts without considering a whole divided into equal areas. Moreover, it is difficult for PPST to differentiate the figures which were utilized to represent fractions. They faced challenges in finding the different types of representations of fractions. This result might be caused by the limitations of utilizing representation in the primary school mathematics textbook, which emphasizes the part-whole sub-construct with a limited type of the area model. Lemon (2012) argued that the constraining of utilizing part-whole interpretation had left students with an impoverished notion of rational numbers.

Regarding the findings of the interviews, PPSTs' SCK was limited. They could solve the problems, but they found it difficult to explain the reason for calculating the fractions concept problems. This finding indicated the link between CCK and SCK. PPSTs tried to describe the reason for the procedure in solving problems with their limited CCK. As regards the SCK on measure and operator sub-constructs in item Q2, PPSTs still applied part-whole sub-constructs to solve and lack of understanding of fractions as magnitude. This result is related to the limitations of utilizing part-whole sub-constructs more than other sub-constructs in the primary school mathematics textbooks. Once again, for KCS, PPSTs understood students' difficulties and misconceptions. They were able to describe all sub-constructs of fractions. However, the explanation was insufficient and shallow based on the constraint of their SMK. If teachers teach with inadequate knowledge of fractions, they would be facing the challenges of identifying students' difficulties or misconceptions and finding the solutions or instructions to remedy students' misconceptions (Turnuklu & Yesildere, 2007). According to the KCT questions, PPSTs tended to utilize part-whole sub-constructs as the examples for teaching fractions, which focused on the area model. This result indicated that PPSTs understood the part-whole sub-constructs with the limited idea of the area representation, which led to their poor performance in the part-whole items in the questionnaire. Moreover, PPSTs could provide instructional strategies to overcome students' difficulties and eliminate misconceptions in various ways. They could explain by utilizing the representation and oral explanation. However, they faced challenges in drawing a representation of a quotient sub-construct, which has more than one object.

Furthermore, PPSTs' performance varied, depending their backgrounds, although their genders did not have any influence on their performance. The PPSTs who achieved high performance in the grade 12 national examination performed better in this survey. The Ministry of Education Youth and Sport has encouraged competent candidates to enroll in the teacher education program. However, most high-performing students in the upper secondary did not get involved in the teacher education program (Prigent, 2016; Tandon & Fukao, 2015). The background of the teacher education institution that PPSTs were enrolled in had influence on their performance as indicated by the results of the questionnaire survey. Specifically, it was found that PPSTs in PPTEC performed lower than those in SVPTTC. However, this result should be interpreted with caution because at the moment PPTEC is piloting and reforming its teacher education system and curriculum. Therefore, it might cause a misunderstanding in teaching and learning among teacher educators and pre-service teachers. The participants were second-year pre-service teachers, and they still have two years more for training. PPSTs who enrolled in the 12+2 program in PPTEC also faced difficulties in solving the fractions questions. The SVPTTC is training the 12+2 program, so PPSTs almost finish their training and achieve the curriculum learning outcome. This may have influenced their performance. Moreover, whether or not they were pursuing their study at other universities and their math grade might have impacted their performance as well. PPSTs in SVPTTC preferred to enroll in the other universities that might have enhanced their knowledge. The number of PPSTs in SVPPTC had a higher math grade than those in PPTEC.

7. Conclusion and recommendations

As the results of this study showed, PPSTs' Mathematical Knowledge for Teaching (MKT) on fractions concepts focusing on the five sub-constructs of fractions was moderately low. Their performance differed by each sub-construct of fractions and components of the MKT model. Among the five sub-constructs of fractions, the part-whole sub-construct received a poor result. They had restricted part-whole knowledge, which referred to a limited understanding of equal parts of the representations and an improper fractions representation model. Likewise, the PPSTs' SCK is considered the main issue in this study. PPSTs could solve the fractions problems (CCK); however, a large number of them could not provide an explicit explanation. It was challenging for them to describe the reason behind their answers. The result in this study revealed that PPSTs had inadequate specialized content knowledge (SCK) on fractions. Moreover, the result of PPSTs' common content knowledge (CCK) and specialized content knowledge (SCK) indicated issues regarding their PCK. The limited knowledge of SCK led PPSTs to provide a poor discussion on students' difficulties and misconceptions. The knowledge of content and student (KCS) was strongly influenced by PPSTs' SCK. Furthermore, regarding the knowledge of content and teaching (KCT), PPSTs found it difficult to provide the representation, particularly for fractions greater than 1. Moreover, in terms of finding examples to explain fractions, PPSTs tended to provide limited meanings of fractions, which mainly focus on the part-whole sub-construct.

This study's results imply that teacher education institutions play a role in improving and strengthening PPSTs' MKT on fractions, especially the SCK that revealed the strong relations

the PPSTs' PCK. The part-whole sub-construct also needs to be enhanced since it was utilized as the fundamental concept of fractions in primary school education. Furthermore, it is recommended that curriculum developers expand the concept of fractions and the integration of multi-facets of fractions in both primary school education and teacher education programs. The particular concept of fractions as the part-whole sub-construct is not enough for students to understand the meaning and representations of fractions. Meanwhile, the various representation models also suggest emphasizing and providing a clear demonstration in utilizing different representation models to support pre-service primary school teachers.

References

Ball, D. L. (1990). The Mathematical Understanding That Prospective Teachers Bring to Teacher Education. *The University of Chicago Press Journals*, *90*(4), 449–466.

Ball, D. L., Phelps, G. C., & Thames, M. H. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, *59*(5), 389–407.

Byrnes, J. P., & Wasik, B. A. (1991). Role of Conceptual Knowledge in Mathematical Procedural Learning. *Developmental Psychology*, *27*(5), 777–786. https://doi.org/10.1037/0012-1649.27.5.777

Chan, R. (2015). Mathematics Education in Cambodia from 1980 to 2012: Challenges and Perspectives 2025. *Journal of Modern Education Review*, *5*(12), 1147–1153. https://doi.org/10.15341/jmer(2155-7993)/12.05.2015/006

Chua, V. C. G. (2018). Mathematical Knowledge for Teaching : a Literature Review on Ideology, Instrumentation, and Investigations, (August).

Creswell, J. W., & Plano Clark, V. L. (2011). Choosing a mixed-methods design. Designing and conducting mixed methods research, 2, 53-106.

Creswell, J. W. (2014). *Research design: Qualitative, Quantitative, and Mixed method approached* (4th ed, Vol. 3). United States of America: SAGE Publication Retrieved from http://repositorio.unan.edu.ni/2986/1/5624.pdf

Depaepe, F., et al. (2015). Teachers' content and pedagogical content knowledge on rational numbers: A comparison of prospective elementary and lower secondary school teachers. *Teaching and Teacher Education*, *47*, 82–92.

Depaepe, F., Verschaffel, L., & Kelchtermans, G. (2013). Pedagogical content knowledge: A systematic review of the way in which the concept has pervaded mathematics educational research. *Teaching and Teacher Education*, *34*, 12–25.

Hansen, N., Jordan, N. C., & Rodrigues, J. (2017). Identifying learning difficulties with fractions: A longitudinal study of student growth from third through sixth grade. *Contemporary Educational Psychology*, *50*, 45–59.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, *42*(2), 371–406.

JICA. (2017). Preparatory Survey Report for the Project for the Construction of Teacher Education Colleges in the Kingdom of Cambodia.

Jordan, N. C., Hansen, N., Fuchs, L. S., Siegler, R. S., Gersten, R., & Micklos, D. (2013). Developmental predictors of fraction concepts and procedures. *Journal of Experimental Child Psychology*, *116*(1), 45–58.

Kieren, T. E. (1993). Rational and fractional numbers: From quotient fields to recursive understanding. *Rational numbers: An integration of research*, 49-84.

Kilic, C. (2015). Analyzing pre-service primary teachers' fraction knowledge structures through problem posing. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(6), 1603–1619. https://doi.org/10.12973/eurasia.2015.1425a

Kilic, H. (2011). The nature of pre-service teachers' pedagogical content knowledge. *In Proceedings of the Seventh Congress of the European Society for Research in Mathematics Education–CERME7*, 2690–2696. Retrieved from http://www.cerme7.univ.rzeszow.pl/WG/17a/CERME7_WG17A_Kilic.pdf

Kolar, V. M., Čadež, T. H., & Vula, E. (2018). Primary teacher students' understanding of fraction representational knowledge in Slovenia and Kosovo. *Center for Educational Policy Studies Journal*, *8*(2), 71–96.

Lee, M. Y., & Son, J. (2015). Pre-service teachers'fractional concepts in solving advanced fractions problems. *Teacher Education and Knowledge: Research Reports*, 724–731.

Lamon, S. J. (2012). Teaching fractions and ratios for understanding: Essential content knowledge and instructional strategies for teachers. Routledge

Lisa. F & Robert. S. (2011). Teaching Fraction. UNESCO International Bureau of Education, International Academy of Education. https://unesdoc.unesco.org/ark:/48223/pf0000212781

Loewenberg Ball, D., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, *59*(5), 389–407. https://doi.org/10.1177/0022487108324554

Lortie-Forgues, H., Tian, J., & Siegler, R. S. (2015). Why is learning fraction and decimal arithmetic so difficult? *Developmental Review*, *38*, 201–221.

Ma, L. (1999). Knowing and Teaching Elementary Mathematics: Teacher's Understanding of Fundamental Mathematics in China and the United States. Lawrence Erlbaum Associates, Incorporated.

MoEYS. (2014). National Assessment Collaboration, 1–18. Retrieved from http://mcc.ca/examinations/nac-overview/

MoEYS. (2015a). Curriculum Framework of General Education and Technical Education. *Department of Curriculum Development*, 1–18.

MoEYS. (2015b). Results of Grade Six Student Achievement from the National Assessment in 2013.

MoEYS. (2015). Teacher Policy Action Plan. *Teacher Traning Department.*

MoEYS. (2016). Mid-Term Review Report in 2016 of the Education Strategic Plan 2014-2018 and Projection to 2020, 31.32.

MoEYS. (2019a). Cambodia's Education 2030 Roadmap: Sustainable Development-Goal 4.

MoEYS. (2019b). Education Congress: Performance in the academic year 2017-2018 and goals for the academic year 2018-2019 [Unofficial Translation], (March).

MoEYS. (2019c). Education Strategic Plan 2019-2023, (June 2019), 1–132.

MoEYS. (2015). Results of Grade Six Student Achievement from the National Assessment in 2013. *Education Quality Assurance Departement (EQAD)*, 18-24

MoEYS. (2017). Framework Bachelor of Arts (Education): Teacher Education College. *Teacher Traning Department*. Phnom Penh.

MoEYS. (2017). The curriculum of teacher training program 12+2 for primary school level based on the credit system. Phnom Penh.

Mohsin Uddin MD., & BABA, T. (2007). Analysis of Primary Mathematics in Bangladesh from Pupils' and Teachers' Perspectives : Focusing on Fraction. *International Journal of Curriculum Development and Practice*, *9*(1), 37–53.

Newton, K. J. (2008). An extensive analysis of pre-service elementary teachers' knowledge of fractions. *American Educational Research Journal*, *45*(4), 1080–1110. https://doi.org/10.3102/0002831208320851

Ngo, F. J. (2013). The distribution of pedagogical content knowledge in Cambodia: Gaps and thresholds in math achievement. *Educational Research for Policy and Practice*, *12*(2), 81–100. https://doi.org/10.1007/s10671-012-9133-1

Nguyen, P. L., Duong, H. T., & Phan, T. C. (2017). Identifying the concept fraction of primary school students: The investigation in Vietnam. *Educational Research and Reviews*, *12*(8), 531–539. https://doi.org/10.5897/err2017.3220

Pienaar, E. (2014). Learning about and understanding fractions and their role in the high school curriculum. *Zhurnal Eksperimental'noi I Teoreticheskoi Fiziki*.

Petrou, M., & Goulding, M. (2011). Conceptualizing teachers' mathematical knowledge in teaching. In Mathematical knowledge in teaching (pp. 9-25). Springer, Dordrecht.

Prigent, S. (2016). *Improving Teacher Quality: Maximazing Returns on Investment in Teacher Education in Cambodia*. Retrieved from http://www.kapekh.org/files/report_file/75-en.pdf

Puredorj, O., & BaBA, T. (2009). Transformation of the Mathematics Subject Matter Knowledge Teaching by Mongolian Teachers into Classroom. *Journal of JASME: Research in Mathematics Education*, *15(1)*, 107–122.

Purevdorj, O. (2015). Teacher Mathematical Knowledge for Teaching Geometry in Mongolian Secondary Schools-Focusing on Concept Image and Concept Definition Theory. Journal of JASME: research in mathematics education, 22(1), 79-104.

Purevdorj, O. (2019). Mongolian secondary school teachers' Mathematical Knowledge for Teaching with a reference to Geometry (Doctoral deissertation, Hiroshiam Uinversity).

Reeder, S., & Utley, J. (2017). What Is a Fraction? Developing Fraction Understanding in Prospective Elementary Teachers. *School Science and Mathematics*, *117*(7–8), 307–316. https://doi.org/10.1111/ssm.12248

Royal Government of Cambodia [RGC]. (2014). National Strategic Development Plan 2014-2018. *Royal Governament of Cambodia*, 232. https://doi.org/http://dx.doi.org/10.1186/s12891-016-1103-y

Shulman, L. S. (1986). Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher*, *15*(1.2), 4–14. https://doi.org/10.1017/CBO9781107415324.004

Siegler, R. S., & Lortie-Forgues, H. (2015). Conceptual knowledge of fraction arithmetic. *Journal of Educational Psychology*, *107*(3), 909–918. https://doi.org/10.1037/edu0000025

Song, S. (2012). Influences on academic achievement of primary school pupils in Cambodia. *Excellence in Higher Education,* 3(2012), 79-87.

Song, S. (2015). Cambodian teachers' responses to child-centered instructional policies: A mismatch between beliefs and practices. *Teaching and Teacher Education*, *50*, 36–45. https://doi.org/10.1016/j.tate.2015.04.004

Tandon, P., & Fukao, T. (2015). *Teaching the Next Generation: Improving Teaching Quality in Cambodia*. Washington, DC.

TEDS-M. (2012). *Policy, Practice, and Readiness to Teach Primary and Secondary Mathematics in 17 Countries*. *International Association for the Evaluation of Education Achievment*. https://doi.org/10.1177/004051757204200613

Turnuklu, E. B., & Yesildere, S. (2007). The pedagogical Content Knowledge in Mathematics: Pre- Service Primary Mathematics Teachers' Perspectives in Turkey. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, *1*.

Van, L., Mao, S., & Cnudde, V. (2018). Improving Pedagogical Content Knowledge on Rational Numbers of Cambodian Teacher Trainers. *Global Education Review*, *5*(3), 196–211.

Van Steenbrugge, H., Lesage, E., Valcke, M., & Desoete, A. (2014). Pre-service elementary school teachers' knowledge of fractions: A mirror of students' knowledge? *Journal of Curriculum Studies*, *46*(1), 138–161.

Wright, K. B. (2008). *Assessing EC-4 pre-service teachers' mathematics knowledge for teaching fractions concepts* (Doctoral dissertation, Texas A&M University).

The Development of Tests to Diagnose Cambodian Teacher Trainees' Misconceptions about Atoms and Molecules

SAMBOREY SO*[1], SHIMIZU KINYA[2] and SOVANSOPHAL KAO[3]

*[1] *Graduate School for International Development and Cooperation, Hiroshima University, Japan, Email: sosamborey@gmail.com*

[2] *Graduate School for International Development and Cooperation, Hiroshima University, Japan, Email: kinyas@hiroshima-u.ac.jp*

[3] *Graduate School for International Development and Cooperation, Hiroshima University, Japan, Email: sovansophal@gmail.com*

Received: December 22, 2020/ Accepted: May 08, 2021

Abstract

The purpose of this study is to develop a test with multiple-choice and agree-disagree questions to diagnose teacher trainees' misconceptions about atoms and molecules in a Cambodian context. There were four steps to develop the test: (1) defining the content area; (2) researching students and teachers' misconceptions; (3) developing test items; and (4) piloting the test for the content area of the concepts of atoms and molecules. The researchers also used open-ended questions in each test item. The test consisted of 17 questions covering the four components of characteristics of atoms, atomic structure, isotopes, and molecules. The test was first validated with 83 teacher trainees and then administered to 1,049 teacher trainees who are studying at four Provincial Teacher Training Centers and two Teacher Education Colleges in Cambodia. The reliability of the test increased from 0.600 in the pilot to 0.881 in the main survey. The content of the test was checked and revised according to the comments from 4 chemistry teachers. The results showed that the test was reliable and valid to measure students' misconceptions about the concepts of atoms and molecules in the Cambodian context. We found five critical items, and items that received more than 30% incorrect answers were considered as a misconception.

Keywords: Teacher trainees; Misconceptions; Diagnostic test; Atoms and molecules; Cambodia

1. Introduction

Teachers are always concerned about students' understanding of science lessons. Teachers need to investigate students' misconceptions before or after the lessons. During the learning process, the teachers are trying to impart new knowledge to the students who will try to connect their prior knowledge with the new knowledge. If the students and teachers have misconceptions, they will have difficulties in catching up and linking prior knowledge to the new knowledge. The difficulty and complexity of the concept of atoms and molecules can be

the cause of students' misconceptions about [what?]the basic contents. Many students find it difficult to learn about the abstract concepts of atoms and molecules and many teachers find them difficult to teach as well. As previous studies have shown, many researchers have researched students and teachers' misconceptions on different topics (atoms, molecules, chemical bondings etc.). For example, many students find it difficult to learn chemistry, and they are often unable to build accurate concepts. Nakhleh (1992) claimed that students "cannot fully understand the more advanced concepts that build upon the fundamentals". Students might have held a few misconceptions before they come to class or before learning new concepts. Ouchand Shimizu (2017) mentioned that future studies could identify other misconceptions in other topics in the Cambodian context. Atoms and molecules are abstract and difficult concepts for students or pre-service teachers to understand, and both groups hold misconceptions about this concept (Cokelez & Dumon, 2005; Kiray, 2016; Muştu & Özkan, 2017; Nakiboglu, 2003; Nicoll, 2001; Papageorgiou et al., 2016; Peterson & Treagust, 1989;). A recent report showed that some teacher trainers in Cambodia faced problems such as limited knowledge and misconceptions about the lessons themselves (VVOB, 2016). This report also mentioned that misconceptions existed with chemistry teacher trainers as well as trainees at Provincial Teacher Training Centers (PTTCs). Therefore, the present study aims to develop a test with multiple-choice questions and agree-disagree questions to diagnose teacher trainees' misconceptions on atoms and molecules. The test will enable teacher trainers to use it as a tool to investigate students' misconceptions and enhance their understanding of the concepts of atoms and molecules.

2. Literature review

In order to diagnose students' understanding, various diagnostic instruments have been developed and used. A recent study by Patil et al. (2019) showed that there are eight types of test development for diagnostic tests that can be used to identify students' misconceptions, such as (i) multiple-choice questions, (ii) open-ended questions, (iii) two, three and four tier diagnose tests, (iv) drawing test, (v) word association tests, (vi) conceptual change tests, (vii) concept inventories, and (viii) online diagnostics tests. The common instrument that many researchers used for diagnosing students' understanding and misconceptions is multiple-choice questions (Hufnagel, 2002; Krishnan & Howe, 1994; Martin et al., 2004; Peterson & Treagust, 1986; Tan & Treagust, 1999; Tan et al., 2008; Treagust, 1988). However, multiple-choice questions alone cannot determine what students understand and what they do not. Previous researchers added another part after multiple-choice questions that could be the multiple reasons, called two-tier diagnose tests (Lin, 2004; Tan et al., 2005; Treagust & Haslam, 1986; Widiyatmoko & Shimizu, 2018) or short answers for finding the reasons for their responses.

A study by Cros et al. (1986), which investigated 400 students using unstructured interviews and questionnaires, revealed that first-year undergraduate students provided only a limited explanation of the interactions of sub-atomic particles. A report on misconceptions, using a two-tier diagnostic test of a specific topic "covalent bonding and structure" was easy for teachers to address students' misconceptions in the classroom (Treagust, 1988). Perterson and

Treagust (1988, 1989) who developed two-tier multiple-choice items to test grade 12 students found that students had misconceptions related to bond polarity, the shape of molecules, the polarity of the molecule, intermolecular forces, and the octet rule. Harrison and Treagust (1996) conducted an interview-based study with 48 students from grades 8 to 10, using the mental model of atoms and molecules. The study showed that some students confused: the language use in biology and chemistry (shell and nuclei), models of atoms, atoms can grow and reproduce and atomic nuclei can be divided (Harrison & Treagust, 1996).… As can be seen from the previous studies, there seems to be no study that has measured misconceptions on atoms and molecules through the diagnostic test in multiple components of atoms and molecules concepts, such as characteristics of atoms, atomic structure, isotopes and molecules. The present study aims to fill in this knowledge gap by exploring the development of a test to diagnose Cambodian teacher trainees' misconceptions about atoms and molecules.

1. Methodology

This study followed four stages of procedure of test development such as (1) defining the content, (2) researching on students' and teachers' misconceptions, (3) developing test items, and (4) piloting tests (Figure 1).

The first stage was to define the content. According to 8th grade and 10th grade chemistry textbooks, the concepts of atoms and molecules can be defined into four components: the characteristics of atoms, atomic structure, isotopes, and molecules. The contents of the test were validated by three experienced chemistry teachers and one science professor. Table 1 shows the test items related to four concepts of atoms and molecules.

The second stage was to research students' and teachers' misconceptions on the concepts of atoms and molecules. This stage has drawn from previous studies that focused on students and teachers' misconceptions related to atoms and molecules concepts. The misconceptions found in those studies (e.g., …) were compiled to be used in developing test items.

The third stage was to develop test items. Based on stage 2, the test was categorized into four components of the concepts of atoms and molecules: the characteristics of atoms, atomic structure, isotopes, and molecules (see Table 1). The test comprised multiple choice and agree-disagree questions based on content drawn from chemistry textbooks of grades 8th and 10th. In addition, the researcher added open-ended questions in each question (see Figure 1 and 2).

4. The atomic number of an element is the number of (Atomic Structure)
□A. electrons in its ions
□B. neutrons in the nucleus
□C. protons in the nucleus
□D. neutrons and protons in the nucleus
Explain your answer: ……

Figure 1. Example of multiple-choice questions

9. All chemical bonds occur when there are attractions between the negative and positive atoms. (Molecule)
□ Agree □ Disagree
Please explain: ……

Figure 2. Example of agree-disagree questions in the test

Table 1 shows the four components of the concepts of atoms and molecules of the test items could identify misconceptions.

Table 1
The four components of the test and test items

Components	**Test items**
Characteristics of atoms	QI1, QI2, QII3, QII4
Atomic structure	QI3, QI4, QII1, QII2
Isotopes	QI5, QI6, QII5, QII6
Molecules	QI7, QI8, QII7, QII8, QII9

The fourth stage was to pilot the test. This study conducted a pilot test of twenty items on a sample of 83 teacher trainees (25 males and 58 females) and one teacher trainer from Kampot PTTC to check the reliability of the test. After the pilot study, the test was checked and revised by four chemistry teachers who work at different workplaces, such as secondary school, high school, provincial teacher training canter, and regional teacher training college, respectively . A multistage cluster random sampling was used to select the sample for the main study. The sample was divided into four areas (plain area, coastal area, plateau and mountainous area, and the surrounding Great Lake Tonle Sap area). Each PTTC was randomly chosen from each area with all teacher trainees and trainers teaching science. Then, the test was distributed to four PTTCs and two TECs in Cambodia. The test items were revised from twenty items (pilot) to seventeen items (main study) (see Appendix A). There were a total of 1,049 teacher trainees (312 males and 737 females) who participated in this study.

To score the test, the following scoring rubric was employed:

- If the participants chose the wrong or right answer but provided no explanation, the answer was coded as “no concept” and scored as 0 (no concept).
- If they chose the right answer and provided an incorrect explanation, it was coded as “misconception” and scored as 1 (misconception).
- If they chose the wrong answer but provided a correct explanation, it was coded as “confusion” and scored as 2 (confusion).

- If they chose the right answer and explained correctly, it was coded as the "right concept" and scored as 3 (correct answer).

The data were computed in Excel and pasted into Statistical Package for the Social Science (SPSS) software version 23 for Windows. The reliability in each component and total reliability of the test in pilot test and main study are shown in Table 3.

The contents of the test were checked and revised according to the comments from four chemistry teachers .

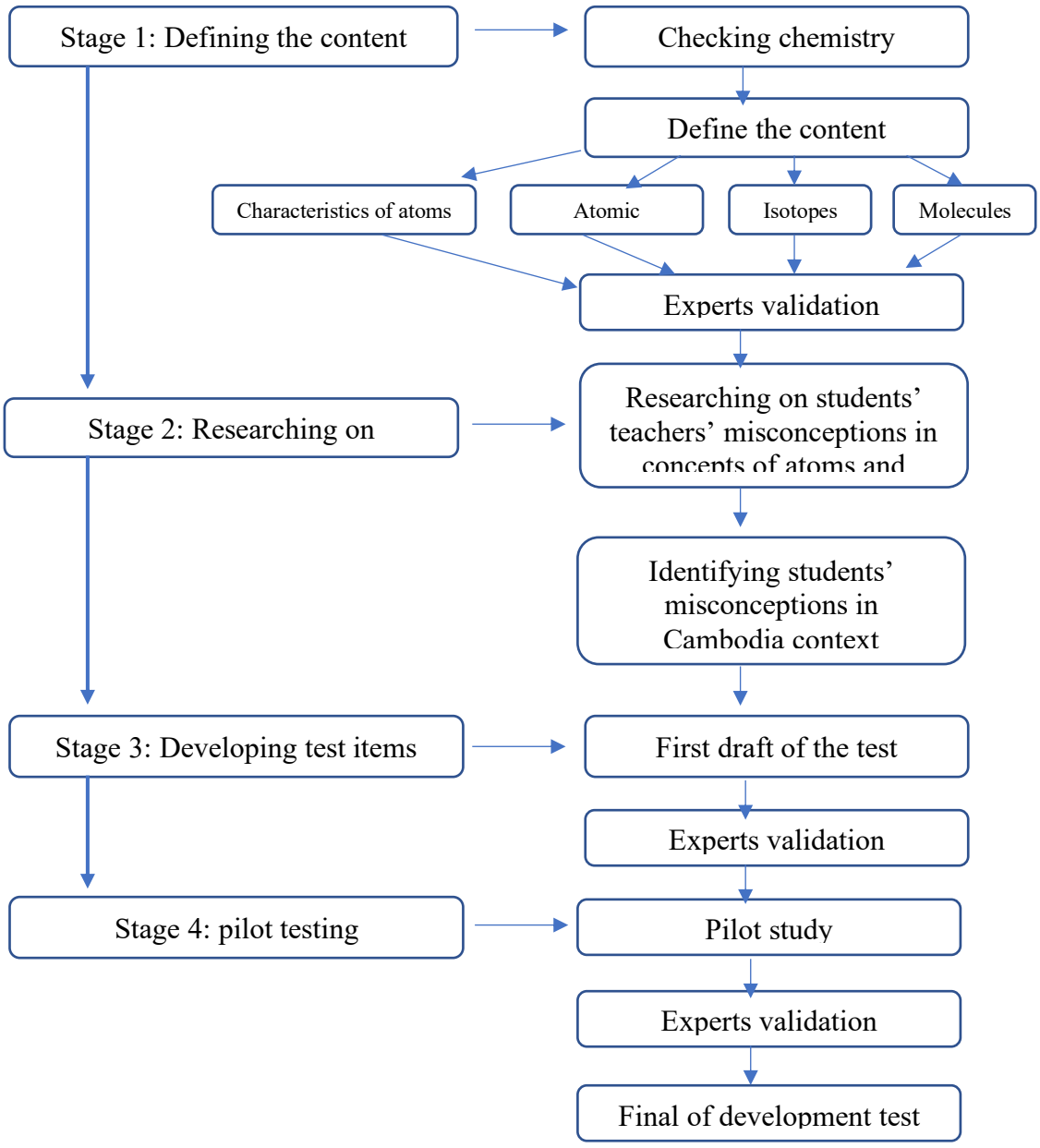


Figure 3. Flowchart of development test on atoms and molecules

2. Results and discussion

The reliability of this test—each component as well as the overall reliability—is shown in Table 2. After we got the reliability from the pilot test, researchers looked for four chemistry experts from different institutions, such as secondary school, high school, provincial teacher training center, and reginal teacher training college, to check the content again and revise those items to be included in the main survey. This could ensure that the test is acceptable in assessing the understanding of the concepts of atoms and molecules and can be used in the Cambodian context.

Table 2
The reliability of the test

Component	Pilot study	Main study
Characteristics of atoms	.285	.638
Atomic structure	.342	.658
Isotopes	.581	.842
Molecules	.214	.646
Total	**.600**	**.881**

Note: The pilot study contains 20 items and the main study contains 17 items.

The test in this study addressed teacher trainees' understanding of four components: the characteristics of atoms, atomic structure, isotopes and molecules. To find out what misconceptions are, the researchers checked teacher trainees' answers with multiple-choice, agree-disagree questions and check their explanations below each item. First, the researcher calculated the percentages of each item to find out what questions are difficult. Table 3 shows the percentages for the multiple-choice questions and Table 4 shows the percentages for the agree-disagree questions. As seen in Tables 3 and 4, 90.6%, 58.1%, 41.4%, and 87.7% of the teacher trainees respectively showed their understanding in the part about the characteristics of atoms (I1, I2, II3, and II4). Meanwhile, 85.4%, 59.1%, 81.7%, and 57.2% of the teacher

Table 3
Percentage of teacher trainees by multiple-choice responses

Test item	Percentage			
	A	B	C	D
I1	1.4%	6.4%	1.6%	90.6%
I2	15.1%	58.1%	3.3%	23.5%
I3	85.4%	2.1%	8.1%	4.4%
I4	33.1%	2.0%	59.1%	5.8%
I5	89.1%	1.9%	5.2%	3.7%
I6	2.6%	95.8%	1.0%	0.6%
I7	2.5%	19.8%	21.4%	56.3%
I8	48.1%	13.3%	28.6%	9.9%

Note: The highlighted percentages refer to the correct answers.

trainees showed their understanding in the component of atomic structure (I3, I4, II1, and II2),

respectively. For the understanding of the component of isotopes (I5, I6, II5, and II6), teacher trainees' understanding was89.1%, 95.8%, 95.0%, and 85.3%, respectively. Moreover, 56.3%, 48.1%, 90.6%, 43.5%, and 21.7% of the teacher trainees respectively showed their understanding in the component of molecules (I7, I8, II7, II8, and II9).

Table 4
Percentage of teacher trainees by agree-disagree responses

Test item	**Percentage**	
	Agree	Disagree
II1	81.7%	18.3%
II2	42.8%	57.2%
II3	58.6%	41.4%
II4	87.7%	12.3%
II5	95.0%	5.0%
II6	14.7%	85.3%
II7	9.4%	90.6%
II8	56.5%	43.5%
II9	78.3%	21.7%

Note: (The highlighted percentages refer to the correct answers).

After examining the percentages of each item, this study picked the critical items, i.e., the items with more than 30% incorrect answers. Out of a total of 17 test items, five (I4, II2, II3, II8, and II9) had a percentage of more than 30% inaccuracy. These critical items are shown in Table 5. Among the five items, question number II9 has the highest percentage of inaccuracy (78.3%), which shows that teacher trainees had difficulty choosing the correct answer for this question.

To reveal teacher trainees' understanding of the correct and acceptable scientific answers for the concepts of atoms and molecules, the researcher looked for their explanations in the second part of the test items (Table 6).

To measure teacher trainees' misconceptions, the authors examined the teacher trainees' explanations in each item that they misapplied the general principles of atoms and molecules as a conceptual misunderstanding. Conceptual misunderstandings or misconceptions occur when the students are taught the scientific information in a way that does not allow them to challenge conflicts resulting from nonscientific beliefs and their own preconceived notions (Patil, Chavan, & Khandagale, 2019). To know the conceptual misunderstanding of teacher trainees regarding the concepts of atoms and molecules, the researcher analyzed teacher trainees' explanations of their answers. As can be seen in Table 6, the highest percentage is 52.24% of the teacher trainees, showing their conceptual misunderstanding of the molecules concepts. However, the lowest percentage is 0.57% of the atomic structure.

These results indicated that a number of teacher trainees did not know the correct concepts as an acceptable scientific answer and hold some misconceptions about atoms and molecules

concepts. The test used in this study can assess teacher trainees' conceptual misunderstanding and analyze their misconceptions about atoms and molecules. The test not only can be used

Table 6
Percentage of teacher trainees' reasons to their choices

Teacher trainees' reasons	**Percentage**
1. Atoms with the same charge will repel each other but atoms which have different charges will attract each other to form molecules.	52.24%
2. All molecules are made up of different types of atoms.	18.68%
3. Chemical bonds come from the attraction between metal and non-metal atoms.	5.14%
4. Atoms have positive and negative poles. Atoms with the same pole cannot form chemical bonds but atoms with different poles can do so.	0.85%
5. All chemical bonds are linked by positive ions & negative ions. For e.g., $H^+ + Cl^- \rightarrow H–Cl$ $Na^+ + Cl^- \rightarrow Na–Cl$	1.71%
6. Atoms are around the nucleus.	8.96%
7. Atoms are in the nucleus.	6%
8. Atoms have the same size as their ions when they have the same electron shells or the numbers of electrons.	11.63%
9. The atomic numbers = number of protons = number of neutrons	0.57%
10. The atomic number represents the number of electrons in the outer shell.	6.86%

with teacher trainers but it may also be used with secondary school students. Classroom teachers might use the test before and after teaching the concepts of atoms and molecules to examine the gradual change of students' understanding.

Two-tier multiple-choice tests were developed and have been used to identify alternative concepts and misconceptions in science, as seen in previous studies (Adodo, 2013; Kanli, 2015; Treagust, 1988; Treagust & Haslam, 1986; Yusrizal & Halim, 2017). It has been found that teachers had an easy way to evaluate students' ideas with the two-tier multiple-choice test (Chen et al., 2002). Moreover, the use of two-tier multiple-choice tests allows teachers to explore and identify students' misconceptions about weight, sound, heat and light … (Tsai & Chou, 2002). This study has also found that multiple-choice and agree-disagree questions with students' explanations behind their answer choices can be used to explore students' understanding of science topics such as atoms and molecules.

3. Conclusion

Based on the results of the current study, it is concluded that the test with multiple-choice questions and agree-disagree questions is reliable and valid to assess teacher trainees' understanding and diagnose their misconceptions about atoms and molecules. Chemistry teachers can also use this test to identify their students' understanding of the concepts of atoms and molecules. They also can use it as an instructional approach to emphasize correct scientific concepts.

The findings of this study suggest that teacher trainees have difficulty in learning and lack a clear understanding of the concepts of atoms and molecules. Therefore, training programs are needed to help improve their content knowledge and understanding of the concepts of atoms and molecules as well as other important topics in chemistry. In light of this study's findings, future studies can use this test to identify what learners and teachers' misconceptions about atoms and molecules are. This test may be used as a model test to diagnose students' misconceptions about other concepts.

References

Adodo, S. O. (2013). Effects of two-tier multiple choice diagnostic assessment items on students' learning outcome in basic science technology (BST). *Academic Journal of Interdisciplinary Studies*, *2*(2), 201201.

Cokelez, A., & Dumon, A. (2005). Atom and molecule: Upper secondary school French students' representations in long-term memory. *Chemistry Education Research and Practice*, *6*(3), 119–135.

Chen, C. C., Lin, H. S., & Lin, M. L. (2002). Developing a two-tier diagnostic instrument to assess high school students' understanding-the formation of images by a plane mirror. *Proceedings-National Science Council Republic of China Part D Mathematics Science and Technology Education*, *12*(3), 106-121.

Cros, D., Maurin, M., Amouroux, R., Chastrette, M., Leber, J., & Fayol, M. (1986). Conceptions of first-year university students of the constituents of matter and the notions of acids and bases. *European Journal of Science Education*, *8*(3), 305–313.

Harrison, A. G., & Treagust, D. F. (1996). Secondary students' mental models of atoms and molecules: Implications for teaching chemistry. *Science Education*, 80(5), 509–534.

Hufnagel, B. (2002). Development of the astronomy diagnostic test. *Astronomy Education Review*, *1*(1), 47-51.

Kanli, U. (2015). Using a two-tier test to analyze students' and teachers' alternative concepts in astronomy. *Science Education International*, *26*(2), 148-165.

Kiray, S. A. (2016). The pre-service science teachers' mental models for concept of atoms and learning difficulties. *International Journal of Education in Mathematics, Science and Technology*, *4*(2), 147–162.

Krishnan, S. R., & Howe, A. C. (1994). The mole concept: Developing an instrument to assess conceptual understanding. *Journal of Chemical Education*, *71*(8), 653-653.

Lin, S. W. (2004). Development and application of a two-tier diagnostic test for high school students' understanding of flowering plant growth and development. *International Journal of Science and Mathematics Education*, *2*(2), 175-199.

Martin, J. K., Mitchell, J., & Newell, T. (2004). Analysis of reliability of the fluid mechanics concept inventory. In *34th Annual Frontiers in Education, 2004.*.

Muştu, Ö. E., & Özkan, E. B. (2017). The use of analogy for the determination of pre-service science teachers' cognitive structures about the concept of atom. *European Journal of Education Studies,3(10),* 583-594

Nakhleh, M. B. (1992). Why some students don't learn chemistry: Chemical misconceptions. *Journal of Chemical Education*, *69*(3), 191-196.

Nakiboglu, C. (2003). Instructional misconceptions of Turkish prospective chemistry teachers about atomic orbitals and hybridization. *Chemistry Education Research and Practice*, *4*(2), 171–188.

Nicoll, G. (2001). A report of undergraduates' bonding misconceptions. *International Journal of Science Education*, *23*(7), 707–730.

Ouch, S., & Shimizu, K. (2017). Exploring misconceptions about the characteristics of solid, liquid, and gas among junior high school students in Kampot province, , Cambodia. *Unnes Science Education Journal*, *6*(3), 1669-1676.

Papageorgiou, G., Markos, A., & Zarkadis, N. (2016). Understanding the atom and relevant misconceptions: Students' profiles in relation to three cognitive variables. *Science Education International*, *27*(4), 464–488.

Patil, S. J., Chavan, R. L., & Khandagale, V. S. (2019). Identification of misconceptions in science: Tools, techniques and skills for teachers. *Aarhat Multidisciplinary International Education Research Journal, 8*(2), 466–472

Peterson, R., & Treagust, D. (1986). Identification of secondary students' misconceptions or covalent bonding and structure concepts using a diagnostic Instrument. *Research in Science Education*, *16*, 40-48.

Peterson, R. F., & Treagust, D. F. (1988). Students' understanding of covalent bonding and structure concepts. *The Australian Science Teachers Journal*, 33, 77–81.

Peterson, R. F., & Treagust, D. F. (1989). Grade-12 students' misconceptions of covalent bonding and structure. *Journal of Chemical Education*, *66*(6), 459-460.

Tan, K. C. D., Taber, K. S., Goh, N. K., & Chia, L. S. (2005). The ionisation energy diagnostic instrument: a two-tier multiple-choice instrument to determine high school students' understanding of ionisation energy. *Chemistry Education Research and Practice*, *6*(4), 180-197.

Treagust, D. F. (1988). Development and use of diagnostic tests to evaluate students' misconceptions in science. *International journal of science education*, *10*(2), 159-169.

Treagust, D. F., & Haslam, F. (1986). Evaluating secondary students' misconceptions of photosynthesis and respiration in plants using a two-tier diagnostic instrument. 21(3), 203-211.

Tsai, C. C., & Chou, C. (2002). Diagnosing students' alternative conceptions in science. *Journal of Computer Assisted Learning*, *18*(2), 157-165.

Weinstein, H., Politzer, P. & Srebrenik, S. (1975). A misconception concerning the electronic density distribution of an atom. *Theoret. Chim. Acta*, 38(2), 159–163

Widiyatmoko, A., & Shimizu, K. (2018). The development of two-tier multiple choice test to assess students' conceptual understanding about light and optical instruments. *Jurnal Pendidikan IPA Indonesia*, *7*(4), 491-501.

Yusrizal, Y., & Halim, A. (2017). The effect of the one-tier, two-tier, and three-tier diagnostic test toward the students' confidence and understanding toward the concepts of atomic nuclear. *Unnes Science Education Journal*, *6*(2), 1593-1600.

Appendix

Table 5
Critical items for teacher trainees' answers

Test Item	**Incorrect answer**	**Percentage**
I4. The atomic number of an element is the number of: ☐A. electrons in its ions ☐B. neutrons in the nucleus ☐C. protons in the nucleus ☐D. neutrons and protons in the nucleus	☑A. electrons in its ions	33.1%
II2. The radius of a chlorine atom has the same size radius of a chloride ion because it has the same number of electron shells (3 electron shells). ☐ Agree ☐ Disagree	☑ Agree	42.8%
II3. Atoms move around the nucleus. ☐ Agree ☐ Disagree	☑ Agree	58.6%
II8. All molecules are made up of different types of atoms linked together. ☐ Agree ☐ Disagree	☑ Agree	56.5%
II9. All chemical bonds occur when there are attractions between the negative and positive atoms. ☐ Agree ☐ Disagree	☑ Agree	78.3%

Acknowledgment

We are thrilled to launch the very first volume of the Cambodian Journal of Educational Development (CJED). At the core of this achievement is commitment, patience, and resilience of the following dedicated individuals that we wish to show our sincere gratitude here. Without their invaluable contributions throughout the editorial process, this publication would not have been possible.

We would like take this opportunity to first of all express our heartfelt appreciation to Professor Kinya Shimizu and Associate Professor Takayoshi Maki of Graduate School of Humanities and Social Sciences, Hiroshima University (HU), Japan. Their precious time and effort, enthusiastic support, and constant encouragement from the early stage until its present form has always been very much appreciated.

We also would like to gratefully acknowledge the Japanese International Cooperation Center (JICE) for their financial assistance, especially Mr. Morishita Taishi for his technical support all the way through from funding application preparation to submission and to approval. His clear guidance and prompt responses have made communication with JICE headquarter more smoothly and timely.

Our sincere gratitude is owed to all reviewers and co-editor from different institutions, countries and disciplines for their constructive comments to ensure that the manuscripts are of good quality.

Profound thanks to all authors, who are willing to contribute their original work to the first volume of our journal. Without their multiple revisions, we could not possible to carry on further procedure.

Finally, further gratitude goes to CJED Editorial Team, all of whom have been working hard to achieve one common goal which is to create and nourish CJED together in promoting research in Cambodia. Their great efforts are very much appreciated for this success.

Supported by

Copyright © Cambodian Journal of Educational Development

Office address:

Human Resource Development for Education Research Lab

International Education Development Program

Graduate School of Humanities and Social Sciences

Hiroshima University

1-5-1 Kagamiyama, Higashi-Hiroshima City, Hiroshima, 739-8529, Japan

Website: www.cjed.hiroshima-u.ac.jp