การพัฒนาดัชนีการเรียนรู้ เครื่องมือวัด และแนวทางการส่งเสริมการเรียนรู้ของนักเรียน: การศึกษาระดับมหภาคและจุลภาคในประเทศกัมพูชา

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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาครุศาสตรดุษฎีบัณฑิต
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DEVELOPING LEARNING INDEX, MEASUREMENT INSTRUMENT, AND GUIDELINES FOR ENHANCING STUDENT LEARNING: MACRO- AND MICRO-LEVEL STUDIES IN CAMBODIA

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A Dissertation Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy Program in Educational Research Methodology
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Thesis Title	DEVELOPING LEARNING INDEX, MEASUREMENT INSTRUMENT, AND GUIDELINES FOR ENHANCING STUDENT LEARNING: MACRO- AND MICRO-LEVEL STUDIES IN CAMBODIA
By	Mr. Bunhe Harth
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บุนเฮ ฮวด : การพัฒนาดัชนีการเรียนรู้ เครื่องมือวัด และแนวทางการส่งเสริมการเรียนรู้ของนักเรียน: การศึกษาระดับมหภาคและจุลภาคในประเทศกัมพูชา (DEVELOPING LEARNING INDEX, MEASUREMENT INSTRUMENT, AND GUIDELINES FOR ENHANCING STUDENT LEARNING: MACRO- AND MICRO-LEVEL STUDIES IN CAMBODIA) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ศ. ดร. สุวิมล ว่องวาณิช, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: อ. ดร. ชยุตม์ ภิรมย์สมบัติ, 175 หน้า.

การวิจัยในครั้งนี้มีวัตถุประสงค์เพื่อ 1) พัฒนาเครื่องมือวัด และกำหนดดัชนีการเรียนรู้ของนักเรียน 2) วิเคราะห์ดัชนีการเรียนรู้ของนักเรียนกัมพูชา และอธิบายโปรไฟล์ดัชนีการเรียนรู้ตามตัวแปรภูมิหลังที่ศึกษาในระดับมหภาค และ 3) พัฒนาแนวทางการส่งเสริมดัชนีการเรียนรู้ของนักเรียนด้วยการถอดบทเรียนจากการปฏิบัติจริงของครูในโรงเรียนในระดับจุลภาค ตัวอย่างวิจัยระดับมหภาคเป็นนักเรียนชั้นมัธยมศึกษาตอนปลายทั่วประเทศ จำนวน 1,619 คน ได้มาจากการสุ่มแบบหลายขั้นตอน ส่วนตัวอย่างวิจัยระดับจุลภาคมีจำนวน 24 คน เครื่องมือวิจัยเป็นแบบสอบถามมาตรประมาณค่า 5 ระดับ การวิเคราะห์ข้อมูลประกอบด้วยสถิติบรรยาย การวิเคราะห์สหสัมพันธ์ การทดสอบที การวิเคราะห์องค์ประกอบเชิงยืนยัน การวิเคราะห์การถดถอยแบบพหุคูณ การวิเคราะห์เนื้อหา การวิเคราะห์ความเที่ยง การวิเคราะห์ความเป็นปรนัย การวิเคราะห์ความไม่แน่นอน และการกำหนดเกณฑ์ปกติวิสัย ด้วยโปรแกรม R เวอร์ชัน 3.3.2 และ Mplus เวอร์ชัน 7 ผลการวิจัยสรุปได้ดังนี้

1. เครื่องมือวัดการเรียนรู้ของนักเรียนประกอบด้วย 2 องค์ประกอบหลัก คือ การเรียนรู้เพื่อรู้ และการเรียนรู้เพื่อปฏิบัติ แต่ละองค์ประกอบประกอบด้วยองค์ประกอบย่อย 2 ด้าน ได้แก่ กระบวนการและผลลัพธ์ของการเรียนรู้ แต่ละองค์ประกอบย่อยประกอบด้วยตัวบ่งชี้ 3 ด้าน แบบวัดทั้งฉบับประกอบด้วยข้อรายการ 56 ข้อ ผลการวิเคราะห์คุณสมบัติทางจิตมิติของเครื่องมือวัดการเรียนรู้ของนักเรียน พบว่ามีความตรงตามเนื้อหา (ค่าดัชนี IOC ระหว่าง .50 -1.00) มีความเป็นปรนัยในการเก็บรวบรวมข้อมูล มีความไม่แน่นอนอยู่ในเกณฑ์ที่ยอมรับได้ มีความตรงเชิงโครงสร้าง (X^2(15, N=1619) = 22.32, p = .10, CFI = 1.00, TLI = .99, SRMSR = .01, RMSEA = .02) มีค่าความเที่ยงสูง (α = .83 - .94) มีความตรงตามเกณฑ์สัมพันธ์วัดโดยใช้กลุ่มรู้ชัด สำหรับดัชนีการเรียนรู้ของนักเรียนได้พัฒนาขึ้นจากวิธีการ 2 วิธี คือ ดัชนีการเรียนรู้แบบอิงเกณฑ์ และดัชนีการเรียนรู้แบบอิงกลุ่ม การวิจัยนี้เลือกใช้ดัชนีการเรียนรู้แบบอิงกลุ่มนักเรียนกัมพูชา มีเกณฑ์การแปลระดับการเรียนรู้ออกเป็น 4 ระดับ ได้แก่ ดัชนีการเรียนรู้ระดับต่ำ (.000-.062) ดัชนีการเรียนรู้ระดับปานกลาง (.063-.375) ดัชนีการเรียนรู้ระดับค่อนข้างสูง (.376 -.680) และดัชนีการเรียนรู้ระดับสูง (.681-1.000) นอกจากนี้ยังได้นำเสนอเกณฑ์ปกติวิสัยสำหรับการแปลผลดัชนีการเรียนรู้ของนักเรียนกัมพูชาไว้อีกด้วย

2. ผลการศึกษาระดับมหาภาค พบว่าดัชนีการเรียนรู้ของนักเรียนกัมพูชามีค่าเฉลี่ย .65 โดยดัชนีการเรียนรู้ของนักเรียนแตกต่างกันตามภูมิหลังของนักเรียน ได้แก่ เพศ ฐานะทางเศรษฐกิจของครอบครัว สังกัดโรงเรียน ชื่อเสียงโรงเรียน การมีอินเทอร์เน็ตในโรงเรียน โดยในภาพรวมตัวแปรภูมิหลังของนักเรียนและบริบทโรงเรียนสามารถอธิบายระดับการเรียนรู้ได้ร้อยละ 3

3. ผลการศึกษาระดับจุลภาคในโรงเรียนกำปงเชอเตียลซึ่งเป็นโรงเรียนกรณีศึกษา ทำให้ได้บทเรียนในการกำหนดแนวทางส่งเสริมการเรียนรู้ของนักเรียนด้วยการจัดกิจกรรมการเรียนที่มีปฏิสัมพันธ์กันระหว่างการเรียนการสอนของครูกับนักเรียน ผลการศึกษายังพบว่านักเรียนมีการเรียนรู้สูงขึ้นหลังการทดลองจัดกิจกรรมส่งเสริมการเรียนรู้ของนักเรียนโดยครู

ภาควิชา	วิจัยและจิตวิทยาการศึกษา	ลายมือชื่อนิสิต	.....
สาขาวิชา	วิธีวิทยาการวิจัยการศึกษา	ลายมือชื่อ อ.ที่ปรึกษาหลัก	.....
ปีการศึกษา	2559	ลายมือชื่อ อ.ที่ปรึกษาร่วม	.....

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BUNHE HARTH: DEVELOPING LEARNING INDEX, MEASUREMENT INSTRUMENT, AND GUIDELINES FOR ENHANCING STUDENT LEARNING: MACRO- AND MICRO-LEVEL STUDIES IN CAMBODIA. ADVISOR: PROF. SUWIMON WONGWANICH, Ph.D., CO-ADVISOR: CHAYUT PIROMSOMBAT, Ph.D., 175 pp.

This research aimed to 1) develop instruments to measure students' learning and determine the learning index of students, 2) analyze the learning index of Cambodian students and explain the learning index profiles with selected school backgrounds at the macro level, and 3) develop guidelines for enhancing the learning index of students by analyzing lessons learnt from classroom practices of teachers at the micro level. The research sample for the macro level consisted of 1,619 high school students selected by using a multistage random sampling technique, while 24 students were selected for the micro level study. The research instrument was a 5-point rating scale. Data were analyzed by descriptive statistics, correlation analysis, t-test analysis, confirmatory factor analysis, multiple regression, content analysis, reliability analysis, objectivity analysis, uncertainty analysis, and norms development for the learning index interpretation, using R version 3.2.2 and Mplus version 7. Key research findings were summarized as follows:

1. The instrument to measure student learning consisted of two main components: Learning to Know and Learning to Do. Each component was composed of two sub-components: processes and outcomes of learning. Each sub-component was measured by three indicators. The qualities of the instrument based on the six of psychometric properties were examined. The instrument had content validity (IOC ranged between .50-1.00). The objectivity and uncertainty analyses also showed acceptable results. In addition, the instrument had a high level of construct validity *($X^2(15, N=1619) = 22.32$, $p = .10$, $CFI = 1.00$, $TLI = .99$, $SRMSR = .01$, $RMSEA = .02$)*, highly reliable (Cronbach's $\alpha = .83$-$.94$), and acceptable criterion-related valid as examined by using the known-group technique. For the learning index interpretation, this study proposed two approaches: criterion-referenced and norm-referenced. Employing the norm-referenced interpretation, this study classified Cambodian students' learning index into 4 levels: low (.000 - .062), moderate (.063 - .375), relatively high (.376 - .680), and high (.681 – 1.000). This study also calculated the percentile rank of Cambodian students' learning index.

2. At the macro level, the average of Cambodian students' learning index was .649. The learning index of Cambodian students could be explained by the backgrounds of students and school contexts. It was found that gender and family incomes of students, academic stream, school jurisdictions, school contexts (competing/non-competing schools), and school internet access accounted for 3% of the learning variation.

3. At the micro level, the results of Kampong Chueteal High School as the case study of this research indicated that student learning index was higher after implementing the teacher-designed activities to enhance student learning based on their learning index. Lessons learned from the study, for example interactive instructional activities between teachers and students, were developed to create guidelines for enhancing student learning.

Department:	Educational Research and Psychology	Student's Signature	.....
Field of Study:	Educational Research Methodology	Advisor's Signature	.....
Academic Year:	2016	Co-Advisor's Signature	.....

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Introduction

1.1. Background Information

A student's learning affects all areas of their lives, including physical, emotional, and spiritual components. Student learning is a repeated process of gaining knowledge, skills, and values throughout all stages of students' lives and beyond (Saisana, 2008; UNESCO, 2014). It has also been noted that the more subjects students intend to learn, the more subjects they practise, the more knowledge and experiences they gain during the learning process (Scheerens, 1990).

However, student learning is comprised of many dimensions and styles. Most students pay more attention to their learning to achieve ultimate learning goals (Wirth & Perkins, 2008). It is also an important ingredient for student learning success, including the ability to engage and sustain attention in the learning process itself (Brunvand & Byrd, 2011). Additionally, well-developed learning abilities enable students to manage and direct their learning, and to select learning strategies that are appropriate to their learning efforts (McLean, Attardi, Faden, & Goldszmidt, 2016; OECD, 2004). The development of student learning skills and attitudes could be identified as a main goal of schooling. It is considered as a significant outcome of the learning process (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010). Moreover, student learning is intended to coalesce into a platform of applicable knowledge as a result of the synthesis of components of learning, including real world work, practical learning engagement, and continuing self-development.

Therefore, student learning is defined as students actively producing their own knowledge. It means that students are actively participating in the learning process, constructing meaning to bridge prior knowledge with new information. Students with well-developed abilities are able to manage their own learning toward appropriate learning goals (OECD, 2004; Wirth & Perkins, 2008). Accordingly, student learning is the foundation of other types of knowledge generation.

Student learning is the process in which students can be able to know, do, live with others, and be autonomous in deciding to think and do things they intend (Delors,

1996). This means that student learning is considered to be an indicator of individual student development in gaining knowledge, skills, professional jobs, autonomy, and plurality acceptance (UNESCO, 2014). Thus, knowing how to learn and practice what is learnt may generate desirable learning outcomes.

However, several researches (e.g. Canadian Council on Learning, 2010; European Union, 2010; Kim, 2016) examined measurement models of student learning. The Canadian Council on Learning (CCL) developed the Composite Learning Index (CLI) to obtain information about the lifelong learning situation of each community in Canada. The development of CLI aimed to monitor how learning conditions impact economic and social well-being in Canada. CLI includes 17 indicators and 25 specific measures to assess the state of lifelong learning. Additionally, the European Union (EU) also developed the European Lifelong Learning Index (ELLI), which aimed to describe the levels of lifelong learning status of each European country. ELLI was used to follow up diverse learning situations among schools, societies and homes. ELLI includes 17 indicators and 35 measures to calculate the lifelong learning scores of EU countries. Lastly, J. Kim (2016) developed the global lifelong learning index (GLLI) to study state-level lifelong learning which outlines student-school accessibilities, as well as the quality of schools and universities. GLLI includes 35 measures and 12 sub-categories.

Composite Learning Index (CLI) was first invented by Canadian Council on Learning (2006, 2010). It was first learning instrument used to measure the state of learning, over time, for individual communities and across the OECD country. The state of learning was measured by four pillars such as Learning to Know, which includes the acquisition of knowledge and the mastery of learning tools such as concentration, memory and analysis. Learning to Do, which concerns occupational, hands-on and practical skills. Learning to Live Together, which is learning that strengthens cooperation and social cohesion. Learning to Be, which includes the fulfillment of the whole person, as an individual, as a member of a family and as a citizen. CLI includes 17 indicators and 25 specific measures to assess the state of lifelong learning.

The European Lifelong Learning Index (ELLI) was constructed by European Union 2010. It was a measurement instrument used to measure wide range of learning activities including participation rates in formal education and training, literacy skills (PISA), employees participating in CVT courses, labor market policies expenditure,

and community engagement through cultural activities, among others. It is also used to identify the known economic and social outcomes of learning, such as income, employability, population health and social cohesion and democracy. These outcomes were perceived as components of the well-being of a society. This instrument combines 36 variables of lifelong learning. ELLI includes 17 indicators and 35 measures to calculate the lifelong learning scores of EU countries.

Global Lifelong Learning Index (GLLI) was constructed Kim (2016). It was developed to measure state-level of lifelong learning in which learning to know and Learning to Do of the measurement model were measured by quality and quantity of learning while Learning to Live Together and Learning to Be were measured in terms of learning participation, tolerance and self-directed learning. GLLI includes 35 measures and 12 sub-categories.

Based on early studies (CCL, 2010; ELLI, 2010; Kim, 2016), it was confirmed that the research studies adapted the concepts of four pillars of education proposed by UNESCO. The measurement models were to test students' achievement. The test results of any testing do not indicate how students learn which will be more meaningful to teachers for their student development. The results indicate only students' achievement in regards to the curriculum provided to students during the academic year.

Therefore, detailed information about student learning should be provided for students' themselves, for teachers, and for educational stakeholders that would enable them to reconsider students' concepts of learning and its outcomes.

To date, this study also applies the concept of the four pillars of education as proposed by UNESCO. UNESCO's four pillars of education (i.e., Learning to Know, Learning to Do, Learning to Live together, and Learning to Be) are fundamental principles for lifelong learning. Among these four pillars, Learning to Know (know) and Learning to Do (do) are the crucial basic components for students to actively participate in their learning process and successfully achieve their learning goals. The study would be conducted to develop new items of student learning based on these two pillars. Therefore, new items were developed based on the concepts of process and outcome of learning in which one item in the process of learning should produce one item in the outcome of learning. Hence, items of this study are pairs-developed.

This study also aimed to develop a student learning composite index based on the Learning to Know and Learning to Do components. Additionally, the newly developed index would be used to investigate Cambodian student learning.

The methods used for the development of a learning index need to be examined in the light of ongoing change in the phenomena being measured, new understanding of learning indices and feedback from the process of teaching and learning. There is an ongoing need to examine the appropriateness of such indices to ensure that they are sufficient and sound for empirical extraction and utilization for the promotion and initiation of student learning processes and outcomes (Rany, Zain, & Jamil, 2012).

1.2. Research Questions

1. What are the components of student learning? How should this variable be measured? And, how will the learning index be determined?

2. To what extent is the learning index of Cambodian students; and how does the selected variable explain the learning index of students?

3. What will be the guidelines for enhancing the Cambodian measurement model of student learning developed from classroom practices? How effective are the developed guidelines?

1.3. Research Objectives

1. To develop instruments to measure student learning and determine the learning index of students.

2. To analyze the learning index of Cambodian students and explain the learning index profiles from a selected school background at the macro level.

3. To develop guidelines for enhancing the learning index of students by analyzing lessons learned from classroom practices of teachers at micro-level.

1.4. Scope of the Study

The theory of learning in the 21st century proposed by Delors (1996) is to lead students to the previously mentioned Four Pillars of Education as promoted by UNESCO. This concept has been broadly studied and utilized, such as in the study of the Canadian Council on Learning (Composite Learning Index), the study of the

European Union (European lifelong learning index), and UNESCO, the Faure report, the Delors report, and the political utopia of lifelong learning (Elfert, 2015). Most of these studies are based on adult samples and the concept of lifelong learning. Additionally, measurement parameters included the student dropout rate, specific majors, and specific academic years which students should pursue in that of academic year. However, the current study will be conducted with a selected group of high school students in Cambodia who study the curriculum of the Ministry of Education Youth and Sport (MoEYS, 2013). The curriculum includes such subjects as math, physics, chemistry, biology, earth science, history, geography, Khmer literature, home economics, foreign languages, and morality. Therefore, the concept and items to determine the measurement model of student learning may differ from other cases.

The four core components as proposed by Delors' proposal (1996) and promoted by UNESCO requires students to rise to the needs of 21st century learning skills. This research will focus only on the first two main components— Learning to Know and Learning to Do, as high school students may not have had a reason to achieve the last two main components—learning to live together and learning to be, based on the age and curriculum goals of the Cambodian educational system (MoEYS, 2014; Tan, 2007). On the contrary, high school students are under the control of parents or guardians who always provide them support, both hard and soft materials for schooling, life, and so on. Therefore, the achievement of the last two main components would not be appropriate parameters for measuring the outcomes and processes of high school students. Therefore, every student need to fulfill the four pillars of education that would lead them to developed students.

But this research study will be conducted with the early first two main pillars of education— Learning to Know and Learning to Do. Based on few reasons such as sample group, belief of learning theory, and lifelong learning.

The samples of this study are high school students under the control of parents or guardians. Students have been provided support both materials and opinions to choose or study during students' schooling life. Therefore, to reach the last two main pillars of education seems difficult for high school students to meet the process and outcomes of Learning to Live Together and Learning to Be. On the other hand, based on the pilot study learning to live together and learning to be were not saturated. E.g.

Learning to live together for high school students fulfilled only the learning in group team work at school or collaboration work. This concept could not reach the concept of Learning to Live together of UNESCO, as well as, Learning to Be was also not yet confirmed such as self-regulated learning of high school students were still not clearly identified by the pilot study too.

Theory of learning stated that student learning also demonstrated that Learning to Know and Learning to Do are the fundamental knowledge building to enrich complete students through Learning to Be. Learning to Be refers to the development of all the dimensions of the complete students. Thus, in order to reach learning to be students need fundamental steps beforehand.

Learning to be, concept of lifelong learning, retrieved from the fulfillment of learning to know, Learning to Do, and learning to live together.

This study aims to investigate a learning index as perceived by high school students. This study will be conducted in two phases. The first phase is to study at the macro level by sampling high school students nationwide based on school demographic information. The second phase will be conducted at the micro level as a case study of Kampong Cheuteal high school students to find out appropriate guidelines for enhancing their learning index.

1.5. Definition of the Terms

Learning to Know is defined as learning desire, learning engagement, and learning how to learn by developing student's concentration, memory skills and the ability to think. It is concerned less with the acquisition of structured knowledge than the mastery of learning tools of students.

Learning to Do is defined as putting knowledge and skills into practice innovatively through skill development and practical know-how. Learning to Do is concerned about the development of competence, life skills, personal qualities, aptitudes and attitudes to communicate actively and productively with the world of work and continuing skill development.

Learning to Live Together is defined as the development of social skills and values such as respect and concern for others, social inner personal skills and the appreciation of the diversity of the world. Students with this skill should be with other in any situation collaboratively and happily.

Learning to Be is defined as the completed fulfillment of students, in all richness of students' personality, the complexity of students form of expression and students' various commitments. Learning to Be is the complete students who know the position of selves, be confident, and self-regulated.

Student learning is defined as the mental and physical ambitions that students commit their learning in terms of learning process and learning outcomes while they both during and outside of school time.

Student learning index is defined as a scaled composite learning variable. It is a learning summary measure designed to capture learning properties in a single number. The single number is valued between .00 – 1.00.

1.6. Significances of the Study

Three possible significant benefits will accrued by the education system in Cambodia as a result of this study.

1. Policy Level

Educational institutions and stakeholders such as teachers, administrators, schools, district office of educations, provincial office of educations, and ministry of education youth and sport, will be able to use this new developed learning index to detach levels of measurement models of student learning, to identify the strengths and weaknesses of each component, and to promote and enhance student learning process and outcomes.

2. Academic Level

The learning index is an instruction instrument that enhances the ability of education providers to follow up on their daily work. It is also considered as a tool to help close learning gaps. It may perform as educational quality promotion guidelines that can be used to identify individual teachers and students in teaching for learning and

student learning, which would enable educational stakeholders or providers to identify levels of teaching and learning processes and outcomes.

3. Practical Level

Teachers can obtain guidelines that can be used to reflect the values of the learning index. It is an additional instruction instrument that can be used to identify the strengths and weaknesses of instruction, and to improve the instruction process for the benefit students.

Whenever teachers use the values of a learning index to measure student learning process and student learning achievement, it can enable and enhance students to change their learning perspective, style and learning behavior after a reflection of teaching and learning process provided to them following teaching and learning activities both in and out of school.

Chapter 2

Literature Review

2.1. Introduction

Learning is considered as the main factor that increases knowledge, memorization, acquisition of facts and procedures, abstraction of meaning, and understanding of reality and empirical natural phenomena in which the happenings of everyday life and working processes occur (Entwistle & Ramsden, 2015; Kember & Gow, 1994). Learning is relevant to investigations about the knowledge of students, which would be effectively associated with the utilization of strategies in learning (Lin, Liang, & Tsai, 2015) and motivation toward learning activities (Klatter, Lodewijks, & Aarnoutse, 2001). These concepts contribute to students' perception of the classroom environment and approaches to learning (Entwistle & Ramsden, 2015; Sriklaub, Wongwanich, & Wiratchai, 2015; Wolters & Hussain, 2015; Zullig et al., 2015). A broader concept of student learning holds that students' perception of learning achievement from their daily experience and practice of every day learning is critical (Entwistle & Ramsden, 2015; Yang & Tsai, 2010).

With regards to the previous research studies that have attempted to identify the factors that have an effect on student learning (Sriklaub et al., 2015), the Composite Learning Index (CLI) developed by Canadian Council on Learning to identify gaps of learning, attendance at school, difficulties in accessing school services and the lack of resources of students and school itself to provide learning services to students (Canadain Council on Learning, 2010) has served as a useful method to survey students' study gaps, and assisting in the identification of the needs of students and market requirements that most student should fulfill.

But the learning index in this research study was developed in response to the starting point of students who effectively contribute to the realization of their learning processes, learning outcomes, and learning goals. A fuller understanding of learning systems is to develop aspirations and goal-facilitated students to achieve their learning opportunities, learning processes, learning outcomes and learning goals. In an educational context, a competence could be defined as the ability to handle complex learning needs successfully or to carry out an activity or learning task fruitfully (Cappon

& Laughlin, 2013). This needs-oriented or functional definition of a measurement model of student learning is supplemented by an understanding of students' competencies as an internal mental structure of those abilities, capacities and dispositions which is embedded in the individual student on their learning habits.

2.2. Definition of Learning Index

The aims of education are not only to develop engaged learning students, but also to develop engaged human beings (Scatliff & Meier, 2012). The concept of education is manipulated to be a good learning environment that can help and motivate students to aspire to something better (Brophy, 2013b). Hence, it is important to determine how to identify learning indices. Which level of learning index initiates students toward the desirable goal of education? The term learning index is necessary to become competent in this era globalization (Allan & Charles, 2015; Caruana, 2014).

Student learning concept has been analyzed in psychological research for decades (De Houwer, Barnes-Holmes, & Moors, 2013). Questions about student learning are broadly addressed in all areas of psychology, education, and other fields (Barron et al., 2015). It is defined as a change in behavior based on the adaptation of experiences that students earn during their schooling and everyday life activities. Student learning is a latent process of gathering past experience onto behavior adaptation (Lachman, 1997). This experience may fluctuate over time, meaning that as time passes the experience changes cause human behavior changes congruently to adapt themselves to the movement of globalized world. E.g. experience at time 1 influences learning behavior and learning process at subsequent times (De Houwer et al., 2013).

Student learning is a collective causal effect of experiences on behavioral development. It can be defined as the changes in human behavior of an organism that are the results of regularities in the environment of that organism. It consists of three components—change in the behavior of the organism, regularity of the organism, and causal relationships between the regularity in the environment and the changes in behavior of the organism (De Houwer et al., 2013; Lachman, 1997).

Learning has been defined as the continuous process of individual students and social development based on the experience and memory students earn during their schooling (Barron et al., 2015).

It is used, for instance, to reflect students' benefits of employability, competitive economy offers, individual and social benefits of health, happiness, and citizen empowerment (Hoskins & Mascherini, 2009; Lachman, 1997). It indicates that the objectives of learning are to reflect a holistic understanding of individual student and to combine variety of knowledge, skills, values, and attitudes that students attain (Saisana, 2008).

The Learning index of students is a valuable measurement instrument that recognizes how learning process and outcomes throughout students' lives of schooling and different stages of life across different learning environment of school, community, work and home life differ (Cappon & Laughlin, 2013). It is also defined as a long-lasting change of behavior caused by students' experiences about learning.

2.3. Factors Affecting on Learning Index

To improve student learning is the main goal of educators. However, there is concern about the number of failing students, high dropout rates, and low achievement of learning outcomes. There are many factors that influence learning index processes and learning outcomes.

Many factors have an effect on student learning processes and outcomes. Some research studies indicate that the school environment has an effect on the learning index (Guthrie et al., 2004; Korir & Kipkemboi, 2014); the classroom climate has an effect on learning index process (Sriklaub et al., 2015); teachers also have an effect on learning index (Korir & Kipkemboi, 2014); teaching affects individual measurement models of student learning directly (C. Bryson & Hand, 2007); teaching interaction causes individual student learning process to be better (Barbetta, Norona, & Bicard, 2005); peer interaction also produces individual student learning process and performance (Doll, Spies, LeClair, Kurien, & Foley, 2010); and student engagement, additionally, influences the learning index process (Corso, Bundick, Quaglia, & Haywood, 2013; Fredricks & McColskey, 2012; Skinner & Belmont, 1993); tutoring is also another factor that has a positive effect on the learning index of students (Barbetta et al., 2005).

The school environment or school characteristics are not only factors that influence on learning index and performance (Korir & Kipkemboi, 2014; Wigfield et

al., 2008), but it affects all parts and perspectives of teaching and the learning process that enables student to engage with their learning process. A strong learning process would produce high learning outcomes. In contrast, classrooms with too many students can make it more challenging for the student to attain curriculum goals, as well as make it more difficult for teachers to interact regularly with students to reach students in their learning activities (Moalosi, 2012). The typical student spends almost one fourth of their daily time outside the classroom. Hence student's out-of-classroom learning activities has a dramatic impact on their learning performance. While a student spends time with friends, they may have a negative effect on student learning (Ream & Rumberger, 2008). When students spend much of their time at school systematically with nearby environment or people, they would have a greater opportunity to interact with positive adult role models. Moreover, students have more occasions to interact with adults who share similar aspirations and can inspire students to do well in classroom learning performance (Karl A Smith, Sheri D Sheppard, David W Johnson, & Roger T Johnson, 2005).

Classroom climate is known as an important factor which can enhance the learning processes and outcomes of students. The classroom climate is known as a set of attitudes, affective responses, and perceptions related to classroom learning climate process among teacher-student and student-peer interactions (Zahn, Kagan, & Widaman, 1987). Positive classroom climate influences student academic motivation, student engagement, and student participation in the learning process and in learning outcomes (I. M. Evans, Harvey, Buckley, & Yan, 2009; Sriklaub et al., 2015).

Classroom practice activities strongly influence learning index and performance (Korir & Kipkemboi, 2014). Teachers can set up minimized learning time, set up high expectations, and provide enough time for student-teacher interaction. Teachers are also able to prepare instruction methods in response to student needs, involving students in setting their own individual learning goals, engaging students in their learning activities. These activities are manipulated by teachers to attract students to engage in daily learning performance. The teacher ability to develop a healthy learning environment is a good predictor of student learning and classroom climate (Wang & Degol, 2014). When teachers perform their sense and behavior with care and a helpful attitude toward students, students will be happier and more enthusiastic in the

classroom. Support from teachers enables student to try harder to achieve and to be more persistent with their learning activities. Thus the amount of autonomy and appropriate structure of student experience predicts their motivation and learning (Korir & Kipkemboi, 2014).

Additionally, teachers are defined as central communicators who can connect students with their related learning process and performance. The teacher is also an essential moderator in the classroom climate, teaching and learning environment, and for conducting learning processes (C. Bryson & Hand, 2007). Teaching for learning enables teachers to devote their behavioral, emotional, and cognitive effort to facilitate the process of improving learning index. The teaching and learning process facilitates students to engage with their learning (Klassen, Yerdelen, & Durksen, 2013). Additionally, teaching for learning is an essential factor that engages students with their learning process (Biggs, 1996). Teacher interaction with students enables students to feel secure, safe, and friendly with their instruction process. Good interaction between teachers and students allows students to be close with teachers. Students who stay close with teachers have been shown to have more fruitful learning processes (Chalofsky & Krishna, 2009). This is a normal teaching context that every teacher provides students during their schooling and beyond.

Teacher and student interaction are similar to the attachment bonds between children and parents in several aspects (Pianta, Hamre, & Stuhlman, 2003). Teachers and students must always care, trust, respect, and be fair to each other mutually (Doll et al., 2010). The adequacy of teacher-student interaction has a positive effect on students' behavioral outcomes (Greene, Abidin, & Kmetz, 1997). academic process, and social success (Pianta & Hamre, 2009). In the teaching process, whenever students highly value their teacher, they would pay more attention to their learning activities. Thus, both teachers and students could strengthen their interaction (Doll et al., 2010; Greene et al., 1997). In addition, teachers share interaction with students by providing warmth, caring, assistance, fairness, and responsible behavior. Students can be taught learning methods to expand and to sustain their interaction with their teachers' instruction both inside and outside the classroom (Doll et al., 2010).

Peer interactions consist of all negative and positive relationships that students have with their classmates and other acquaintances (Doll et al., 2010). Peer interactions

have been significantly correlated with student learning and academic achievement (Dodge, 1983). A strong classroom climate provides students with a then encouragement to form strong positive peer interaction that exhibits student with the opportunity to work and learn with other students cooperatively. Students and peers could have fun together in the classroom climate structures. Moreover, students retrieve techniques to identify appropriate solutions for the learning process with peers.

Student learning is another factor that may assist students to engage with their learning process. A tutor facilitates student learning process and stimulates the learning operation. It also gears towards challenging the students to clarify their own ideas, and incites students (De Grave, Boshuizen, & Schmidt, 1996; Karl A. Smith, Sheri D. Sheppard, David W. Johnson, & Roger T. Johnson, 2005). Students with tutoring process will be more active in the learning process, more sensitive to the group development process and handling interpersonal conflicts. On the other hand, to improve students to engage with their learning process is to intervene in a normal teaching context to them.

A normal teaching context is a factor in which teaching is principally focused on the content conveyed to students (Hattie, Biggs, & Purdie, 1996). To teach student to learn seems to put intervention to learning process. Intervention is classified as cognitive, metacognitive, and affective in nature, Cognitive intervention focuses on developing and enhancing specific skills, while metacognitive intervention focuses on self-management of learning, planning, implementing, and monitoring student learning efforts, and on the conditional knowledge. Moreover, affective intervention is focused on the non-cognitive context of student learning.

In sum, there are many factors affect learning index, such as teaching for learning, student engagement, teaching interaction, peer interaction, and tutoring. However, two main factors have an especially strong effect on learning index: teaching for learning and students' involvement and students' engagement in the learning process and outcomes.

2.4. Effects of Learning

Learning index is designed to measure the progress and outcomes of student learning at any point, or as an indication in a specific situation which is happening in

the community or at regional and national levels, by assessing the development of the knowledge, skills, qualifications, morality, and values throughout all stages of students' schooling life (Cappon & Laughlin, 2013). Consequently, learning affects all areas of students' lives, whether they are in schooling period or adulthood (Delors, 2013).

Learning is the goal of education, and is crucial to students' continued competitiveness and self-autonomy (Cooke & Schienstock, 2000), prosperity and social cohesion, critical thinking (Wang & Degol, 2014), and especially, the growing skills which can enable them to deal with problems or can survive accordingly with the contexts people face and process in daily life (Saisana, 2008; Wang & Degol, 2014), Learning generates inputs of learning, and the economic and social benefits of learning such as income, employability, population health, civic engagement, literacy, child development, and school readiness, society's economic and social welfare (Guerra, Modecki, & Cunningham, 2014).

Learning index is crucial to student competiveness in the 21st century. Learning is a factor that enables students to face the challenges of the marketplace, competition, and the constant renewal of the world with opportunity and risks, and new innovations(Cooke & Schienstock, 2000; Resource & Guide, 2008). Learning is also called as a shift from manufacturing to services that resulted from critical thinking, problem solving, and cognitive skills (Resource & Guide, 2008).

Students approach learning with qualitatively different motives and strategies. Sometimes, students have a fear of failure and a focus for learning by good instruction that can produce prosperity and social cohesion, and the critical thinking of students passes through the practices (Wang & Degol, 2014). Students who study a subject deeply will attribute this to the situational environment, and individual qualities that enable students to develop social cohesion, and critical thinking (Biggs, 1993, 1996). This term demonstrated that good instruction provides good habits of learning and produces good outcomes of students through social cohesion, critical thinking, and problem solving skills.

Learning index is also a primary driver of student learning commitment to identify with and internalize organizational goals and values to meet the intended goal as set in the action plan (Chalofsky & Krishna, 2009).

2.5. Measurement Model of Learning

The measurement model of learning index has been developed based on the four pillars of the lifelong learning as promoted by UNESCO and its revised version in Chinese (Delors, 1996, 2013; J. Kim, 2016). This concept is used to initiate students learning accompanied with a new environment of changes such as the way to ensure the physical and psychological well-being of students or way to understand the surrounding environment of learning (Elfert, 2015). In addition, learning index of UNESCO is to encourage students to perform with their traditions, play with pluralism, and widen their spirit and mind to the real world of work. The essence of the four pillars of learning is appropriately interpreted and transformed to the empirical practice in the teaching and learning process (J. Kim, 2016; Nan-Zhao, 2005). To break through, learning must bridge the worlds of school and work; to respect student diversity, to challenge with the stability, and to move along with social cohesion and the globalized world. The learning goal of the 21st century skill consists of four components that enable students to survive with the real world of work and to live with others peacefully and respectfully due to their plurality (Cappon & Laughlin, 2013; Delors, 1996; J. Kim, 2016).

Based on the early scope of study this concept would be proposed into two early factors— Learning to Know and Learning to Do.

Learning to Know

The concept of student learning to Know was first promoted by UNESCO in 1972, and at that time it was focused on the development of human potential. This publication recommendation is relevant to Delors' Report in 1996 and the revised version of Tawil and Cougoureux in 2013 which provided insightful learning processes and outcomes which students should obtain both during and their formal education.

Learning to Know is often considered as the conventional process of gaining knowledge by acquiring itemized information or factual knowledge and skills in the route of learning toward the world of work, market requirements, and 21st century skills (Darling-Hammond, 2008; Delors, 1996; Trilling & Fadel, 2009). Acquiring new knowledge is a continuous process of gaining knowledge that can be expanded broadly by all forms of experiences that people are able to earn during their school and daily life activities (J. Kim, 2016; Pianta & Hamre, 2009). Learning to Know involves the

development of the human spirit and mind, such as imagination, reasoning, problem-solving, and the ability to think in a coherent and critical way (Darling-Hammond, 2008). Generally, Learning to Know presupposes student learning to learn continuity (Opfer & Pedder, 2011). It benefits from many processes and performances, especially from ongoing educational opportunities throughout life (Breen & Jonsson, 2005). It is the most essential factor for students' continuous learning. Hence, Learning to Know is stated as both means and ends in learning itself and in the lifetime decay of learning (Brophy, 2013b). It serves individual students to understand almost every phenomenon in the empirical world such as about nature, humankind and its history, environment, society, and global citizenship of students (Allan & Charles, 2015; Hartman, 2015a; Nan-Zhao, 2005).

Learning to Do

Learning to Do is considered as the vocational skills students obtained during school life. Learning to Do emphasizes experiences and skills necessary for students to earn a job or trade. Existing experiences and skills enable students to interact with the world of work and find out new practices of professions or trades as they wish. This term initiates and directs students to develop their abilities to adapt with a variety of future situations, global lives, and market demands (Delors, 1996, 2013).

Accordingly, the four pillars of learning are to implement what students learnt into practice with the real world of work. It is closely linked to vocational-technical education and work skills training (Nan-Zhao, 2005). Learning to Do is widely accepted in bringing knowledge into economic or professional applications. It encompasses new skills, as well as a more behavioral and intellectual mind (Hattie et al., 1996). Learning to Do is defined as the transformation of skills into competence, or a mix of higher-order skills specific to each individual workforce. Therefore, Learning to Do is defined as the ability to communicate effectively between knowledge and application (De Houwer et al., 2013). Additionally, it can be communicated between students from one to another, such as aptitude toward teamwork, social skills in building meaningful interpersonal relations, adaptability to change in the world of work and in social life, competence in transforming knowledge into innovation and job-creation, and readiness to challenge with risks and problems or conflicts (Barbetta et al., 2005).

Learning to Live together

Learning to live together is, the third pillar of education, considered as achievement of the development an understanding of others and their history, tradition and spiritual values (Delors, 1996, 2013). It implies that the teacher should help the students to develop an understanding of other students and appreciation of interdependence since students live in a closely connected world (Zullig et al., 2015). Learning to live together is to enhance students to handle with emotion, to retrieve the skills for self-control, to allow students to communicate, to help students interpret other behavior, to help students generate critical thinking, to help student build the relationship and cooperation, to help students to negotiate, and help students to do problem solving and decision making (Tawil & Cougoureux, 2013).

In the context of increasing globalization, Delors (1996) placed a special emphasis on this pillar of learning. It implies an education taking into discovery of others and on another, experience of shared purposes throughout life (Tawil & Cougoureux, 2013; Van Petegem, Creemers, Rossel, & Aelterman, 2005).

The empathy and cooperative social behavior in caring and sharing such as respect of other people and their cultures and value systems, capability of encountering others and resolving conflicts through dialogue, and competency in working towards common objectives (Barron et al., 2015; Nan-Zhao, 2005).

Learning to Be

It is considered as the central theme of future report which emphasized on development of human potential with responsibility to society and global world. It needs to be strengthen with a strict exercise toward independence and personal responsibility (Tawil & Cougoureux, 2013).

The concept of “Learning to Be” was reported by UNESCO in 1972. Learning to be is to demonstrate that all people are out of the fear they used to face in the past. This concept was based on the principle that human development is to fulfill a person in many traits such as fulfill richness of personality, fulfill the complexity of human expression, and fulfill various commitments that a man should perform in their daily lives (Nan-Zhao, 2005; Tomlinson, 2014; Wang & Degol, 2014). Hence, learning to be is interpreted as learning process and learning practice that promote a man to be human, throughout the process of acquiring of knowledge, skills, and value conductive to

personality development in its intellectual, moral, cultural, and physical dimensions (Tawil & Cougoureux, 2013).

It is important to note that the four pillars of learning relate to all phases, development and areas of education. They support and fulfill one another and should therefore be applied as basic principles, cross-cutting themes and generic competences for integration in and across subject areas or learning domains (Delors, 1996, 2013). The four pillars of education of this measurement model were believed to appear as laddering path, meaning that Leaning to Know is the basis for Learning to Do, Learning to Do is the basis for Learning to Live together, and Learning to Live together is the basis for Learning to Be. Students with Learning to Be pillar is the fulfillment of a man (Delors, 2013; Tawil & Cougoureux, 2013).

On the other hand, the 4 pillars of education factors consist of two components including process of and outcome of. It is also believed that "process of learning to…" appear beforehand then following by "outcome of learning to…", but this research study would like to measure only the first two pillars of learning.

The early first two pillars of education proposed by Delors (1996) were selected in this study based on the sample group of students. The samples of this study were high school students. Therefore, it is belief that students at this age are under their parents' or guardians' control, thus, the Learning to Live together and Learning to Be were not possible to achieve the last two pillars of education. On the other hand, it is confirmed that if students could fulfill the first two pillars of education they easily could reach the next two pillars of education which proposed by UNESCO (1996). Hence, the measurement model of student learning was presented in the Figure 2.1.

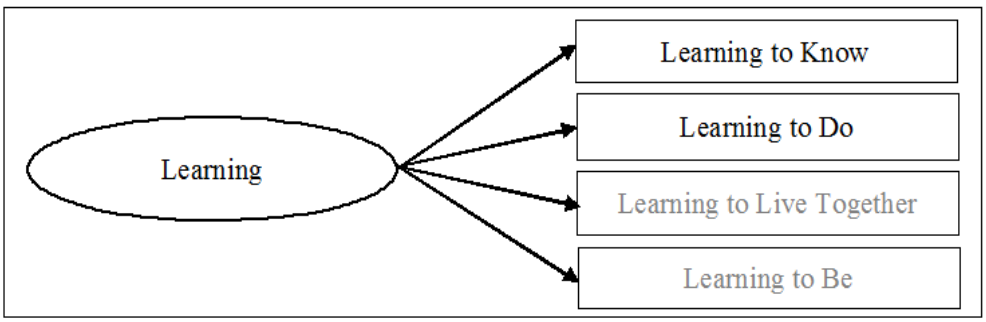

Figure 2.1: Measurement Model of Student Learning

As previous mentioned, it was believed that Learning to Know is the basic for Learning to Do. Learning to Do, in this sense, is not only to do with the subjects they enroll, but also to do with learning facilities, and to do with some basis life skills as intended in the learning goal. Hence, this research study was conducted within 2 levels including macro-and micro-level studies. The macro-level study was conducted to survey student learning index of Cambodian students across the country. But the micro-level study was conducted at Kampong Chhueteal High School.

2.6. Cambodian Education System (Macro-Level Study)

With many obstacles Cambodia needs to overcome in order to provide quality of education for all (Ministry of Education Youth and Sport, 2015a). Thus, Ministry of Education Youth and Sport of Cambodia has launch many strategies to enhance student learning such as ICT skills, lifelong learning, non-formal education, accordingly, four pillars of education proposed by UNESCO was also put into practice in Cambodian educational system (Ministry of Education Youth and Sport, 2004).

Ministry of Education Youth and Sport of Cambodia has also endorsed four pillars of education of UNESCO in educational policy that was also launched in educational practices (Ministry of Education Youth and Sport, 2015b). Thus, the concept of four pillars of education seems harmony with Cambodian education policy in which enable students to learning full of their competency. Thus, macro-level study to survey student learning was conducted.

Macro-level study of this research was conducted to survey with high school student learning across Cambodia. Thus, the characteristic of Cambodian educational systems was presented.

1. Educational Background

Traditional education in Cambodia was processed by the local wat (pagoda), and the bonzes were the teachers. The students were almost entirely boys, and the education was limited to memorizing Buddhist chants in Pali. During the period of the French protectorate, an educational system based on the French model was inaugurated alongside the traditional system (Royal Government of Cambodia, 2015).

From the early twentieth century until 1975, the system of mass education operated on the French model. The educational system was divided into two kinds including primary, secondary, higher, and specialized technical and vocational education (Seng, 2009; Sothy, Madhur, & Rethy, 2015). Primary education, divided into two cycles of three years each, was carried out in state-run and pagoda-run schools. Successful completion of a final state examination led to the award of a certificate after each cycle. French language instruction began in the second year of lower secondary school. Khmer was the language of instruction in the first cycle, but French was used in the second cycle and thereafter (Forsberg & Ratcliffe, 2003).

During Pol Pot's communist regime (1975-1979), there were no schools or any forms of education. All schools and universities were then closed and allowed to fall into disrepair. School buildings were often put to other uses such as storehouse for grain and livestock or as prisons (Seng, 2009).

The 1990s saw a period of emergency relief and reconstruction, with heavy dependence on external assistance from donor agencies and nongovernment organizations (NGOs). Recognizing the need for improved coordination of external assistance, the government approved an education investment plan 1995-2000 (Forsberg & Ratcliffe, 2003).

Primary school ran from the first to the sixth grade. Theoretically one primary school served each village. Secondary education also was divided into two cycles, three of six years taught at a lower secondary school, followed by three of six years taught at upper secondary high school. Upon completion of the first cycle, students could pursue upper secondary high school or vocational education (Sothy et al., 2015). Upon last year completion of the second cycle, students could take a state examination for the first baccalaureate, and, after their third year of the second cycle, they could take a similar examination for the second baccalaureate or university (Ministry of Education Youth and Sport, 2005).

Cambodian education system changed three times-After 1979, first time changed was a10-year education system (primary school 4 years, secondary school 3 years, high school 3 years) or (4+3+3) and in 1986 it, second change, was expanded to 11 years (5+3+3) and the last changed in 1996 12 years (6+3+3). In this last system,

pupils need to take final national test only in grade 12 in order to earn their university credit (Seng, 2009; Sothy et al., 2015).

2. School Jurisdiction

Education jurisdiction in Cambodia was divided into two groups—public and private school jurisdiction.

2.1 Public School

From the early twentieth century until 1975, the system of mass education run by French model. The educational system was categorized into primary, secondary, higher, and specialized levels (Seng, 2009). Public education was under the jurisdiction of the Ministry of Education, which exercised full control over the entire system; it established syllabi, hired and paid teachers, provided supplies, and inspected schools. An inspector of primary education, who had considerable authority, was assigned to each province. Cultural committees under the Ministry of Education were responsible for "enriching the Cambodian language" (Ministry of Education Youth and Sport, 2005). The education system was conducted within 12 years (called general education).

2.2 Private School

For a portion of the urban population in Cambodia, private education was important in the years before the communist takeover. Some private schools were operated by ethnic or religious minorities—Chinese, Vietnamese, European, Roman Catholic, and Muslim—so that children could study their own language, culture, or religion (Farnen & Meloen, 2000). Other schools provided education to indigenous children who could not gain admission to a public school. Attendance at some of the private schools, especially those in Phnom Penh, conferred a certain amount of prestige on the student and on the student's family (Seng, 2009). Usually, to study in private school students need to pay much more than the public ones. Accordingly, private school mostly located in town and capital.

In sum, the school system today has pre-school for children aged three to five (but this kind of school is available only in some areas), Primary education in grades one to six, and Lower Secondary education from grades six to nine. After grade nine was credited, students could enroll intended upper secondary (grades ten to twelve). After grade twelve, student should pass the national test to credit for university.

Previously there was then a separate entrance exam for the university level, but now the exams already sat are studied for highest scores in certain topical areas to decide which students will be allowed to continue to university.

2.7. Kampong Chheuteal High School Education (Micro-Level Study)

Kampong Chhueteal high school is the first school in Cambodia which provides students dual systems of learning including general and vocational education. It is a relative high school in terms of learning resources and facility. Consequently, the four pillars of education of UNESCO to teach students to survive with the 21th century skills in which requires Learning to Know and Learning to Do what they know respectively. Thus, Kampong Chueteal High School is the most appropriate high school for this case study at micro-level study.

Kampong Chheuteal High School was situated in Sambor village, Prasat Sambor District, Province of Kampong Thom, the Kingdom of Cambodia. The Thai-Cambodian Joint Commission appointed as the Joint Ad Hoc Working Group had undertaken the mission by following Her Royal Highness Princess Maha Chakri Sirindhorn's concepts for the operation of the school as the ultimate goal. Her Royal Highness Princess Maha Chakri Sirindhorn visited the Kingdom of Cambodia several times to study its archeology and history because she acknowledged the country as a learning resource to the civilized world.

To come away each time, people of this country would be waiting to greet their majesties with courtesy. Therefore, Her Royal Highness Princess returned the friendly hospitality of the Cambodians. In recognition to the kind hospitality of its people, Her Royal Highness Princess thought that giving other presents would only benefit Cambodians temporarily but not be sustainable as the provision of education which was the source of knowledge. The gained knowledge would be increased two times. Both teachers and students would apply their knowledge to help develop the Kingdom of Cambodia to progress further.

Kampong Chheuteal High School was built under her Royal Highness Maha Chakri Sirindhorn’s concept and donation on the 17 of May 2000 and the Cambodian government was responsible for providing the site for the school, assisting, supporting and coordinating for the constructional techniques (Kampong Chheuteal High School,

2005). Moreover, Her Royal Highness Maha Chakri Sirindhorn has given her expertise in the educational performance management. Her Royal Highness Princess believes that education was very important and it could help develop societies and consequently the world. Her concept was that…

"...Education provides the opportunity to choose, the opportunity to choose peace. Without the job skills necessary to secure a reasonable quality of life for them and their dependences, refugees face hard time and are forced into circumstances that might cause trouble for others..." (Her Royal Highness's speech in the meeting of UNESCO Geneva, B.E. 2545).

Her Royal Highness Princess's speech at the meeting of Thai and Cambodian committee in Soun Chelda Palace, in B.E. 2548 was "I am satisfied that Kampong Chheuteal High School has processed its work for a segment. Both Thai and Cambodian committee have performed their tasks which have been satisfied. I want to participate in educating Cambodian youth who have good potential. If they are good educated and trained, they will be useful for themselves, for Cambodian and global society continuity". Her Royal Highness Maha Chakri Sirindhon expected from those learners of Kampong Chheuteal High School that

1. Learners have academic knowledge which is capable to apply that of knowledge to set up business or to be able to perform other works and to be able to continue to study.
2. Learners have good ethics, honesty, and to be ready to help other people.
3. Learners have good physical health; they are able to perform other learning and works perfectly.
4. Learners are able to manage organization effectively, especially; they should come to help to drive Kampong Chheuteal High School continuity. They should not give this school up. Her Royal Highness Princess Maha Chakri Sirindhorn expected that these youths will have good opinions and vision to develop this duty to be fruitfully which benefits to everyday life and to develop Cambodia continuity.

Today, Kampong Chheuteal High School is ready for personnel, buildings, books, media, educational curriculum and system infrastructures which can manage teaching-learning process and other activities in various formats which focus on

practices that make professionals increase their incomes and develop the community and society (The Princess' school board, B.E. 2548).

2.8. Development of Index

In the process of assessing educational quality and the educational process, the indicator is the most appropriate instrument that the assessor aims to use. Indicators are designed to simplify information for educators and stakeholders, not to overwhelm them but also to provide them enough information about teaching and learning that enable them to improve and enhance their work based on the evidence they get from indicators and other supported data. Although indicators are widely used, the concepts of indicator development are still the subject of controversy (Cherchye, Moesen, Rogge, & Van Puyenbroeck, 2007). There are many issues that are considered widely to cause credibility such as standard construction methodology and inescapable subjectivity involved in indicator construction.

This review is to identify the meaning of indicators, the process to develop indicators, and the usefulness of educational indicators. There is no completely accurate and completed definition of indicators and indicator development, but this section aims to define the key functions of indicator development and the key function that indicators can provide in educational systems. Additionally, the review will outline the way to develop indicators and select credible indicators that are appropriate for this study's needs in order to develop quality items and indicators.

2.7.1 Statement of the Purpose

In the process of indicator development, researchers may clearly identify and demonstrate the objectives of indicator development, and identify usefulness and applications of the indicators in context-specific needs.

2.7.2 Definition

Numerous definitions of indicators have been proposed by academicians. Thus, there is no universally accepted definition of indicator. Hence, some definitions and development process will be presented.

Chalmers (2008). Indicators are defined as those associated with the measurement of quantity or amount, and are expressed as numerical values; something to which meaning or value is given by assigning it a number.

Bryk and Hermanson (1993). Indicator is a statistic, reporting on a set of something (units measured), that provide detail information about the valued condition of the educational system.

Shavelson (1991). Indicators are defined as statistical tools used to monitor complex conditions that we would probably judge imprecisely or miss altogether in day-to-day observations.

Index defined as a variable or composite variables employed to represent in quantitative form changes in a trait. Index provides only quantitative values, thus, it is in interval scale between two numbers.

In summary, indicator means the factors or variable which display the quantitative characteristics or volume of the system process in a period of time whether the operational factor reaches the ultimate goal. An indicator is not permanent. It fluctuates depending on the time, situation, place or context used.

2.7.3 Development of Indicators

Four steps are provided to develop indicators for a learning index. They are: defining the indicator scope, choosing the indicators, Piloting the indicators, and communicating the findings.

1. Define the Indicator Scope

It is important for someone to scope indicators for the specific context and usefulness utilized. The nature that indicator produces depending on the effect indictor scope that it was framed at planning stage (Bravo, 2014). A framework of organizing indicators should be determined and criteria for selecting indicators should be set in response to users' needs and the utilized context (Chalmers, 2008; Hoskins & Mascherini, 2009).

Defining the indicator scope will promote clarity in terms of:

- Addressing the needs of the target group of using indictors and the context in which it will be employed.
- Allowing the project to stay focused on indicator development and validation.
- Promoting the project about indicator development because it is an empirical tool that can prove working performance and quality.

- Communicating the results of indicator development to stakeholders.

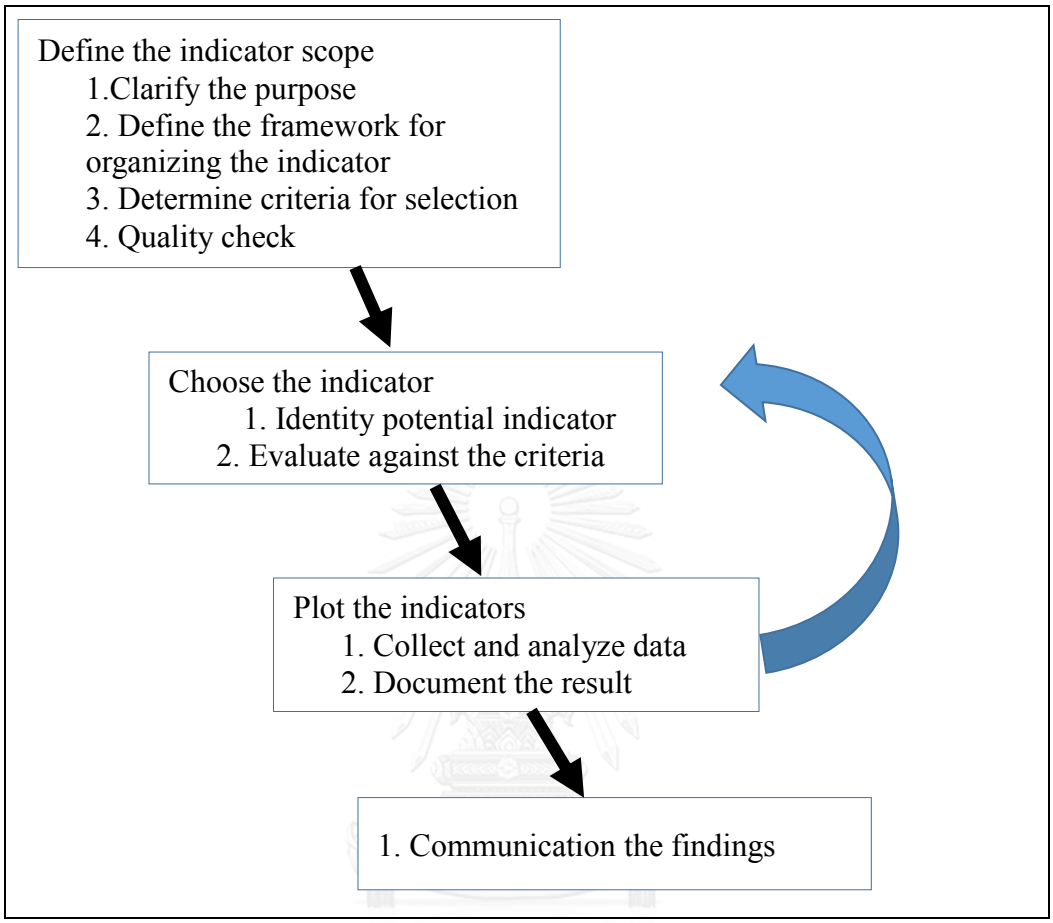

Figure 2.2: Indicator Development Process

(1) **Clarifying the Purpose**

Multiple purposes of indicator development are defined based on the needs and progress in terms of goals and outcomes of using that of indicators such as for whom the development of indicators is for and why. (Nardo & Saisana, 2008; Nardo, Saisana, Saltelli, & Tarantola, 2005).

For example, to develop indicators for assessing community accountability in terms of working and helping others process is a measurement tool that can provide detailed information for utilizers to improve their work and provide help to others (Bravo, 2014; Chalmers, 2008).

(2) Define Framework for Organizing the Indicators

An indicator framework should be provided with means to organize and assess the indicators compared to goals or criteria set from the beginning of the work (Giovannini et al., 2008; Nardo & Saisana, 2008; Ravallion, 2012). It should be understandable and relevant to users in terms of working and evaluating the work. The framework should provide enough benefits for the conductor and assessor of the work that they perform during a specific time interval (Bravo, 2014; Park et al., 2008).

(3) Determine Criteria for Selecting Indicators

A good criterion for selecting quality indicator needs to fulfill the potential property of indicators for the final selection of newly developed indicators. A strategic indicator is likely to move forward from classic to modern indicator development that it is harmonizing with the educational process, educational outcomes, and economic growth, and reflects better sustainability for permanent working systems of itself (Nonglack, B.E. 2002; Park et al., 2008; Zhou & Ang, 2009).

(4) Quality Check

It occurs when research is checked for reliability, validity, feasibility, utility, appropriateness, and credibility of indicators (Nardo & Saisana, 2008). Indicator quality check is a method of defining criteria by using central tendency obtained from a persisting population with empirical data or from 50% of standardized population's score (Tarantola, Nardo, Saisana, & Gatelli, 2006). Moreover, Johnstone (1981) stated that good quality indicator characteristics should consist of 4 properties: 1.) Up-to-date indicators are essential to the time and context used. 2.) Valid to goal utilization. 3.) High levels of validity, reliability, objectivity, and applicability. 4.) Measurement criteria of indicator should not provide any bias (Ciegis, Ramanauskiene, & Startiene, 2015), and reflect better sustainable development and improvement (Bravo, 2014; Vidoli, Fusco, & Mazziotta, 2015).

2. Choosing the Indicators

Potential indicators are chosen based on the criterion goal set. This criterion helps researchers move from old fashion to the modern indicators. On the other hand, Indicators will show with economic growth—one to one another that reflects better sustainable development and improvement (Bravo, 2014).

(1) Identify Potential Indicators

To choose high quality, appropriate indicators in the context of education, indicators should be considered in the relation to the following criteria (Chalmers, 2008; Diamantopoulos & Winklhofer, 2001; M Nardo et al., 2005):

- The desired outcomes in which a researcher would like to measure by using this kind of indicators and criteria.
- A target: what is the direction for education? What is the ultimate goal for the education system by using indicators?
- Standard: is there an industry standard for choosing indicators?
- Baseline: can a trend be determined from a starting point of the indicator?

Potential indicators used to measure some specific item and context need to provide both qualitative and quantitative measures (Chalmers, 2008; M Nardo et al., 2005). Qualitative measures of indicators are used to focus on the physical structure and forms which aim to measure those items while quantitative measures focus on community spirit, values and motivation (Manthalu, Nkhoma, & Kuyeli, 2010). Quantitative measures of indicators are more tentative to be used whether it is possible with the measurement context (Diamantopoulos & Winklhofer, 2001). However, qualitative measures should not be underestimated in terms of pointing to emerging concerns and changing priorities in the context to be measured based on the theoretical framework (Ciegis et al., 2015; Park et al., 2008; Shen, Hermans, Brijs, & Wets, 2013).

(2) Evaluating Against Criteria

To evaluate the indicators involves an assessment of the selected indicators against the criteria that is set by nine criteria of strategic indicator criteria (Park et al., 2008). The evaluation processes may be based on the criteria or characteristics that are presented or absent or sometimes it may place values against criteria (Sébastien & Bauler, 2013). The importance of indicator criteria is also considered to need to be addressed as the following concept (Bravo, 2014; M Nardo et al., 2005; Park et al., 2008). Indicator need to be:

- Representative for the criteria intended for measurement model.

- Sustainable for utilization in every context with both qualitative and quantitative measures.
- Understandable for all stakeholders in using indicators to develop quality work processes that they are responsible for.
- Relevant to the goal of measuring context intended.
- Measurable values that indicate true values that stakeholders need to know.
- Assessable with the criteria set as the ultimate goal of the working process.
- Timely for data collection, empirical and emergency utilization.
- Responsive to the desirable outcomes and context intended to measure.
- Compatible with data collection process and analysis process.

An indicator will probably not address all the criteria that make up a strategic indicator. The evaluation process and criteria will identify indicators with the best match, the strengths and the weaknesses that need to be demonstrated when interpreting data obtained from indicators (Ciegis et al., 2015; Diamantopoulos & Winklhofer, 2001). To set the criteria for evaluating indicators, expertise is necessary—technical and specialist knowledge that can guide issues related to the feasibility of the indicators (Cherchye et al., 2007; Nardo & Saisana, 2008). Moreover, balanced judgments are a criterion for the evaluation of indicators based on value and supported empirical evidence that the indicator is measuring and what it is intended to measure.

3. Piloting the Indicators

To pilot indicators is to test indicator properties in terms of practice to find out the quality of indicator, feasibility and appropriate utilization (Giambona & Vassallo, 2014). This process enables researchers to check and follow up the indicators' usefulness and feasibility within the specified context. The pilot process involves many steps, such as locating and analyzing the data to support indicator development and feasibility of use (Diamantopoulos & Winklhofer, 2001). Additionally, to conduct a pilot study means to allow researchers to find out the appropriateness and sensitivity of indicators while they are used in different contexts and time intervals, such as empirical data sources (Bravo, 2014; Luzzati & Gucciardi, 2015).

(1) Collecting and Analyzing Data Sources

Data sources obtained should be used to support indicator development and utility. This may refer to existing sources from previous studies. Data were collected by regulatory authorities that all related agencies approved voluntarily (Ciegis et al., 2015). On the other hand, data collection of indicators should be held by private sectors, such as utility institution, contractors and primary based organization of indicator developers (Luzzati & Gucciardi, 2015). The criteria evaluation group should be validated in a common way that relevant agencies and groups are likely to approve of (Shavelson, 1991). On the other hand, criteria used to judge indicators should be standard (Nardo & Saisana, 2008; M Nardo et al., 2005).

The data collected is based on the area and context specific to the studies, thus to interpret the data researchers should be aware of specific data of the specific context, which sometimes cannot be generalized to other indicator contexts (Bravo, 2014; Hoskins & Mascherini, 2009; Shavelson, 1991). Data needs to be restricted collected and investigated as commercial-in-confidence and for the protection of privacy for the safety of respondents (Tule, Ajilore, & Ebuh, 2016).

(2) Documenting the Results

The data collection process and interpretation of indicators assists users in understanding the effectiveness of working and direction of that work in which indicators drive that work goal forward (Al Shami, Lotfi, & Coleman, 2013; Bravo, 2014). Therefore, indicators should be documented in terms of characteristics, underpinning measures and recommendations regarding use and further development such as indicator title, measure, rationale, target, frequency, scale and format, source, shortcoming, and recommendation for further study (Diamantopoulos & Winklhofer, 2001; Luzzati & Gucciardi, 2015; Shavelson, 1991).

4. Communicating the Findings

To communicate indicator results is very important for initiating awareness and enhancing action that responds to the needs of quality assurance or a working process. The way to communicate indicators is the way to engage developers with the use of indicators (Floridi, Pagni, Falorni, & Luzzati, 2011). This will enable users to understand the process of using indicators to promote their working process (Chalmers,

2008; Shavelson, 1991). There are many ways—including report cards, summary reports, and technical reports, to communicate between indicator developer with the users that enable them to work collaboratively and effectively (Floridi et al., 2011; Giovannini et al., 2008). (Floridi et al., 2011; Giovannini et al., 2008). Another facilitator that can assist with the communication of indicators is the Internet, which offers a way of accessing reports and communicating progress toward mean goals and targets (Otoiu, Titan, & Dumitrescu, 2014; Saltelli, 2007).

2.7.4 Index Calculation

There are two concepts that can be used to assess indices—norm criteria and known group criteria. Norm criteria are applied with percentile scoring of each sub-index (Chalmers, 2008; Shaker & Zubalsky, 2015). Cut points of the value of index are based on researchers' judgment. Additionally, known-group criteria are employed to analyze data based on the index researchers' measurements (Park et al., 2008). Then, index value will be classified into groups such as index of low level group, index of moderate group, and index of high level group (Bravo, 2014; Marungruang, Wongwanich, & Tangdhanakanond, 2014; M Nardo et al., 2005).

$$Index = \frac{Value - min}{Max - min}$$

2.7.5 Usefulness of Educational Index

The usefulness of educational indicators were considered within 6 dimensions including in the following.

- Identify accurate policy and goal of education, additionally, ease to control.
- Conduct and assess educational systems by comparing different time studied of data collection. This state means to control variation comparing to set criteria whether it can reach the desired goal.
- Order and separate educational system types sensationalized to each country or each region based on that of country or region development or criteria.
- Provide educational system research development, even though it cannot provide causal student learning relationships.

- Be responsible to position and quality assessment. Educational indicator implication is used to assess direct outputs based on composite output criteria and administration type, and performance.
- Identify intended goals following multiple steps in which it is used to better reach hierarchical desired goals as planned.

2.8 Conceptual Framework of Student Learning

As previously mentioned, the student learning which is studied in this research study will be extracted from the four pillars of education as proposed by UNESCO. The first two of the four pillars was considered. Thus, the conceptual framework of student learning would be outlined as the following.

The student learning was studied within two main components— Learning to Know and Learning to Do. The two main components consist of two components each. Thus, student learning was measured by two main components and four sub-components as shown in Figure 2.3.

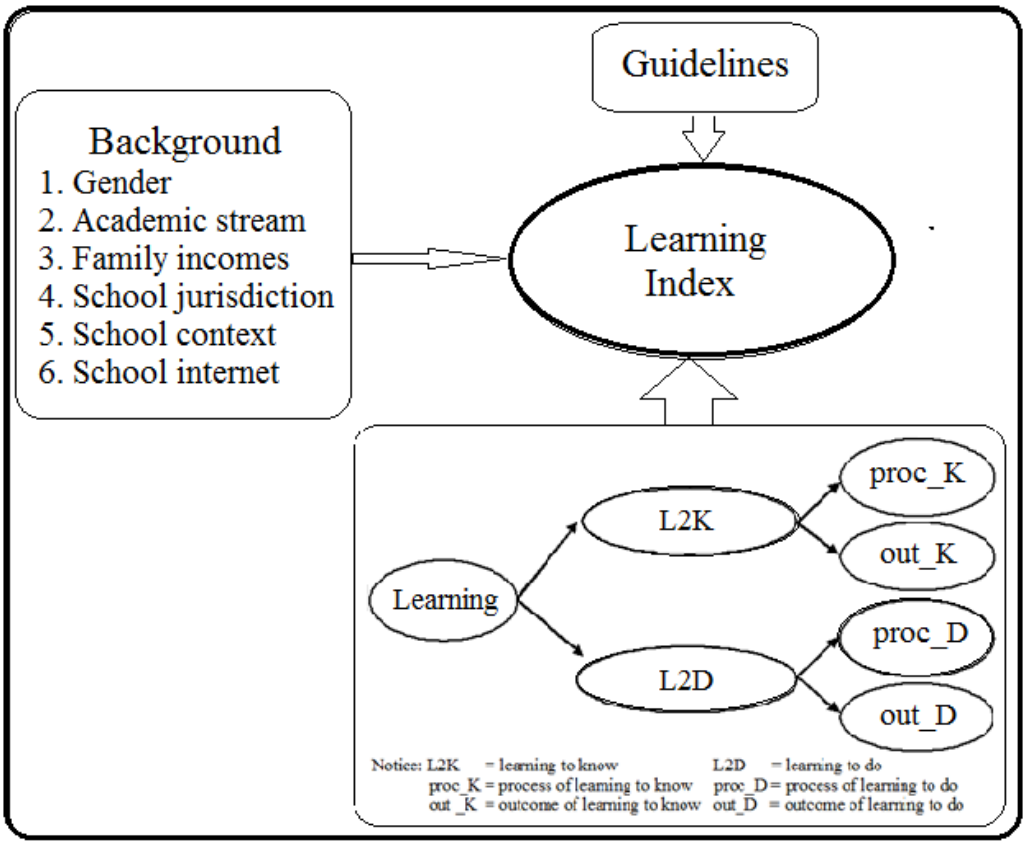

Figure 2.3: Conceptual Framework of Student Learning

Chapter 3
Research Procedure

Macro- and Micro-level studies of the research study would be conducted within three phases. At the Macro-level study the research was conducted to answer the research objective one and objective two. Micro-level study was to response objective three.

The first phase was to develop a measurement model of student learning and determine the learning index. This research was intended to develop measurement model of student learning and determine the learning index of students, to analyze learning index of Cambodian students and explain the learning index profiles with the selected school background, and to develop guidelines for enhancing student learning index. In the development of measurement model of student learning, psychometric properties of measurement model were tested in terms of content validity, objectivity, uncertainty, construct validity, reliability and criterion-related validity.

The second phase was to analysis learning index of Cambodian students and explain the learning index profiles with the selected school background.

The last phase was to develop guidelines for enhancing student learning index with high school students of Kampong Chhueteal.

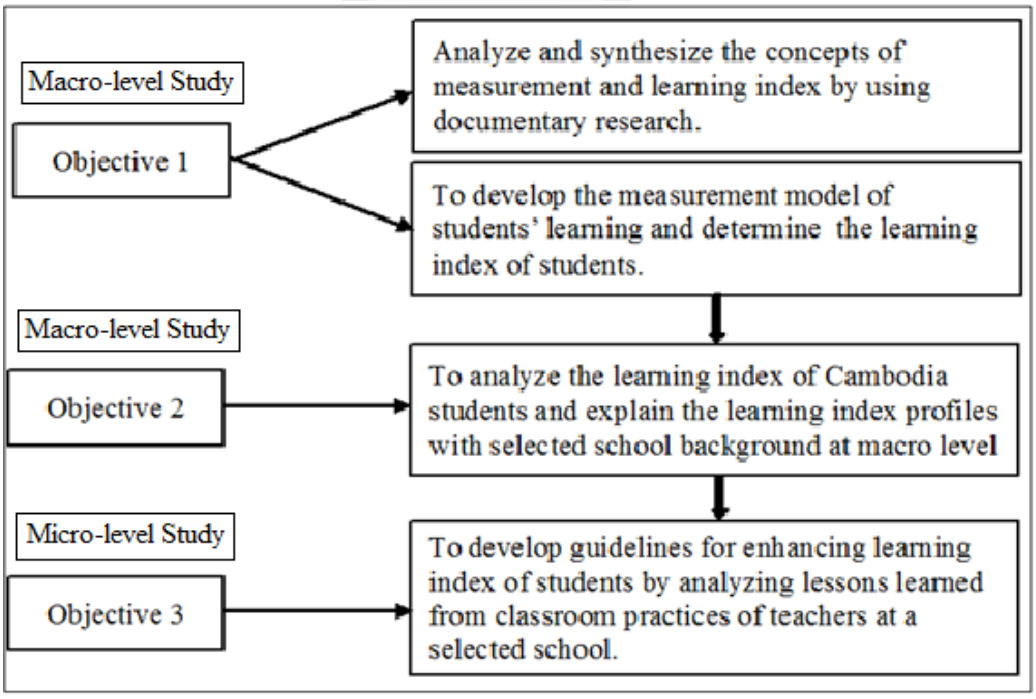

Figure 3.1: Research Procedure

Phase I: Development of Measurement Model of Student Learning (Macro-Level Study)

This study was to develop an instrument to measure the measurement model of student learning and determine the learning index of Cambodian high school students.

In this phase, the research was conducted in 2 steps—the first one was to develop the component of student learning and the instrument to measure student learning. The second step was to validate the psychometric properties of the instrument.

1.1. Components of Learning

The measurement model of student learning was developed by synthesizing related documentary and research. Afterward, the developed components were examined for their psychometric properties.

Components of the measurement model of student learning were obtained from related documentation and research by synthesis. The main documentation was obtained from the proposal of Delors (1996), talking about the four pillars of education, as well as Tawil and Cougourux (2013), talking about revisiting the four pillars of education. Additionally, the Canadian Council on Learning's (CCL, 2010) Canadian Composite Learning Index, the European Union's (ELLI, 2013) work on the European Lifelong Learning Index and the Global Learning Index (GLI) by J. Kim (2016) were key points of reference. The indicators and measures of these studies were used to measure fundamental knowledge to develop the components of student learning.

The synthesis of related documentation and research resulted in a measurement model of student learning composed of two main components- Learning to Know (L2K) and Learning to Do (L2D). Each of these consists of two major factors: process of learning and outcomes of learning. Thus, the composite learning of students includes the L2K process, L2K outcomes, L2D process, and L2D outcomes. In total, there are 4 sub-components for learning measurements.

Under each sub-factor, there are 3 indicators. As for the two sub-components of L2K, the indicators are the process and outcomes of learning desire, process of learning engagement, and process of learning to learn. For the two sub-components of L2D, the indicators are the process and outcomes of "the concern of learning as the real world of

work", practical engagement, and continuing self-development. In sum, there were 12 indicators for measuring student learning as shown in figure 3.2.

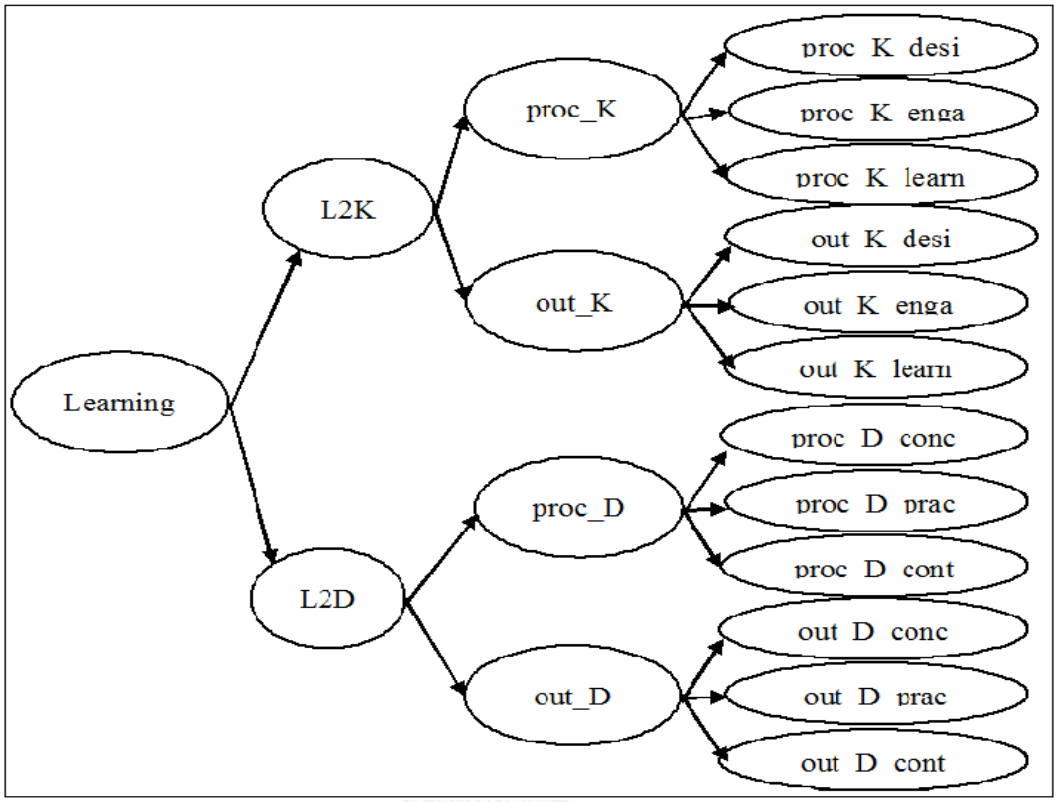

Figure 3.2: Measurement Model of Student Learning

Notice: L2K = Learning to Know
proc_K_desi = process of learning desire
proc_K_enga = process of learning engagement
proc_K_learn = process of learning to learn
out_K_desi = outcome of learning desire
out_K_enga = outcome of learning engagement
out_K_learn = outcome of learning to learn

L2D = Learning to Do
proc_D_conc = process of concern learning as the real world of work
proc_D_prac = process of practical engagement
proc_D_cont = process of continuing self-development
out_D_conc = outcome of concern learning as the real world of work
out_D_prac = outcome of practical engagement
out_D_cont = outcome of continuing self-development

1.2. Operational Definition of Student Learning

To develop a student's learning measurement instrument, the concept of four pillars of education reported by UNESCO (1996), Canadian Lifelong Learning Index (CLI), European Lifelong Learning Index (ELLI), and Global Lifelong Learning Index

(J. Kim, 2016) were implemented as the main concepts for drafting the instrument of student learning items. Beside the reports of the four sources, other related documentation and research were also reviewed and synthesized to help clarify the concepts of student learning (Delors, 2013; J. Kim, 2016).

Table 3.1: Operational Definition of Student Learning

Component	Factor	Indicators	
1. Learning to Know consists of learning process of Learning to Know and outcomes of Learning to Know	1. proc_K	1.proc_K_desi	• Learning desire is defined as motivation to reach a better and permanent future goal.
		2.proc_K_enga	• Learning engagement refers to a "student's willingness, need, and compulsion to participate in, and be successful in the learning.
		3.proc_K_learn	• Learning to learn is defined as the ability to pursue and persist in learning, to organize one's own learning, including through effective management of time and information, both individually and in groups.
	2. out_K	4.out_K_desi	• Outcome of learning desire is defined as knowledge necessary for students to achieve the learning goals.
		5.out_K_enga	• Outcome of learning engagement is defined as learning satisfaction, learning responsibility, learning application, and learning in extra-curriculum.
		6.out_K_learn	• Outcome of learning to learn is defined as learning how to learn with memorization, note taking, reading comprehension, calculation skills, ICT skills, strength and weakness analysis, and producing satisfaction learning results.
2. Learning to Do consists of learning process of Learning to Do and outcomes of Learning to Do	3. proc_D	7.proc_D_conc	• Concern learning as the real world of work is defined as the emotion of knowledge and skill practice leading to skillful manner.
		8.proc_D_prac	• Practical engagement is defined as using knowledge and skills to interact with the world of work.

Component	Factor	Indicators	
		9.proc_D_cont	• Continuing self-development is defined as the rapid development of professional knowledge and skill.
	4. out_D	10.out_D_conc	• Outcome of concern of learning as the real world is defined as practical knowledge necessary for students to achieve the learning goals.
		11.out_D_prac	• Outcome of practical engagement is defined as working preparation/planning, systematic working, responsible working, and learning enquiry.
		12. out_D_cont	• Outcome of continuing self-development is defined as qualified and timeframe working, usable working, widening working application, and creative/innovative working.

Hence, an operational definition of each factor of student learning was adopted in order to develop the measurement instrument of student learning indicators that is suitable for measuring the components as intended, based on the operational definition. It is detailed in the following processes.

1.3. Measurement Instrument Development

A questionnaire was developed to measurement student learning. The questionnaire is comprised of two main parts. The first part of the questionnaire intended to collect seven respondents' background information. The seven background items of respondents consisted of gender, academic stream (social science or sciences), school location, school context, school computer, school internet, and students' monthly family incomes.

The second part of the questionnaire intended to have students express their point of view on student learning themselves. The second part of the questionnaire consists of 56 items with a 5-point Likert Scale. (1= 0-20% agree, 2= 21-40% agree, 3= 41-60% agree, 4= 61-80% agree, 5= 81-100% agree).

1.4. Testing of Psychometric Properties of Student Learning

This research identified 6 types of Psychometric Properties of Student learning to be tested: content validity, objectivity, uncertainty, construct validity, reliability, and criterion-related validity. Data analyses for each of the psychometric properties were performed as follows:

1.4.1. Content Validity

Content validity of the measurement model of student learning was validated. This phase was conducted with two step. The first step was expert selection. Experts were chosen by the criteria of experience in educational measurement and evaluation of more than 5 years, experienced in educational research and instrument development of more than 5 years, and experience in the content intended to measure—four pillars of education, lifelong learning, sustainable development in education, and educational management. The second step was to adjust item content based on expert recommendations and calculate the item objective congruence (IOC) of each item. Accordingly, some criteria were also considered to retain or exclude items based on experts' scoring of IOC. The considered criteria was 0.50-1.00 of the score of IOC on each item will be retained for empirical implementation. This score indicated that the developed items were valid with the content intended for measurement. Accordingly, this measurement model of student learning provided IOC values of 0.75-1.00 except item52 which provided only 0.50 of IOC value. Content validity was considered by item objective congruence (IOC) index that was scored by four experts (appendix A) in terms of content comprehension, content accuracy, and content clarity by using an IOC index in scoring the items. The IOC index of each item, retained in the measurement model, should be higher than 0.50 (Drost, 2011).

Table 3.2: IOC Validation on Student Learning

Original items	IOC results and experts' recommendations				Revised items by experts
	inval (-1)	(0)	valid (+1)	IOC	
1. I know good learning requires clearly-desired goals.			1 (4)	1	1. I know good learning requires clearly-desired goals.
2. Learning happens everywhere, every time regardless inside/outside the school or at home.			1 (4)	1	2. Learning happens everywhere, every time regardless inside/outside the school or at home.

Original items	IOC results and experts' recommendations				Revised items by experts
	inval (-1)	(0)	valid (+1)	IOC	
3. It is important to provide myself with opportunity to learn new knowledge.		0 (1)	1 (3)	0.75	3. It is important to provide myself with opportunity to learn new knowledge.
4. I believe that effective learning emerges from my own efforts.			1 (4)	1	4. I believe that effective learning emerges from my own efforts.
5. I try to inspire and enhance myself to learn new things all the time.			1 (4)	1	5. I try to inspire and enhance myself to learn new things all the time.
6. I manage myself to have learning discipline and concentration.			1 (4)	1	6. I manage myself to have learning discipline and concentration.
7. I pay attention to my learning so that I can gain knowledge and use it for real benefits.			1 (4)	1	7. I pay attention to my learning so that I can gain knowledge and use it for real benefits.
8. I focus on my learning and participate in activities both inside and outside the classroom.			1 (4)	1	8. I focus on my learning and participate in activities both inside and outside the classroom.
9. I like searching for good remembering techniques and I apply those techniques in my learning.			1 (4)	1	9. I like searching for good remembering techniques and I apply those techniques in my learning.
10. I like using a variety of taking-note strategy so that it helps me to remember the lesson easily.			1 (4)	1	10. I like using a variety of taking-note strategy so that it helps me to remember the lesson easily.
11. I use a various strategies to practice reading.			1 (4)	1	11. I use a various strategies to practice reading.
12. I learn to clearly understand the sequence of work as well as the procedure to do the calculation or to solve the mathematic problem.		0 (1)	1(3)	0.75	12. I learn to clearly understand the sequence of work as well as the procedure to do the calculation or to solve the mathematic problem.
13. I have different methods to gain knowledge and use it for maximized benefits.			1 (4)	1	13. I have different methods to gain knowledge and use it for maximized benefits.
14. I have techniques to control myself for effective learning.			1 (4)	1	14. I have techniques to control myself for effective learning.
15. I try to analyze my own weakness, strength and method to deal with learning problems I encounter.			1 (4)	1	15. I try to analyze my own weakness, strength and method to deal with learning problems I encounter.
16. I try to find new learning methods to gain fundamental knowledge for achieving of my ultimate goal.			1(3)	0.75	16. I try to find new learning methods to gain fundamental knowledge for achieving of my ultimate goal.

Original items	IOC results and experts' recommendations				Revised items by experts
	inval (-1)	(0)	valid (+1)	IOC	
17. Currently, I have clear learning goals. I know what I want to learn and what I learn for.		0 (1)	1 (3)	0.75	17. Currently, I have clear learning goals. I know what I want to learn and what I learn for.
18. I am happy with such learning environment: at school, at home and other places.			1 (4)	1	18. I am happy with such learning environment: at school, at home and other places.
19. I always provide myself with opportunity to join learning activities organized by schools and other organizations.			1 (4)	1	19. I always provide myself with opportunity to join learning activities organized by schools and other organizations.
20. Being a student, I spend much of time on learning as it is consider to be the most prioritized thing.			1 (4)	1	20. Being a student, I spend much of time on learning as it is consider to be the most prioritized thing.
21. Everyone commented that I love learning and being enthusiastic to seek new knowledge.		0 (1)	1 (3)	0.75	21. Everyone commented that I love learning and being enthusiastic to seek new knowledge.
22. I am in class on time, submit assignment on time.		0 (1)	1 (3)	0.75	22. I am responsible for my study (e.g. attend classes on time, submit all assignment on time).
23. I can link and integrate between existing and newly-gained knowledge together for the use any particular situations.			1 (4)	1	23. I can link and integrate between existing and newly-gained knowledge together for the use any particular situations.
24. I am the one who have broad knowledge from reading and doing activities in addition to what teachers teach.			1 (4)	1	24. I am the one who have broad knowledge from reading and doing activities in addition to what teachers teach.
25. I am able to remember what I learnt. I can retrieve it to apply.			1 (4)	1	25. I am good at remembering what is taught and I am able to apply it in any circumstances.
26. I have techniques for quick writing and taking note.			1 (4)	1	26. I have techniques for quick writing and taking note.
27. I can read the book fluently and I can understand what I read.			1 (4)	1	27. I can read the book fluently and I can understand what I read.
28. I am skillful in calculation and mathematic.			1 (4)	1	28. I am skillful in calculation and mathematic.
29. I can search for new knowledge myself and I can integrate those of knowledge by using facility "ict"		0 (1)	1 (3)	0.75	29. I can search for knowledge by using a variety of methods such as using ICT-assisted device or asking experts in the field.
30. I am happy that I can learn what I want to learn about without concern		0 (1)	1 (3)	0.75	30. I can learn effectively what I want to learn without any concerns.

Original items	IOC results and experts' recommendations				Revised items by experts
	inval (-1)	(0)	valid (+1)	IOC	
31. I know my strength and weakness and I can improve my weakness.			1 (4)	1	31. I know my strength and weakness and I can improve my weakness.
32. I have academic achievement at satisfactory level.			1 (4)	1	32. I have academic achievement at satisfactory level.
33. I realize that the only theoretical knowledge embedded in the course is not enough for practical work.			1 (4)	1	33. I realize that the only theoretical knowledge embedded in the course is not enough for practical work.
34. I know what fundamental concept I should have.		0 (1)	1 (3)	0.75	34. I know what fundamental concept I should have.
35. I am well-realized that basic knowledge is important for practical and real-life work.			1 (4)	1	35. I am well-realized that basic knowledge is important for practical and real-life work.
36. I am well-realized that in this real world, those who are successful are the ones who have clear and achievable learning goal.			1 (4)	1	36. I am well-realized that in this real world, those who are successful are the ones who have clear and achievable learning goal.
37. I am well-planned and well-prepared for my work.			1 (4)	1	37. I am well-planned and well-prepared for my work.
38. I try to analyze the work so that it would flow orderly as planned.			1 (4)	1	38. I try to analyze the work so that it would flow orderly as planned.
39. I need to control myself well and train myself to work with diligent and tolerant manner.			1 (4)	1	39. I need to control myself well and train myself to work with diligent and tolerant manner.
40. I see the importance of regular monitor and restructure of the work			1 (4)	1	40. I see the importance of regular monitor and restructure of the work
41. I try to train the skills in working of myself to be skillful.			1 (4)	1	41. I try to train the skills in working of myself to be skillful.
42. I always exchange my learning method and work with others that enable my work to be used in real situation.			1 (4)	1	42. I always exchange my learning method and work with others that enable my work to be used in real situation.
43. I try to develop working method to improve to reach better achievement.			1 (4)	1	43. I try to develop working method to improve to reach better achievement.
44. I find, adjust, integrate or apply new method in my work.			1 (4)	1	44. I find, adjust, integrate or apply new method in my work.
45. I intent to study both theory and practices.			1 (4)	1	45. I intent to study both theory and practices.

Original items	IOC results and experts' recommendations				Revised items by experts
	inval (-1)	(0)	valid (+1)	IOC	
46. I have all necessary knowledge for practical work.			1 (4)	1	46. I have all necessary knowledge for practical work.
47. Before doing practical work, I evaluate my own foundation knowledge and enrich it as necessary.			1 (4)	1	47. Before doing practical work, I evaluate my own foundation knowledge and enrich it as necessary.
48. I have clear learning goal. I also know the knowledge and skill needed to use in future.			1 (4)	1	48. I have clear learning goal. I also know the knowledge and skill needed to use in future.
49. I can plan and prepare what is needed for perfectly-operated work.			1 (4)	1	49. I can plan and prepare what is needed for perfectly-operated work.
50. My teachers told me that most of my works are well systematic and orderly correct.			1 (4)	1	50. My teachers told me that most of my works are well systematic and orderly correct.
51. The work I am responsible for is completed smoothly as planned.			1 (4)	1	51. The work I am responsible for is completed smoothly as planned.
52. I ask related experts to get feedback in adjusting my working method.	-1 (1)		1 (3)	0.50	52. I try to improve my weakness and strength through various methods such as self-assessment, teacher-assessment, and peer-assessment.
53. I finish my work with quality on time.			1 (4)	1	53. I finish my work with quality on time.
54. My working achievement can be applicable for maximum benefits.			1 (4)	1	54. My working achievement can be applicable for maximum benefits.
55. Teachers and others appreciate my work as it is widely applicable.			1 (4)	1	55. Teachers and others appreciate my work as it is widely applicable.
56. My working achievement is much appreciated as it is innovative and applicable.			1 (4)	1	56. My working achievement is much appreciated as it is innovative and applicable.

Notice: Bold and italic items were adjusted based on experts' comments.

In conclusion, items were used to measure student learning including two main components—Learning to Know and Learning to Do, which consisted of 56 items. The IOC index of all items was higher than 0.50. IOC index indicated that the IOC values ranged from 0.75 to 1.00, respectively, except for item 52, which provided a 0.50 IOC index. Hence, items of student learning were valid to the content intended for measurement based on the operational definition and sample situation.

1.4.2. Objectivity Analysis

The concept of objectivity is considered inter-subjective knowledge in social sciences. It is also considered as a free of bias, checked, and controlled knowledge. Therefore, to check the objectivity of this measurement model of student learning required the validation of all experts in the field on the language use, scoring method, and interpretive criteria of the score obtained (1= 0-20% accept, 2 = 21-40% accept, 3 = 41-60% accept, 4 = 61-80% accept, and 5 = 81-100% accept). It is useful for respondents in scoring the questionnaire based on the point of views with a reliable and credible object together.

1.4.3. Uncertainty Analysis

The development of evident on composite learning indicators are not only to response to multiple demands of teachers/educational stakeholder but also the result of disagreement within the calculating method on which indicators are the most appropriate for calculating learning as a whole. There is no complete rule for building composite learning indicators that is globally applicable and sufficiently detailed at any specific point of time (Cherchye et al., 2008). This concept may be due to the disentanglement role of composite learning indicators in both analysis and advocacy (Saltelli, 2007). There is no clear confirmation on the methodologies in developing composite learning score and learning index.

When building an index or composite learning score to measure student learning, it is necessary to retrieve existing methodologies in order to avoid eventual skewness in the assessment and decision-making (Saisana, 2008). Developers could determine whether the main results of composite learning change substantially when the main methodologies are varied over a reasonable range of possibilities (Cherchye et al., 2008; Giovannini et al., 2008; Saltelli, 2007). There are many methodologies to develop composite learning scores/index that could be to gauge the robustness of the composite scores/index scores and rank, to increase its transparency, to identify those of components/sub-components whose performance improves, and to help frame the discussion on the use of results for policy making. Hence, uncertainty analysis was employed to determine these concepts.

Uncertainty analysis was used to assess the impact of alternative models on the each model ranks. Each model is a different composite indicator in which the choice of

weights and aggregation method have been varied within a plausible range. This uncertainty analysis help to dealt with the criticism on composite measure or rankings that had been calculated under conditions of certainty (Saisana, 2008; Saltelli, 2007).

The objective of uncertainty analysis is not to establish the truth or to verify whether the student learning index is a legitimate model, but rather to test whether the model variation/inferences are robust or violate with respect to method changes.

Uncertainty analysis is a statistical analysis used to determine how much uncertainty exists in the input items of student learning propagates via a construct of the composite learning scores (Giovannini et al., 2008; Juwana, Muttil, & Perera, 2016; M Nardo et al., 2005). It is conducted to check whether there is any uncertainty of data obtained in the methods of calculating composite score changes (four models of weighting & aggregation methods). The determination of uncertainty analysis is to check the quality of robustness of composite scores of student learning when the calculating method changes.

1.4.4. Construct Validity

Construct validity was conducted to check out the validation of measurement model of student learning. Within this sense, the construct validity of this research study was administered within three main measurement models—Learning to Know, Learning to Do, and learning (Figure 3.3, Figure 3.4, and Figure 3.5).

This study would provide detailed information about each measurement model of student learning. The first two measurement models are second-order measurement model and the last one obtaining from the summarized of the first two models. Thus, the third-order measurement model of student learning was also conducted to validate construct validity of student learning measurement model.

As already mentioned, the measurement model of student learning is measured via Learning to Know and Learning to Do. Thus, the two measurement models of student learning are also measured in two measurement models as the following constructs. Learning to Know is measured by two components—process of Learning to Know (proc_K) and outcome of Learning to Know (out_K). Additionally, the two components of Learning to Know are measured by three indicators. The measurement model of student learning to Know is measured with second-order confirmatory factor analysis model as shown in Figure 3.3.

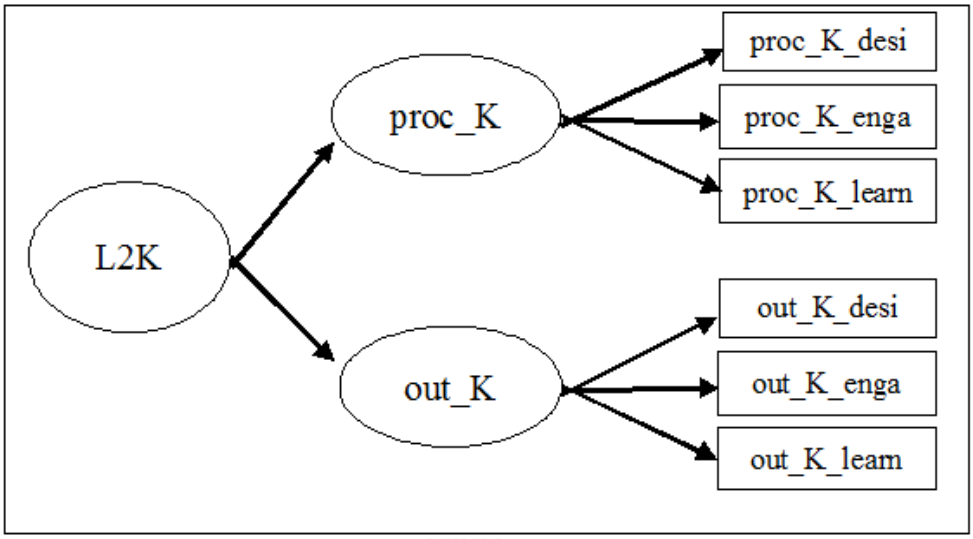

Figure 3.3: Measurement Model of Learning to Know

In the same sense, the measurement model of students' Learning to Do is also measured by two components—process of Learning to Do (proc_D) and outcome of Learning to Do (out_D). The two components comprised three separated indicators. Therefore, the second-order confirmatory factor analysis of student Learning to Do was conducted to investigate the construct validity of the learning to Do model.

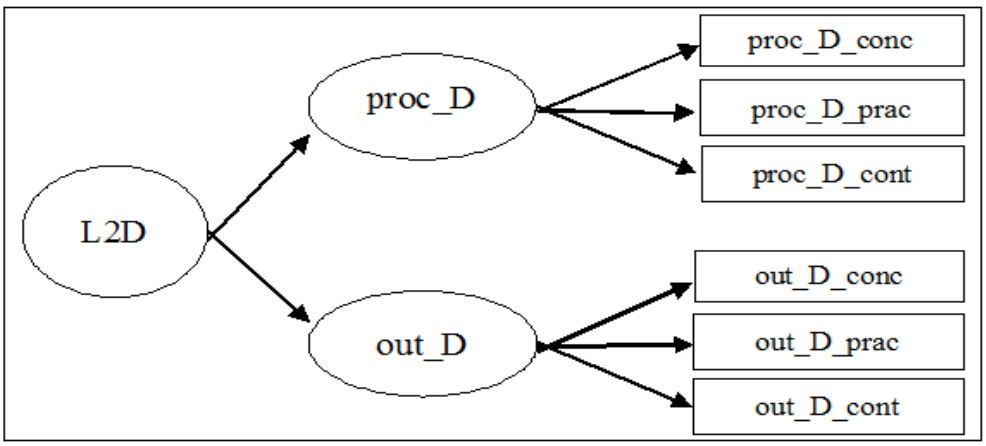

Figure 3.4: Measurement Model of Learning to Do

The measurement model of student learning obtained from the summarization of the 2 early measurement models: L2K and L2D. Hence, the measurement model of student learning consisted of 2 factors, 4 components, and 12 indicators (Figure 3.5).

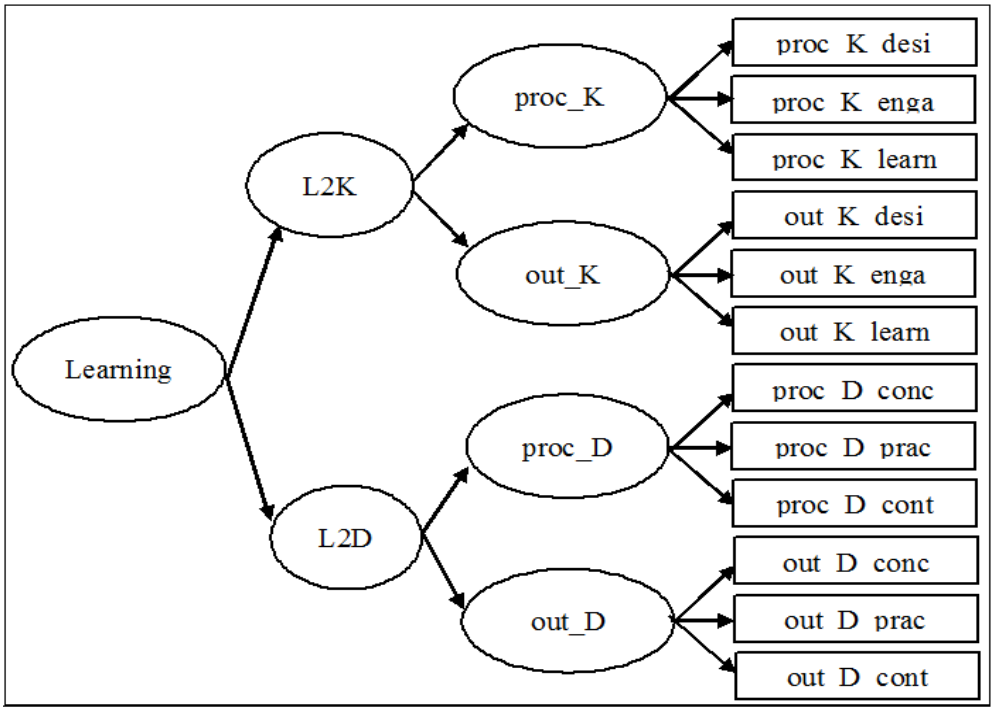

Figure 3.5: Measurement Model of Learning

1.4.5. Reliability

Pilot study with 25 Cambodian high school students was employed to calculate reliability coefficients of the measurement model of student learning.

The measurement model of student learning comprised of 2 components, 4 sub-components, and 12 indicators. Each indicator comprised of 4 items nested in itself except the process of learning to learn indicator and outcome of learning to learn which comprised of 8 items nested in. thus, the reliability coefficients of this research study consists of 12 indicator reliability coefficients, 4 sub-component reliability coefficients and 2 component reliability coefficients of student learning measurement model.

Cronbach's Alpha coefficients were calculated. The results of the analysis revealed that reliability coefficients of each indicators ranged between .830 - .920, reliability coefficients of each sub-component were ranged between .940 - .960, lastly,

reliability coefficients of each component were .970. The detailed reliability coefficients of each variable were presented in Table 3.3.

Table 3.3: Reliability Coefficients of Student Learning

Indicator of the research instrument		Items	Reliability Coefficients
learning desire	proc_K_desi	4	.89
learning engagement	proc_K_enga	4	.89
learning to learn	proc_K_learn	**8**	.93
process of Learning to Know		**16**	**.96**
outcome of learning desire	out_K_desi	4	.80
outcome of learning engagement	out_K_enga	4	.85
learning outcomes of learning to learn	out_K_learn	**8**	.91
outcome of Learning to Know		**16**	**.94**
Learning to Know (L2K)		**32**	**.97**
concern as the real world of work	proc_D_conc	4	.83
practical engagement	proc_D_prac	4	.92
continuing self-development	proc_D_cont	4	.86
process of Learning to Do		**12**	**.94**
outcomes concern as the real world of work	out_D_conc	4	.87
outcome of practical engagement	out_D_prac	4	.92
outcome of continuing self-development	out_D_cont	4	.86
outcome of Learning to Do		**12**	**.95**
Learning to Do (L2D)		**24**	**.97**

1.4.6 Criterion-Related Validity

Criterion-related validity was conducted to explore the relationship between intended students and the student learning index. Therefore, 2 known-groups of students at Kampong Chueteal High School would be preferable to be selected as the criterion based on the teachers' perspectives.

Based on the criterion-related validity concept, a case study of Kampong Cheuteal High School was implemented. Two teachers were asked to select 24 students. Twenty-four students were divided into 2 known-groups—low and high level learning index. The twenty-four students were selected from grade 11 and grade 12 of 2016-2017 academic year due to their level of learning. The selected grade 11 students were high level learning and the selected grade 12 students were low level learning students.

High and low learning of the 24 students were perceived by two teachers. The 24 students were used as the criteria for differentiate the low and high learning of students. If the 2 known-groups of students are different, thus, the criterion-related validity was confirmed, meaning that teachers could separate high and low level of student learning index, as well as, the statistics.

After teachers' selection, the t-test was used to confirm with the known-groups that were selected by teachers. If the t-test is statistical significance meaning that the test is confirmed. It is indicated that the students selected by teachers' perspectives could be separated by their learning level of the outcomes (questionnaire).

Table 3.4: Student Learning by Level

Variable	Index level	
Learning Level	L (12 students)	H (12 students)

Notice: L = low level of student learning; H = high level of student learning

The 2 known-groups of students with different learning levels were asked to participate voluntarily in the research process, thus, research questionnaires were provided to students to compare between teachers' perception on student learning level and empirical student learning based on the quantitative data. The detailed information of the criterion-related validity would be discussed in chapter 4 in order to determine the teachers' judgment on student learning with the empirical data collected from questionnaires.

In sum, the measurement model of student learning quality was examined in terms of content validity congruence, objectivity, uncertainty, construct validity, high reliability coefficients, and criterion-related validity. All these approaches were reached the criteria. The approaches indicated that this measurement model of student learning is most appropriate for the application with this research study.

1.5. Development of Students Learning Norm for Cambodian Students

Composite scores of three models of student learning were calculated. The three models of student learning (Learning to Know (L2K), Learning to Do (L2D), and Learning) were calculated in terms of unweighted (raw composite scores) and weighted (additive model with factor loading) additive model. The three model calculation were transferred into percentiles. The percentile ranks would produce detailed information (norm) of the composite scores of each learning model. The norm of composite scores of each learning model distributed thresholds of themselves.

Norm of student learning was developed for the interpretation of the level of Cambodian student learning using percentile ranking (threshold). The unweighted composite learning scores and weighted composite learning scores were converted to percentiles rank for the ease of interpretation, and the comparison with learning index.

1.6. Learning Index Development

Learning index was calculated by using an additive model with factor loadings obtained from uncertainty analysis. The Learning index was determined by using two types of methods: criterion-referenced and norm-referenced indices. The composite learning scores of each student were converted into index by using the following formula. The learning index ranges between .00 – 1.00.

$$Index = \frac{Value - min}{Max - min}$$

Value= composite learning score,

Min= minimum composite learning scores of students

Max= Full composite learning scores (60 points)

1.7. Research Design for Data Collection

1.7.1. Population and Samples

There are 266, 449 students enrolled in high schools country wide in both private and public schools (Royal Government of Cambodia, 2015).

Samples of this research study included 1, 619 private and public high school students due to the need for the study an application of confirmatory factor analysis. Thus, sample size was determined by a prior sample size calculator for structural

equation models (Button et al., 2013). The calculator proposed how to calculate a sample size based on items and unobserved variables which are used for analysis in the model. Hence, the sample size needed in this study is about 600 samples. But this research aimed to develop line data based on a measurement model of student learning. The line data base is more reliable than any other data set in developing a learning index of Cambodian students. Accordingly, large sample size is needed. At first, the goal was to collect data from approximately 2, 000 samples. The questionnaires were sent around the country based on the 5 regions of Cambodia. To compensate for missing data in the data collection process, 30 % of the sample size was administered. Therefore, the total sample size needed for this research study reached 2, 950 students. The samples were obtained by three multi-stage random sampling technique. This sampling technique was conducted in three sequential steps.

There were 5 regions selected in this research study including north, south, east, west, and middle regions.

Step 1 was to randomly select 2 provinces from each early 4 regions. But simple random sampling 3 provinces from middle region based on the density of school population. There is high density of school located in the middle region.

Step 2 was to randomly select 4 schools from each province by randomly stratified select three public schools and one private school. Accordingly, two public schools was randomly selected and also one private school of the middle region.

Step 3 was to randomly select 50 students from each public school and 125 students from private school for the early four regions. But 60 students from each public school and 130 students from private school were randomly selected of the middle regions. Thus, the total number of 30 public and 11 private schools and 2,950 students were randomly selected.

These proportion of sample size needed were based on the density of schools in each area. The proportion of school in each area were not equal. The four early mentioned regions including north, south, east, and west region were spread out in the same number of schools while the middle region was spread out with high density of schools. Therefore, the proportion of questionnaires were sent to each region in a small amount of different proportion both public and private schools.

The proportion of questionnaires sent to both public and private schools was unequal. The public schools in all regions other than the central region were sent a large number of questionnaires, based on the number of schools and number of students who participate in this kind schooling process. The number of non-urban public schools is much higher than that of non-urban private schools. Additionally, the number of public school students is also much higher than that of private school students. Hence, this allowed the researcher to send the questionnaires in differing quantities to both kinds of schools. Conversely, the public school questionnaires in the central region are fewer than those sent to private schools. The number of public schools and public school students in the central region are also higher than that of private schools and private school students, but the researcher considered sending a higher proportion of questionnaires to private schools in the central region as a way to compensate for the disparity between public and private education institutes in the other regions.

After filling the different amount of questionnaires between the two kind of schools, the different percentages of questionnaire sent to both kind of schools is 9.68 % only. It is assumed that the variance of both public and private school would be fulfilled. The detailed information of the number of questionnaires which were sent to both kinds of school are presented in Table 3.5.

The sample size obtained from this data collection were 1,821 students (61.77%). But unqualified and unintentional responses were found in the data obtained, thus, research scanned for qualified and usable questionnaires. The remained qualified questionnaires were 1,619 questionnaires (54.88%) comparing to the questionnaires sent out for data collection.

Table 3.5: Number of Questionnaires Sent Out and Obtained

Province	School	Sent out	Obtained	Percentage
1	Public1	50	23	46.00
	Public2	50	29	58.00
	Public3	50	25	50.00
	Private1	125	49	39.20
2	Public4	50	27	54.00
	Public5	50	22	44.00
	Public6	50	25	50.00

Province	School	Sent out	Obtained	Percentage
	private2	125	57	45.60
3	Public7	50	33	66.00
	Public8	50	37	74.00
	Public9	50	29	58.00
	Private3	125	54	43.20
4	Public10	50	34	68.00
	Public11	50	30	60.00
	Public12	50	39	78.00
	Private4	125	67	53.60
5	Public13	50	33	66.00
	Public14	50	39	78.00
	Public15	50	32	64.00
	Private5	125	51	40.80
6	Public16	50	42	84.00
	Public17	50	27	54.00
	Public18	50	43	86.00
	private6	125	80	64.00
7	Public19	50	40	80.00
	Public20	50	39	78.00
	Public21	50	37	74.00
	Private7	125	89	71.20
8	Public22	50	37	74.00
	Public23	50	33	66.00
	Public24	50	32	64.00
	private8	125	79	63.20
9	Public25	60	45	75.00
	Public26	60	42	70.00
	Private9	130	82	63.08

Province	School	Sent out	Obtained	Percentage
10	Public27	60	45	75.00
	Public28	60	44	73.33
	private10	130	96	73.85
11	Public29	60	40	66.67
	Public30	60	35	58.33
	private11	130	79	60.77
Total	41 Schools	**2, 950**	**1, 821**	**61.73**
Total qualified samples			**1, 619**	**54.88**

1.7.2. Data Collection

Data collection was conducted with high school students countrywide. Data collection was conducted within two phases. The first phase was conducted during July 2016 with the following detailed information.

1. Permission form of data collection was released from the Faculty of Education, Chulalongkorn University of Thailand (released date April 2016).

2. Permission was released to do data collection with both private and public high schools. Data collection was performed country-wide as permitted by the Ministry of Education Youth and Sport of Cambodia (released at the end of May 2016).

3. Requested permission and convenience of data collection from high schools, both private and public, including 41 schools around the country by using an initial phone call followed by a permission letter of data collection released by the Ministry of Education Youth and Sport of Cambodia.

4. Network schools were contacted to ask for cooperation in in research process. Thus, questionnaires were sent to those schools. Additionally, some data collection process was conducted by the researcher.

5. Data collection was conducted during June and July 2016. In the first week of June, school contact was conducted via phone, email, and teacher networks. The second week of June and July of 2016 data collection were conducted. In this process data was obtained in sequence. The total number of schools that allowed data collection was 41 private and public schools (30 public schools, and 11 private high schools).

Number of regions, provinces, and school were provided. Researcher collected data with the numbers of student in each network school.

The second phase of data collection was performed during August and October 2016 in Kampong Chheuteal high school. The data collection was conducted with two kinds of respondents.

1.7.3. Data Analysis

Data analysis of this study is conducted with two main analysis techniques—descriptive data analysis and inferential data analysis.

1. Descriptive data analysis is employed with the background information of the observed variables. This analysis technique is administered to survey the background information of the respondents of the research study by exploring percentages, mean, standard deviation, maximum score, and minimum score. These statistical values were calculated to check the form of data distribution by using SPSS program for Window software.

Evidently, there are some steps of developing composite scores of student learning starting from replacing missing data, defining indicator loadings, and summarizing individual indicators' values (Manthalu et al., 2010). Therefore, some analysis techniques will be employed to determine the composite scores of student learning including uncertainty analysis (Nardo & Saisana, 2008). The following concepts were the steps in developing composite scores of student learning.

1. Weighting was employed using two methods—equal loadings for all indicator and individual loading for each indicator based on the loading obtained from confirmatory factor analysis of the full measurement model of student learning composite scores (Foa & Tanner, 2012; Zhou & Ang, 2009).

1.1 Equal loading was a method of linear calculation all individual indicator score with a fixed loading not considering the different loading of each indicator.

1.2 Individual loading was a method of linear calculation all indicators by not considering its loading from measurement model of student learning.

2. Aggregation method was employed with two main models—additive model and multiplicative model of the analysis.

2.1 The additive model was a method of linear summary all individual indicator scores (Cherchye et al., 2007; Nardo & Saisana, 2008; M Nardo et al., 2005).

$$CI_c = \sum_{i=1}^{m} w_{c,i} \cdot Y_{c,i}^{n}$$

Where CI_c is the composite score for individual student learning j, $Y_{c,i}^{n}$ the (possibly normalized) scores for individual student j on indicator I (i=1,…,m) and w_i the weight assigned to indicator i. weights are generally bounded in $0 \le w_{c,i} \le 1$ and $\sum_{i=1}^{m} w_{c,i} = 1$.

2.2 Multiplicative model was a model of multiplied individual indicator to generate summarizing indicator scores (Nardo & Saisana, 2008; M Nardo et al., 2005).

$$CI_c = \Pi_{i=1}^{m} x_{i,c}^{w_i}$$

Based on the above two models proposed, there are 2 x 2 = 4 sources of uncertainty in developing composite scores of student learning. Thus, the analysis model of uncertainty will be employed with 4 models.

After uncertainty analysis was employed with composite scores of student learning, the researcher choose the most appropriate models for developing student learning. This process enabled researchers to obtain 4 indices of student learning-process of Learning to Know, outcomes of Learning to Know, process of Learning to Do, and outcomes of Learning to Do. When the result was presented, the values enabled the researcher to calculate norm-referenced in terms of percentile ranks.

Phase II: Explanations of Cambodian Student Learning Index

Phase II of the study aimed to explain student learning index profiles. Based on this objective, there are 2 types of belief were employed in this research phase.

The first type of belief went with the belief of UNESCO which proposed that the process and outcome of Learning to Know (L2K) are the basis for Learning to Do (L2D). This belief also proposed four levels of student learning index. The low level learning index was believed that students had process of L2K, moderate level learning index was believed that students had process and outcome of L2K, relative high level learning index was believed that students had L2K and process of L2D, and lastly, with high level learning index was believed that student had both processes and outcomes of Learning to Know (L2K) and Learning to Do (L2D), together.

The second type belief went with the belief that outcomes of Learning to Know (L2K) and Learning to Do (L2D) are based on their learning process. Accordingly, this belief also proposed four level of student learning index. The low level learning index was believed that students had process of L2K, moderate level learning index was believed that students had process of L2K and L2D, relative high level learning index was believed that students had process of L2K and L2D meet outcome of L2K, and high level learning index was believed that student had process and outcome of Learning to Know (L2K) and Learning to Do (L2D), together.

Beside these two type1 of belief, student learning index was analyzed by different background variables in order to explore and explain the fluctuation of Cambodian student learning index due to the student background and schools' background. Thus, some analysis were conducted such as descriptive statistic of student learning index due to the background and multiple regression analysis also conducted to predict and explain the learning index variances.

Multiple regression analysis was analyzed to explain the variances of student learning index. The six explained variables (independent variables) consisted of the genders of students, academic stream, family incomes, school jurisdictions, school context (competitiveness), and school internet access. All of the explained variables were dichotomous variables (coded variables). Cross-tabulations were also performed to describe the association of student learning index and student backgrounds. The association between student learning index and student backgrounds were also described. Additionally, student learning index followed the 2 types of belief obtaining from first objective was also discussed.

Phase III: Developing Guidelines for Enhancing Student Learning Index (Micro-Level Study)

This objective aimed to develop guideline(s) for enhancing learning index of Cambodian students that were developed from purposive classroom practices of Kampong Cheuteal High school, the micro-level study, based on the pattern of student learning indices. Therefore, the guidelines were developed inherence with teaching and learning activities that were conducted by two teachers.

3.1. Teaching for Learning

Teaching methods are rooted in learning theory which student intends to achieve. Good teaching method enables student to construct active learning rather than receiving knowledge passively (Marbach-Ad, Egan, & Thompson, 2015). Teaching method that promotes active construct of knowledge increases critical and higher-level learning (Wieman, 2007). It is demonstrated that the main factor which can produce this kind of active and critical learning is resulted from teacher's efforts in which provide for students.

The concepts of student learning and teachers' teaching are highly interrelated. Both terms cannot be separated. Sometimes, they are spoken out interchangeable. When talking about learning quality, learning process, learning engagement, and good learning achievement (Benoit et al., 2015; Boekaerts, 2016). The two terms have an effect to each other reversibility as said in the figure 3.6.

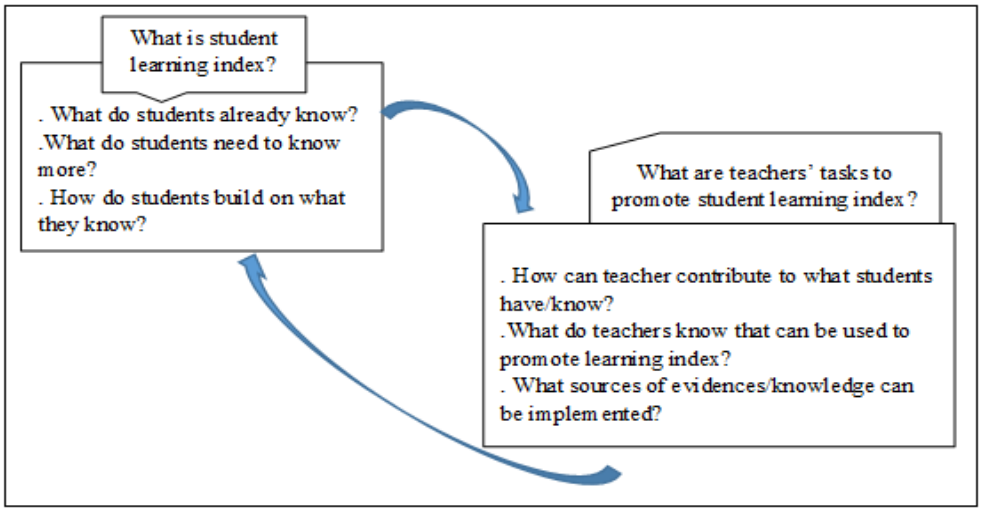

Figure 3.6: Guidelines for Enhancing Student Learning Index

In the figure 3.6, teacher is considered as main actor to promote what student persist in order to earn higher learning index which is studied in the previous research problems. Teacher is the designer of the curriculum implementation during his/her instruction processes. For example, teacher should extend more times and opportunities for student to conduct his/her learning using times and opportunities effectively (Danielson, 2013; Ridnouer, 2011). Teacher should engage students and instruction with external expertize in which will allow students to explore new skills and

knowledge out of the box as his/her learning interest (Ridnouer, 2011). Teacher should advocate student to engage in the learning process than being concerned about whether he/she are volunteered or not. Teacher should set up active learning leaders who lead to professional learning opportunities (Timperley, Wilson, Barrar, & Fung, 2008).

As mentioned in the figure 3.6, it was demonstrating that teacher was preferable to have prior knowledge about students in order to bridge students' experience with what they should combine with new experience or knowledge. Students produce their learning by what they do and think. Teacher help advancing what students do and think by answering the normal question as mentioned in the figure 3.6, additionally, what teachers should do to fulfill what students need (Ambrose et al., 2010).

This approach seem to fulfilled students learning itself. Thus, students have to come to understand that their awareness of how interconnected these learning principles and application. It is not easy to follow up anything students learn such as concepts, skills, or attitudes. Therefore, doing with built-in reflection is a good way that students could improve, upgrade what they are doing both learning and working.

In sum, it is clearly indicated that teachers are main actors who can help students to achieve their learning index. Therefore, students also need accept and work inherently with teachers and peers to make fruitful learning index. Hence, students performed their learning based on what teacher direct them. The following guidelines were what students did during 6 weeks course of math and chemistry. The guidelines were developed depending on the level of student learning index.

3.2. Student Learning

The concept of learning is broadly concerned as foundation for expanding knowledge and skill that students need to pass through and achieve with their schooling life. To obtain more knowledge and skill, students should know how to learn or know learning conduction of selves in which enable students to be ready for, to conduct, and to obtain their learning ambition as intended. Thus, the application of knowledge for learning is to understand one' own learning process, helps to understand one's own thinking, to be aware of a fit between what was learnt and what will learn, and to select the most effective and efficient mean to go about learning.

This cycle of student learning was a teacher task to teach students be able to accompany with this cycle of learning. The cycle consisted of 5 steps that teachers should point out for students.

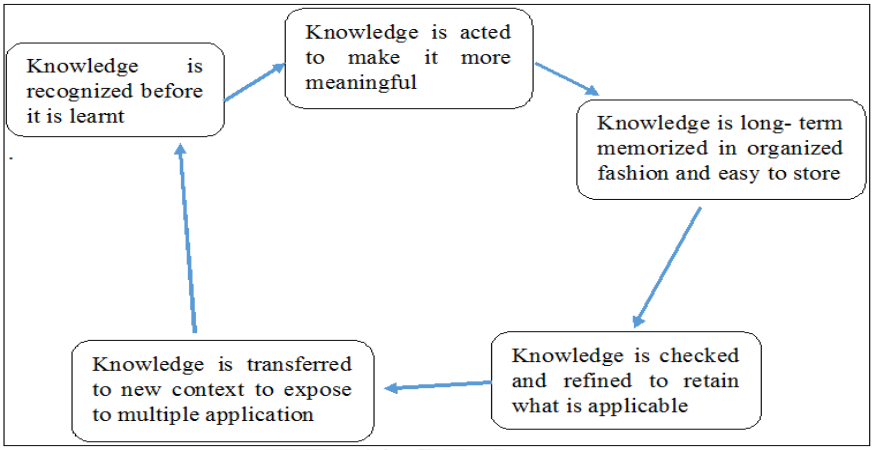

Figure 3.7: Learning Cycle for Learning to Know and Learning to Do

1. Knowledge is recognized before it is learnt. As mentioned earlier, teacher survey students' prior knowledge, how student learnt, strength and weakness of the learning student did. These kinds of information allow teacher to plan for next instruction in which would provide effective instruction to students. Accordingly, students identify self and be ready for new classroom operation.

2. Knowledge is acted to make it more meaningful. Effective teaching strategies that make student learning come alive is to engage students with learning process by allowing student to work individually, or more commonly in small groups. Sometimes, teachers should provide students the case that connect learning activities to real-world problem so that students grapple with the issues and be able to deal with real life.

3. Knowledge is long- term memorized in organized fashion and easy to store. What students learnt should be extracted to empirical use when needed. Thus, teacher follow-up frequently what students learnt and extract those of knowledge back to fulfill the need of use when students encounter with real learning challenges.

4. Knowledge is checked and refined to retain what is applicable. It is usually that some knowledge and skills are old-fashion or out of date. Thus, some knowledge and skills learnt should be refined if it is necessary. Then those of knowledge would be confirmed that they should be retained or be excluded based on the globalization.

5. Knowledge is transferred to new context to expose to multiple application. Knowledge should be applicable with multiple contexts and contents. This issue is in need, because most of students are purely knowledgeable but most of them could not use those of knowledge within the real world of work in any other world of work.

In sum, the concept of teaching for learning and student learning are highly correlated. It is sometimes used interchangeable. The two concepts cannot be separated. Hence, the more teaching happen the more learning also happen. It is indicated that teacher fulfill students, inversely, students fulfill teachers. Accordingly in the process of instruction both teachers and students work closely with each other to generate fruitful learning index.

3.3. Student Learning Enhancement Guidelines

This objective of the research study, at the micro-level study, was to develop guidelines for enhancing Cambodian student learning index. Classroom practices were employed in Kampong Chueteal High School, Kampong Thom province, Cambodia. Two teachers volunteered to participate in this research as case study. Teachers prepare and plan for instruction aimed at enhancing student learning.

Prior to conducting research activities, two teachers were asked for assistance by researcher. Teachers were explained how to analyze, read, and interpret student learning index based on the formula and interpretation criteria.

Teachers were asked to select two groups of students in which separate students into two different groups—high level learning index and low level learning as teachers perceived during their teaching sessions based on the items and indicators of measurement model of student learning.

Two known-groups of students were selected. Then pretest data collection was also employed with the two known-groups of students. Thus, Kampong Chueteal High School student learning index was explicit. This index result was used as primary learning index for teachers in preparing and planning for their upcoming instructions. Teachers update and restructure their teaching as they intend to enhance student learning index.

The study was employed with high school students of Kampong Chueteal studying during the 2015-2016 academic year. Teachers measured the two known-group student learning by using student learning index in second objective. Thus, new

teaching activities was prepared and planned by teachers. Teachers implemented some new designed learning activities to develop student learning index in the period of 6 weeks. During six week instruction, three observation on teaching activities were conducted with two weeks per times.

After the six week-courses, post-test data collection was also conducted to explore whether the learning activities conducted during six weeks have an effect on student learning index.

Two known-groups of students were tested by pretested and post-tested for their learning index, the two periods index was used to explore the effectiveness of teaching activities. The learning indices of students were then analyzed for changes. The two known-groups of students' were presented in Table 3.6.

Table 3.6: Design for the Study of the Results of Learning Index Implementation

Teachers	Grade	students	Hours/week	Weeks
Teacher 1	11	12	3	6
Teacher 2	12	12	4	6

The observation during teaching sessions were also conducted 3 times for each groups of students. Additionally, after the instruction activities were done some interviews were also employed with the two teachers.

Two teacher interviews were conducted after data collection was conducted with the two known-group of students. The interview was used to explore what activities that teachers used in their instruction.

After, the interview and observation were conducted the lessons learned from the classroom practices was extracted. There are many teaching activities and learning activities were conducted during teaching and learning session. Hence, teaching and learning activities were summarized into guidelines.

The guidelines for enhancing student learning index were constructed from lessons learned that were extracted from two teachers interview and the observation that were conducted during teaching and learning sessions. On the other hand, guidelines utilization was also described for further application and instruction benefits.

Chapter 4

Analysis Results

This research study was conducted with macro- and micro-level studies which comprised of 3 main objectives—to develop the learning index and the measurement instrument to measure the learning index of students, to analyze the learning index of Cambodia students and explain the learning index profiles with selected school background at the macro level, and, lastly, to develop guidelines for enhancing the learning index of student by analyzing lessons learned from classroom practices of teachers at Kampong Chhueteal high school for the micro-level study. The macro-level study was employed with early two research objectives. And the micro-level study was employed with the third objective.

Three phases of analysis results will be presented in accordance with the three research objectives. The first phase was conducted to develop a measurement model of student learning. Accordingly, the psychometric properties of the instrument were also validated. The second phase was to explain student learning index as classified by 6 background information items of the students. The third phase was to develop guidelines for enhancing student learning index by lessons-learned analysis. In the analysis model the limited space is presented, thus, some abbreviation would be needed.

Abbreviation use in the analysis processes

There are two different abbreviation types which would be used in this research study the first abbreviation type is statistical abbreviation and the second one is the variable used in analysis abbreviation.

Statistics abbreviation

n = number of samples

χ^2 = goodness-of-fit index in terms of chi-squared

p = level of significance

df = degree of freedom

SE = standard error

GFI = goodness-of-fit index

AGFI = adjusted goodness-of-fit index

RMR = the root mean square residual

RMSEA = root mean square error of approximation

AIC = Akaike information criterion

BIC = Bayesian information criterion

R^2 = regression coefficient

β = standardized factor loading

Abbreviation of observed and unobserved variables of the analysis

Know = Learning to Know

Do = Learning to Do

proc_K = process of Learning to Know

out_K = outcome of Learning to Know

proc_D = process of Learning to Do

out_D = process of Learning to Do

proc_K_desi = learning desire

proc_K_enga = learning engagement

proc_K_learn = learning to learn

out_K_desi = learning outcome of learning desire

out_K_enga = learning outcome of learning engagement

out_K_learn = learning outcome of learning to learn

proc_D_conc = concern learning as the real world of work of work

proc_D_prac = practicing engagement

proc_D_cont = continuing self-development

out_D_conc = outcome of concern learning as the real world of work of work

out_D_prac = outcome of practicing engagement

out_D_cont = outcome of continuing seft-development

Phase I: Development of Measurement Model of Student Learning (Macro-Level Study)

1.1. Background Information of Respondents

Prior to presenting the verification results of further analysis of student learning, measurement instrument, and learning index of students, the demographic information of the respondents of the research study will be presented in Table 4.1.

The respondents of this study consisted of 1,619 high school students. 904 (55.80%) were public high school students, while 715 students (44.20 %) were from private schools, with almost the same gender proportions for both public and private schools (about 50.00% in each group of jurisdiction of school).

More students studied sciences than social science. 700 (77.50 %) out of 904 public school students and 576 (80.60 %) out of 715 private school students were enrolled in science. Moreover, most public school students were from non-urban locations [533 (59.00 %) out of 904], while private school students were mostly from urban locations [544 (76.10 %) out of 715].

Table 4.1: Background Information of Respondents

Background information	**Public student**		**Private student**		**Total**	
gender	**n**	**%**	**n**	**%**	**n**	**%**
male	484	53.50	327	45.70	810	50.00
female	420	46.50	388	54.30	809	50.00
Total	904	100.00	715	100.00	1,619	100.00
academic stream	**n**	**%**	**n**	**%**	**n**	**%**
social science	204	22.50	139	19.40	342	21.20
science	700	77.50	576	80.60	1277	78.80
school location	**n**	**%**	**n**	**%**	**n**	**%**
urban	371	41.00	544	76.10	915	56.50
non-urban	533	59.00	171	23.90	704	43.50
school context	**n**	**%**	**n**	**%**	**n**	**%**
high competitive	323	35.70	401	56.10	724	44.70
medium and low/non competitive	581	64.30	314	43.90	895	55.30
school computer availability	**n**	**%**	**n**	**%**	**n**	**%**
serve student	379	42.90	437	61.10	824	50.90
do not serve student	515	57.10	278	38.90	795	49.10
school internet access	**n**	**%**	**n**	**%**	**n**	**%**
serve student	278	30.70	194	27.10	471	29.10
do not serve student	626	69.30	521	72.90	1148	70.90
family incomes	**n**	**%**	**n**	**%**	**n**	**%**
lower than 800,000 Riel	594	65.71	201	26.99	795	49.11
equal or higher than800,000 Riel	310	34.29	514	73.01	824	50.89

Notice: 1 Thai Bath = 114 Riel

Computer and internet availability was still limited for both public and private school students to use not only for learning and working, but also in searching for new knowledge. At public schools, computers were available for students at the number of 378 (42.90 %) while internet availability was provided for students at only 277 (30.70%).

A slightly different number of computers were available at private schools at the number of 437 (61.10%) out of 715, but internet availability, similarly, was still limited for students to use in learning, searching, and working with a number of responses of 194 (27.10 %) out of 715.

The family incomes of students differed greatly between public and private school students. Family incomes of public school students were mostly under 800,000 Riel, which was a low-income line with the frequency of 594 (65.71%). In contrast, family incomes of private school students were higher than the public ones. It was largely equal to or higher than 800,000 Riel (around 7,000 Thai Baht) with the frequency of 514 (73.01%).

Prior to presenting psychometric property investigation, individual item of student learning was analyzed in terms of frequencies and percentages. The measurement instrument of student learning comprises of two components—Learning to Know (L2K) and Learning to Do (L2D) in which the two components were measured by a 5-point rating scale questionnaire. The first component (L2K) comprised of 32 items, as well as, the second component (L2D) composed of 24 items.

For Learning to Know component, most students responded third and fourth level of the scale of items around 30%. There were few items that fifth-level items were selected around 50%, 40%, and 30% such as item1, item2 throughout item7.

Table 4.2: Frequencies and Percentages of Learning's Items of L2K

Items	Level of opinions				
	1	2	3	4	5
Learning to Know (L2K)					
1. I know good learning requires clearly-desired goals.	42 (2.60)	101 (6.20)	262 (16.20)	404 (25.00)	810 (50.00)
2. Learning happens everywhere, every time regardless inside/outside the school or at home.	46 (2.80)	108 (6.70)	258 (15.80)	440 (27.20)	767 (47.50)
3. It is important to provide myself with opportunity to learn new knowledge.	31 (1.90)	86 (5.30)	257 (15.90)	519 (32.10)	726 (44.80)

Items	Level of opinions				
	1	2	3	4	5
4. I believe that effective learning emerges from my own efforts.	26 (1.60)	69 (4.30)	296 (18.30)	500 (30.80)	728 (45.00)
5. I try to inspire and enhance myself to learn new things all the time.	30 (1.90)	99 (6.10)	371 (22.90)	624 (38.50)	495 (30.60)
6. I manage myself to have learning discipline and concentration.	39 (2.40)	144 (8.90)	433 (26.70)	633 (39.10)	370 (22.90)
7. I pay attention to my learning so that I can gain knowledge and use it for real benefits.	26 (1.60)	112 (6.90)	352 (21.70)	586 (36.30)	543 (33.50)
8. I focus on my learning and participate in activities both inside and outside the classroom.	42 (2.60)	153 (9.50)	444 (27.40)	626 (38.70)	354 (21.80)
9. I like searching for good remembering techniques and I apply those techniques in my learning.	62 (3.80)	199 (12.30)	484 (29.90)	550 (34.00)	324 (20.00)
10. I like using a variety of taking-note strategy so that it helps me to remember the lesson easily.	57 (3.50)	178 (11.00)	474 (29.30)	534 (33.00)	376 (23.20)
11. I use a various strategies to practice reading.	73 (4.50)	221 (13.70)	503 (31.10)	527 (32.50)	295 (18.20)
12. I learn to clearly understand the sequence of work as well as the procedure to do the calculation or to solve the mathematic problem.	72 (4.50)	209 (12.90)	442 (27.30)	533 (32.90)	363 (22.40)
13. I have different methods to gain knowledge and use it for maximized benefits.	81 (5.10)	261 (16.10)	541 (33.40)	504 (31.10)	232 (14.30)
14. I have techniques to control myself for effective learning.	83 (5.10)	212 (13.10)	498 (30.80)	544 (33.60)	282 (17.40)
15. I try to analyze my own weakness, strength and method to deal with learning problems I encounter.	58 (3.60)	164 (10.10)	495 (30.60)	514 (31.70)	388 (24.00)
16. I try to find new learning methods to gain fundamental knowledge for achieving of my ultimate goal.	59 (3.60)	155 (9.60)	435 (26.90)	581 (35.90)	389 (24.00)
17. Currently, I have clear learning goals. I know what I want to learn and what I learn for.	48 (3.00)	128 (7.90)	343 (21.20)	528 (32.60)	572 (35.30)
18. I am happy with such learning environment: at school, at home and other places.	68 (4.20)	171 (10.60)	454 (28.00)	555 (34.40)	371 (22.80)
19. I always provide myself with opportunity to join learning activities organized by schools and other organizations.	125 (7.70)	249 (15.40)	528 (32.60)	427 (26.40)	290 (17.90)
20. Being a student, I spend much of time on learning as it is consider to be the most prioritized thing.	79 (4.90)	214 (13.20)	534 (33.00)	503 (31.10)	289 (17.80)
21. Everyone commented that I love learning and being enthusiastic to seek new knowledge.	101 (6.20)	304 (18.80)	563 (34.80)	432 (26.70)	219 (13.50)

Items	Level of opinions				
	1	2	3	4	5
22. I am responsible for my study (e.g. attend classes on time, submit all assignment on time).	57 (3.50)	155 (9.60)	466 (28.80)	548 (33.80)	393 (24.30)
23. I can link and integrate between existing and newly-gained knowledge together for the use any particular situations.	47 (2.90)	218 (13.50)	576 (35.60)	577 (35.60)	201 (12.40)
24. I am the one who have broad knowledge from reading and doing activities in addition to what teachers teach.	103 (6.40)	337 (20.70)	597 (36.90)	427 (26.40)	155 (9.60)
25. I am good at remembering what is taught and I am able to apply it in any circumstances.	98 (6.10)	324 (20.00)	625 (38.50)	427 (26.40)	145 (9.00)
26. I have techniques for quick writing and taking note.	77 (4.80)	275 (17.00)	554 (34.10)	485 (30.00)	228 (14.10)
27. I can read the book fluently and I can understand what I read.	56 (3.50)	214 (13.20)	540 (33.40)	533 (32.90)	276 (17.00)
28. I am skillful in calculation and mathematic.	203 (12.50)	357 (22.10)	529 (32.60)	393 (24.30)	137 (8.50)
29. I can search for knowledge by using a variety of methods such as using ICT-assisted device or asking experts in the field.	58 (3.60)	219 (13.50)	533 (32.90)	531 (32.80)	278 (17.20)
30. I can learn effectively what I want to learn without any concerns.	60 (3.70)	216 (13.30)	536 (33.20)	520 (32.10)	287 (17.70)
31. I know my strength and weakness and I can improve my weakness.	47 (2.90)	234 (14.50)	481 (29.70)	562 (34.70)	295 (18.20)
32. I have academic achievement at satisfactory level.	69 (4.30)	184 (11.40)	389 (24.00)	495 (30.50)	482 (29.80)

For Learning to Do component, most students responded third- and fourth- level scale of items around 30% each level. There were only two items that fifth level of items were selected around 30% such as item33 and item36.

Table 4.3: Frequencies and Percentages of Learning's Items of L2D

Items	Level of opinions				
	1	2	3	4	5
Learning to Do (L2D)					
33. I realize that the only theoretical knowledge embedded in the course is not enough for practical work.	42 (2.60)	147 (9.10)	434 (26.80)	480 (29.60)	516 (31.90)
34. I know what fundamental concept I should have.	37 (2.30)	138 (8.50)	464 (28.70)	545 (33.60)	435 (26.90)
35. I am well-realized that basic knowledge is important for practical and real-life work.	28 1.70	106 6.50	425 26.30	591 36.50	469 29.00
36. I am well-realized that in this real world, those who are successful are the	21 (1.30)	126 (7.80)	355 (21.90)	538 (33.20)	579 (35.80)

Items	Level of opinions				
	1	2	3	4	5
Learning to Do (L2D)					
ones who have clear and achievable learning goal.					
37. I am well-planned and well-prepared for my work.	58 (3.60)	181 (11.20)	541 (33.40)	575 (35.50)	264 (16.30)
38. I try to analyze the work so that it would flow orderly as planned.	53 (3.30)	179 (11.10)	559 (34.50)	562 (34.70)	266 (16.40)
39. I need to control myself well and train myself to work with diligent and tolerant manner.	40 (2.50)	162 (10.00)	486 (30.00)	590 (36.40)	341 (21.10)
40. I see the importance of regular monitor and restructure of the work	44 (2.70)	180 (11.10)	471 (29.10)	592 (20.50)	332 (20.50)
41. I try to train the skills in working of myself to be skillful.	43 (2.70)	165 (10.20)	500 (30.90)	564 (34.80)	347 (21.40)
42. I always exchange my learning method and work with others that enable my work to be used in real situation.	43 (2.70)	208 (12.80)	513 (31.70)	530 (32.70)	325 (20.10)
43. I try to develop working method to improve to reach better achievement.	44 (2.70)	187 (11.60)	487 (30.10)	567 (35.00)	334 (20.60)
44. I find, adjust, integrate or apply new method in my work.	57 (3.50)	199 (12.30)	517 (31.90)	574 (35.50)	272 (16.80)
45. I intent to study both theory and practices.	46 (2.80)	160 (9.90)	491 (30.30)	552 (34.10)	370 (22.90)
46. I have all necessary knowledge for practical work.	67 (4.10)	268 (16.60)	538 (33.20)	515 (31.80)	231 (14.30)
47. Before doing practical work, I evaluate my own foundation knowledge and enrich it as necessary.	69 (4.30)	201 (12.40)	517 (31.90)	534 (33.00)	298 (18.40)
48. I have clear learning goal. I also know the knowledge and skill needed to use in future.	28 (1.70)	153 (9.50)	426 (26.30)	541 (33.40)	471 (29.10)
49. I can plan and prepare what is needed for perfectly-operated work.	44 (2.70)	183 (11.30)	542 (33.50)	552 (34.10)	298 (18.40)
50. My teachers told me that most of my works are well systematic and orderly correct.	69 (4.30)	237 (14.60)	577 (35.60)	521 (32.20)	215 (13.30)
51. The work I am responsible for is completed smoothly as planned.	57 (3.50)	170 (10.50)	538 (33.30)	569 (35.10)	285 (17.60)
52. I try to improve my weakness and strength through various methods such as self-assessment, teacher-assessment, and peer-assessment.	45 (2.80)	153 (9.50)	500 (30.80)	551 (34.00)	370 (22.90)
53. I finish my work with quality on time.	55 (3.40)	198 (12.20)	585 (36.10)	542 (33.50)	239 (14.80)
54. My working achievement can be applicable for maximum benefits.	53 (3.30)	221 (13.60)	561 (34.70)	530 (32.70)	254 (15.70)
55. Teachers and others appreciate my work as it is widely applicable.	76 (4.70)	267 (16.50)	551 (34.10)	512 (31.60)	213 (13.10)
56. My working achievement is much appreciated as it is innovative and applicable.	83 (5.10)	278 (17.20)	525 (32.40)	492 (30.40)	241 (14.90)

In conclusion, students' responses on the questionnaires mostly fall on third and fourth choice of the 5-point rating scale. Mostly, the two choices were selected by approximately 30 percentages comparing to other choices.

1.2. Psychometric Properties of Student Learning Measurement Instrument

Based on the documentation synthesis, it was confirmed that the measurement model of student learning consists of 56 items nested in 12 indicators.

1.2.1. Content Validity

Content validity check was employed to validate content comprehension, accuracy, and clarity by using IOC index in scoring the items. The IOC index of each item retained in the measurement model of student learning should be higher than 0.50 (Sireci, 1998; Turner & Carlson, 2003).

Table 4.4: Measurement Model of Student Learning and IOC

Models	Components	Sub-components	Indicators	Items	IOC
Learning	L2K	proc_L2K	proc_K_desi	1. I know good learning requires clearly-desired goals.	1.00
				2. Learning happens everywhere, every time regardless inside/outside the school or at home.	1.00
				3. It is important to provide myself with opportunity to learn new knowledge.	.75
				4. I believe that effective learning emerges from my own efforts.	1.00
			proc_K_enga	5. I try to inspire and enhance myself to learn new things all the time.	1.00
				6. I manage myself to have learning discipline and concentration.	1.00
				7. I pay attention to my learning so that I can gain knowledge and use it for real benefits.	1.00
				8. I focus on my learning and participate in activities both inside and outside the classroom.	1.00
			proc_K_learn	9. I like searching for good remembering techniques and I apply those techniques in my learning.	1.00
				10. I like using a variety of taking-note strategy so that it helps me to remember the lesson easily.	1.00
				11. I use a various strategies to practice reading.	1.00
				12. I learn to clearly understand the sequence of work as well as the procedure to do the calculation or to solve the mathematic problem.	.75
				13. I have different methods to gain knowledge and use it for maximized benefits.	1.00
				14. I have techniques to control myself for effective learning.	1.00
				15. I try to analyze my own weakness, strength and method to deal with learning problems I encounter.	1.00
				16. I try to find new learning methods to gain fundamental knowledge for achieving of my ultimate goal.	.75
		out_K	out_K_desi	17. Currently, I have clear learning goals. I know what I want to learn and what I learn for.	.75
				18. I am happy with such learning environment: at school, at home and other places.	1.00
				19. I always provide myself with opportunity to join learning activities organized by schools and other organizations.	1.00
				20. Being a student, I spend much of time on learning as it is consider to be the most prioritized thing.	1.00

Models	Components	Sub-components	Indicators	Items	IOC
			out_K_enga	21. Everyone commented that I love learning and being enthusiastic to seek new knowledge.	.75
				22. I am responsible for my study (e.g. attend classes on time, submit all assignment on time).	.75
				23. I can link and integrate between existing and newly-gained knowledge together for the use any particular situations.	1.00
				24. I am the one who have broad knowledge from reading and doing activities in addition to what teachers teach.	1.00
			out_K_learn	25. I am good at remembering what is taught and I am able to apply it in any circumstances.	1.00
				26. I have techniques for quick writing and taking note.	1.00
				27. I can read the book fluently and I can understand what I read.	1.00
				28. I am skillful in calculation and mathematic.	1.00
				29. I can search for knowledge by using a variety of methods such as using ICT-assisted device or asking experts in the field.	.75
				30. I can learn effectively what I want to learn without any concerns.	.75
				31. I know my strength and weakness and I can improve my weakness.	1.00 1.00
				32. I have academic achievement at satisfactory level.	1.00
	L2D	proc_D	proc_D_conc	33. I realize that the only theoretical knowledge embedded in the course is not enough for practical work.	1.00
				34. I know what fundamental concept I should have.	.75
				35. I am well-realized that basic knowledge is important for practical and real-life work.	1.00
				36. I am well-realized that in this real world, those who are successful are the ones who have clear and achievable learning goal.	1.00
			proc_D_prac	37. I am well-planned and well-prepared for my work.	1.00
				38. I try to analyze the work so that it would flow orderly as planned.	1.00
				39. I need to control myself well and train myself to work with diligent and tolerant manner.	1.00
				40. I see the importance of regular monitor and restructure of the work	1.00
			proc_D_cont	41. I try to train the skills in working of myself to be skillful.	1.00
				42. I always exchange my learning method and work with others that enable my work to be used in real situation.	1.00
				43. I try to develop working method to improve to reach better achievement.	1.00
				44. I find, adjust, integrate or apply new method in my work.	1.00
		out_D	out_D_conc	45. I intent to study both theory and practices.	1.00
				46. I have all necessary knowledge for practical work.	1.00
				47. Before doing practical work, I evaluate my own foundation knowledge and enrich it as necessary.	1.00
				48. I have clear learning goal. I also know the knowledge and skill needed to use in future.	1.00
			out_D_prac	49. I can plan and prepare what is needed for perfectly-operated work.	1.00
				50. My teachers told me that most of my works are well systematic and orderly correct.	1.00
				51. The work I am responsible for is completed smoothly as planned.	1.00
				52. I try to improve my weakness and strength through various methods such as self-assessment, teacher-assessment, and peer-assessment.	.50
			out_D_cont	53. I finish my work with quality on time.	1.00
				54. My working achievement can be applicable for maximum benefits.	1.00
				55. Teachers and others appreciate my work as it is widely applicable.	1.00
				56. My working achievement is much appreciated as it is innovative and applicable.	1.00

In this development of the measurement model of student learning, IOC index each item was ranged from 0.75 to 1.00, except for item 52, which attained only a 0.50 IOC index. Hence, this newly developed measurement model of student learning is content-validated by four experts in the field.

1.2.2. Objectivity

The research instrument of this research study was developed in Thai after Thai version was qualified by experts the translation process was also conducted. Therefore, the objectivity of the research instrument was also employed within two steps. The first step was employed to find the objectivity of the research instrument in Thai by 12 experts. The second step was employed to investigate the objectivity of the research instrument in Khmer version by three experts, respectively.

Within the first step, the objectivity of research instrument in Thai version was checked for a long period of time during an academic class of thesis report writing. Thereafter, the objectivity of research instrument was also checked by professional experts in the field of education in order to find out the specific point of view of each experts on the developed items. After the objectivity was checked by 12 experts (8 master and doctoral students of the program and 4 experts from the appendix A), the results revealed that all experts agreed that the items of the measurement model of student learning are qualified as the criteria needed.

Within the second step, the objectivity of the research instrument in Khmer version was also checked by three experts in the (Appendix C). The three experts were from academic background and from the familiar context intended to measure. The objectivity was used to check out whether the similar sample characteristic understanding the same on the opinion about learning items. Hence, three experts agreed harmoniously with the criteria used in the research instrument in terms of language use, scoring check, and interpretation criteria.

In conclusion, the measurement instrument of student learning was accepted by the criteria of objectivity in terms of language used, scoring check, and interpretation criteria in which implemented in the measurement model of student learning.

The experts viewed that all items are objectively measured in terms of three technical criteria—language use, scoring check, and interpretative criteria. The three concepts of questionnaire objectivity are presented in detail in Table 4.5.

Table 4.5: Objectivity Check of Items of Student Learning

Objectivity	Experts' opinions
1. Language use	Clear language use was implemented in this questionnaire even some items stated in words or phrases. Actually, it should be sentence statement. Item statements are appropriate for high school student of the intended-age group to express their opinion on items provided. Additionally, it can be understood by all age interval of the high school students.
2. Scoring check	Items of both factors of measurement model of student learning measured from summated items of rating scale of 5 points-Likert Scale in which provide objectivity for scoring check even someone scores items he/she would score the same to one another. Thus, scoring check is appropriate and provide same scores for every respondent.
3. Interpretative criteria of the score	Items of measurement model of student learning from both process and outcome of learning to (know and do) consisted of clearly interpretation criteria concerning from means' score of each items. The items' scores are nested under indicators. The indicators are nested under components. The components are nested under factors which is convenient for respondents to score the items.

Table 4.5 shows that the objectivity of items of the measurement model of student learning which were developed appropriately and objectively measure the concept as intended to measure in accordance the operational definition provided. Additionally, ones would understand the same form one to another the criteria provided in the 5-point rating scale, meaning that each interval of opinion was sequent rated.

1.2.3. Uncertainty

To calculate student learning composite scores, there are four models that were proposed. They are equal loading, factor loading, additive, and multiplicative models. The four model of composite scores calculation were believed to produce separate

individual composite scores. Thus, uncertainty analysis was employed to investigate the variation of composite score of student learning.

Uncertainty analysis was used to assess the impact of alternative models on the each model ranks. Each model is a different composite indicator in which the choice of weights and aggregation method have been varied within a plausible range. This uncertainty analysis help to dealt with the criticism on composite measure or rankings that had been calculated under conditions of certainty (Saisana, 2008; Saltelli, 2007).

Composite scores of student learning consisted of a weighting scheme which was comprised of two schemes-equal and non-equal weighting schemes of Learning to Know and Learning to Do, which were obtained from fixed loadings and confirmatory factor analysis' loadings, whereas the two aggregation methods available were the additive and multiplicative methods. Hence, all available models of analysis which should be used in developing composite scores of student learning comprises of 4 models which were used to calculate final composite scores of student learning as intended in research objectives. The four models of calculating the composite score of student learning were used in alternative analysis which would provide more reliable and credible composite scores of student learning (Table 4.6).

Table 4.6: A Development of Composite Scores of Student Learning

Model	Weighting	Aggregation
1	equal loading	additive model
2	equal loading	multiplicative model
3	factor loading	additive model
4	factor loading	multiplicative model

After the treatment of the weights and the alternative aggregation of the items was made, the composite scores of student learning was employed with correlation analysis to be explicit the correlation coefficients.

Accordingly, the correlation coefficients of the 4 combination composite scores of student learning are presented in Table 4.7. The correlation coefficients of the 4 combination composite scores ranged from .75 to .99. Each pair of the correlation coefficients were statistically significant at the alpha level of .05. These coefficients indicated that 4 combination composite scores of student learning of the developed

models were as high as the rank of its composite scores. Hence, the ranks and correlation coefficients of the 4 combination models of student learning harmoniously measured the same objective, as intended.

As previously mentioned, this uncertainty analysis aimed to answer the question regarding which of the weighting schemes and aggregation methods was the most important in determining the composite scores of student learning. Therefore, 4 combinations of weighting schemes and aggregation methods were conducted to answer this question in terms of correlation coefficients.

Table 4.7: Correlation Coefficients of Value and Rank of Composite Score of 4 Models

Model	1	2	3	4
1	1.00			
2	.99**	1.00		
3	.99**	.99**	1.00	
4	.75**	.75**	.75**	1.00

**p<.01

The analysis result shown in Table 4.7 are correlation coefficients of the overall composite scores of student learning calculated across 4 models. Such a correlation coefficient matrix synthesizes the ranking while making the uncertainty explicit. It is beyond doubt that 4th model has slightly low correlation coefficient in composite scores of student learning among the 4 combination models, while other 3 models produce high and the same correlation coefficients. These results concluded that overall composite scores of student learning can be considered as representative of plurality of models and not just of a specific combination model.

Hence, based on Table 4.7, the correlation coefficient results revealed that the composite scores of student learning have changed from equal to non-equal weights resulted in a change in the composite scores by the correlation coefficients between .99 and .75 for additive and multiplicative models, respectively. Accordingly, these results also revealed that the composite scores of student's learning is more uncertain to changes in the aggregation methods, rather than to the changes in the weighting scheme.

A positive result of this analysis is that the ranks of correlation coefficients interval for all models suggests that there is no particularly volatile changes in the

correlation coefficients and all 4 combination models see little change in their correlation coefficients, on average (less than .24). These narrow change intervals suggest that robust conclusion (on average) on the relative calculations on composite score of student learning can be drawn, meaning that 4 models of composite scores development would provide highly harmonious composite scores.

Thus, in this research study, a third model (additive model with factor loading) would be preferable for use in measuring this specific composite scores of student learning. This model was more robust and appropriate model than others. Accordingly, it was convenient in empirical practices and easy to understand to audiences. On the other hand, it was in harmony with principles of measurement and evaluation, in which it distributed high reliability coefficients to measure components/subcomponents.

In the same sense, this model was concerned additive with the unequal factor loadings of individual indicator which were fitted with empirical situation that factor loadings measured by confirmatory factor analysis (CFA) were not equal, in common.

In conclusion, to develop composite scores of student learning, one should provide the concept of developing and verifying the developed composite scores. In terms of theoretical frameworks, this process met the requirements with the references from only 4 main experts (IOC ranked form .50 -1.00) in the field of educational measurement and evaluation, educational policy and management, as well as 8 master degree and doctoral students (in the brainstorming processes) of educational research methodology. Statistical analysis of reliability was also distributed with high reliability coefficients of Cronbach Alpha ranging between .83 - .93 respectively. Furthermore, the calculation methods were also employed to validate the composite scores of measurement model of student learning.

1.2.4. Construct Validity

In order to verify the fit of the student learning measurement model, the CFA(s) were conducted to see whether the model paralleled the empirical data collected from 1619 Cambodian high school students.

Quality items of measurement model of student learning was employed with confirmatory factor analysis (CFA) which will produce construct validity of the measurement model of student learning. As early mentioned, the measurement model

of student learning comprised of two components. Thus, the two components were considered to be the measurement models. Hence, two measurement models of student learning namely Learning to Know and Learning to Do measurement models were validated statistically. The two models would be separately validated by component of student learning. Therefore, the measurement model of student learning was separately confirmed as the following sequences. Thus, the first measurement model is Learning to Know. It was validated by second-order confirmatory factory analysis.

Second-order confirmatory factor analysis of Learning to Know comprises of two components—process of Learning to Know and outcome of Learning to Know, and 6 indicators including process of learning desire (proc_K_desi), process of learning engagement (proc_K_enga), process of learning to learn (proc_K_learn) which are nested under process of Learning to Know, accordingly, outcome of learning desire (out_K_desi), outcome of learning engagement (out_K_enga), and outcome of learning to learn (out_K_learn) which are nested under outcome of Learning to Know.

Second-order confirmatory factor analysis (CFA) results reveled that Learning to Know measurement model distributed goodness-of-fit between model with empirical data with the goodness-of-fit indices of Chi-square (2, N = 1619) = 3.04, p-value of .05, comparative fit index (CFI) of 1.00, Tucker Lewis Index (TLI) of .99, standardized root mean square residual (SRMSR) of .01, and root mean square error of approximation (RMSEA) of .02 (Hu & Bentler, 1998).

All goodness- and badness-fit indices of second-order CFA model meet the criteria, it is confirmed that the measurement model of student learning to Know had construct validity. Thus, statistical values of second-order CFA were presented to describe detailed about any statistical value.

The results indicated that the two components were important to ensure quality of student learning to Know as their standardized factor loadings were statistically significances at the .01 level with the ranged from .72 - .82 for the first-order. Therefore, individual component was interpreted as the following sequences.

The first component of Learning to Know comprises of standardized factor loading between .72 and .82. The highest standardized factor loading of this component was process of learning desire (proc_K_desi), followed by process of learning to learn

(proc_K_learn), and process of learning engagement (proc_K_enga) with the lowest standardized factor loading, respectively.

The second component of Learning to Know comprises of standardized factor loadings between .76 and .82. The highest standardized factor loading of this component was outcome of learning engagement (out_K_enga), followed by outcome of learning desire (out_K_desi), and outcome of learning to learn (out_K_learn) with the lowest standardized factor loading, respectively.

Accordingly, second-order CFA of student learning to Know was also important to ensure quality of student learning as their standardized factor loadings were statistically significances at the .01 level with the ranged from .96 - .99. The highest factor standardized loading was outcome of Learning to Know, followed by process of Learning to Know with the lowest standardized factor loading as shown in Table 4.8.

Table 4.8: CFA Results of Learning to Know Model

Variables	Factor loadings		t	R^2	Factor score coefficients
	β	(SE)			
First-order CFA_know					
proc_K_desi	.82	.00	113.22**	.67	.44
proc_K_enga	.72	.01	50.25**	.51	.01
proc_K_learn	.76	.01	78.86**	.58	.02
out_K_desi	.79	.01	71.50**	.63	.28
out_K_enga	.82	,01	71.64**	.68	.32
out_K_learn	.76	.02	46.42**	.57	.08
Second-order CFA_know					
proc_K	.96	.00	465.17**	.92	.01
out_K	.99	.00	1857.59**	.98	.01
Chi-square (2, N = 1619) = 3.04, p = .05, *CFI* = 1.00, *SRMSR* = .01, *RMSEA*= .02.					

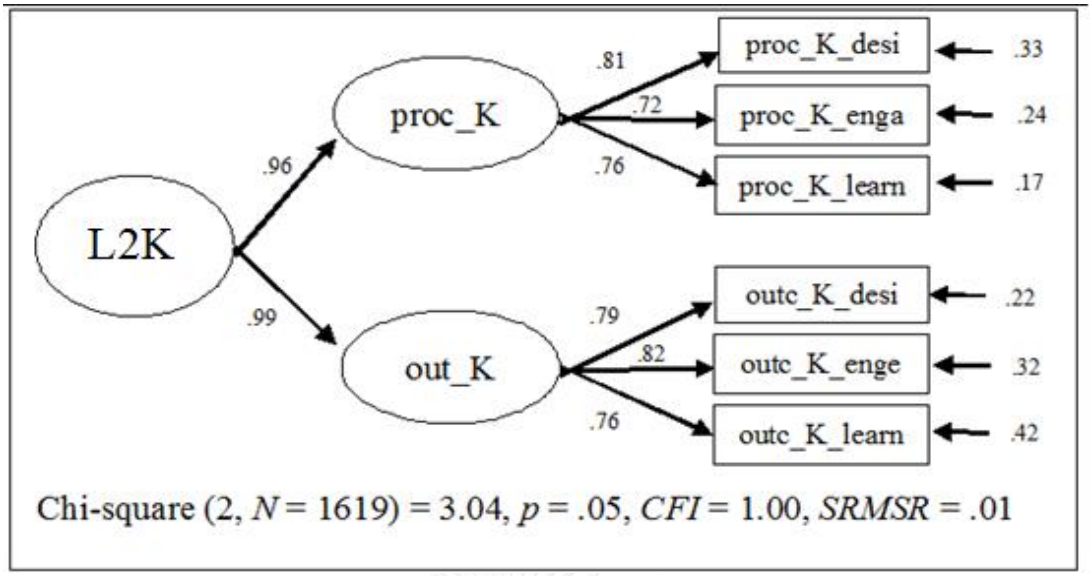

Figure 4.1: Measurement Model of Learning to Know (L2K)

Second-order confirmatory factor analysis of Learning to Do comprises of two components—process of Learning to Do and outcome of Learning to Do, and 6 indicators including process of concern learning as the real world of work (proc_D_conc), process of practical engagement (proc_D_prac), process of continuing self-development (proc_D_cont) which are nested under process of Learning to Do, accordingly, outcome of concern learning as the real world of work (out_D_conc), outcome of practical engagement (out_D_prac), and outcome of continuing self-development (out_D_cont) which are nested under outcome of Learning to Do.

Second-order confirmatory factor analysis (CFA) of students' Learning to Do measurement model results revealed that Learning to Do distributed goodness-of-fit between theoretical model with empirical data with the goodness-of-fit indices of Chi-square (4, N=1619) =7.41, p-value of .12, comparative fit index (CFI) of 1.00, Tucker Lewis Index (TLI) of .99, standardized root mean square residual (SRMSR) of .01, and root mean square error of approximation (RMSEA) of .02. All fitted indices of this model meet the criteria, it was confirmed that measurement model of student Learning to Do had construct validity. Thus, statistical values were presented in the Table 4.9.

The results indicated that the two components were important to ensure quality of student Learning to Do as their standardized factor loadings were statistically

significances at the .01 level with the ranged from .83 - .88 for the first-order. Therefore, individual component was interpreted as the following sequences.

The first component of Learning to Do comprises of standardized factor loading between .83 and .87. The highest standardized factor loadings of this component were process of practical engagement (proc_D_enga) and process of continuing self-development (proc_D_cont), followed by process of concern learning as the real world of work (proc_D_conc) with the lowest standardized factor loading.

The second component of Learning to Do comprises of standardized factor loadings between .83 and .88. The highest standardized factor loading of this component was outcome of practical engagement (out_D_prac), followed by outcome of continuing self-development (out_D_cont), and outcome of concern learning as the real world of work (out_D_conc) with the lowest standardized factor loading.

Accordingly, second-order CFA of student Learning to Do was also important to ensure quality of student Learning to Do as their standardized factor loadings were statistically significances at the .01 level with the ranged from .95 - .96. The highest factor standardized loading was outcome of Learning to Do, followed by process of Learning to Do with the lowest standardized factor loading as shown in Table 4.9.

Table 4.9: CFA Results of Learning to Do

Variables	Factor loadings		t	R^2	Factor score coefficients
	β	(SE)			
First ordered CFA_know					
proc_D_conc	.83	.01	127.25**	.68	.33
proc_D_prac	.87	.01	101.09**	.76	.22
proc_D_cont	.87	.01	99.39**	.75	.25
out_D_conc	.83	.01	93.09**	.69	.06
out_D_prac	.88	.01	110.99**	.77	.07
out_D_cont	.86	.01	102.39**	.74	.27
Second-order CFA_do					
proc_D	.95	.01	394.64**	.91	.01
out_D	.96	.01	556.66**	.93	.01

Chi-square (4, N=1619) =7.41; CFI= 1.00; SRMSR = .01; p = .05; RMSEA= .02.

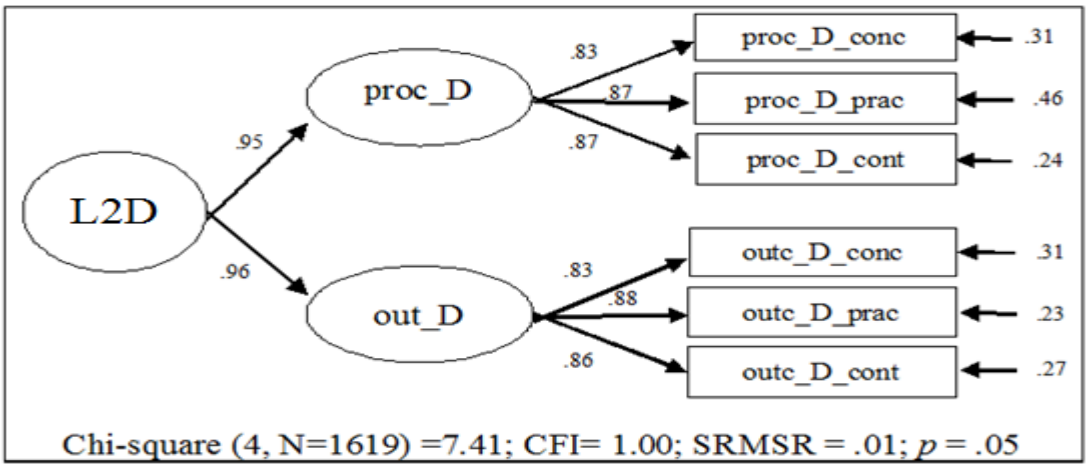

Figure 4.2: Measurement Model of Learning to Do (L2D)

Beside two separated second-order measurement models of student learning to Know and student Learning to Do, a higher order measurement model of student learning was also investigated the construct validity. Thus, the summarization of these two measurement models of Learning to Know and Learning to Do was called measurement model of student learning. The measurement models of student learning combined the measurement models of Learning to Know (L2K) and Learning to Do (L2D) together. Therefore, new measurement model of student learning was validated by third-order confirmatory factor analysis.

Based on the first two second-order confirmatory factor analysis models, Learning to Know consisted of two components—process of Learning to Know and outcome of Learning to Know, as well as, Learning to Do consisted of two components—process of Learning to Do and outcome of Learning to Do.

The process of Learning to Know consisted of three indicators—learning desire, learning engagement and learning to learn. Consequently, the process of Learning to Do comprised of three indicators such as concern learning as the real world of work, practical engagement, and continuing self-development.

On the other hand, outcome of Learning to Know consisted of three indicator—outcome of learning desire, outcome of learning engagement, and outcome of learning to learn, identically, outcomes of Learning to Do consisted of three indicators—outcome of concern learning as the real world of work, outcomes of practical engagement, and outcome of continuing self-development.

Summarizing the conclusion above, student learning measurement model comprises of 2 components—L2K and L2D, 4 sub-components—proc_K, out_K, proc_D, and out_D, and 12 indicators—proc_K_desi, proc_K_enga, proc_K_learn, out_K_desi, out_K_enga, out_K_learn, proc_D_conc, proc_D_prac, proc_D_cont, out_D_conc, out_D_prac, and out_D_cont, respectively.

The third-order confirmatory factor analysis on measurement model of student learning was administered. The results of third-order CFA revealed that the measurement model of student learning had validity. It was confirmed by goodness-of-fit indices of chi-square (15, N=1619) = 22.32, p-value of .10, comparative fit index (CFI) of 1.00, Tucker Lewis Index (TLI) of .99, standardized root mean square residual (SRMSR) of .01, and root mean square error of approximation (RMSEA) of .02.

Based on these goodness- and badness-of-fit indices, it was assumed that measurement model of student's learning was construct valid with the statistical values provided in the Table 4.10.

The results indicated that the two components—L2K and L2D, were important to ensure quality of student learning as their standardized factor loadings were statistically significances at the .01 level with the ranged from .82 - .95 for the first-order. Therefore, individual component was interpreted as the following sequences.

The first component of learning model, L2K, comprises of standardized factor loading between .82 and .95. The highest standardized factor loading of this component was outcome of learning to learn (out_K_learn), followed outcome of learning engagement (out_K_enga), process of learning to learn (proc_K_learn), outcome of learning desire (out_K_desi), process of learning engagement (proc_K_enga), and process of learning desire (proc_K_desi) with the lowest standardized factor loading.

The second component of learning model, L2D, comprises of standardized factor loading between .82 and .86. The highest standardized factor loadings of this component were outcome of concern learning as the real world of work (out_D_conc) and outcome of practical engagement (out_D_prac), followed by process of concern learning as the real world of work (proc_D_conc) and outcome of continuing self-development (out_D_cont), process of practical engagement (proc_D_enga), and process of continuing self-development (proc_D_cont) with the lowest standardized factor loading, respectively.

Second-order CFA of student learning was also important to ensure measurement model quality of student learning as their standardized factor loadings were statistically significances at the .01 level with the ranged from .83 - .99. The highest factor standardized loading was proc_D, followed by out_D, out_K, and proc_K with the lowest standardized factor loadings.

Accordingly, the third-order CFA of student learning comprises of standardized factor loadings between .96 and .98. The highest standardized factor loading of this component was L2D, followed by L2K with the lowest standardized factor loading, respectively as shown in Table 4.10.

Table 4.10: CFA Results of Student Learning Model

Variables	Factor loadings		t	R^2	Factor score coefficients
	β	(SE)			
First-order of learning					
proc_K_desi	.82	.01	114.56**	.67	.34
proc_K_enga	.83	.01	124.12**	.68	.09
proc_K_learn	.91	.01	285.96**	.83	.30
out_K_desi	.87	.01	186.19**	.76	.35
out_K_enga	.93	.01	75.68**	.87	.34
out_K_learn	.95	.01	563.63**	.90	.52
proc_D_conc	.85	.01	144.43**	.72	.30
proc_D_prac	.83	.01	126.83**	.69	.03
proc_D_cont	.82	.01	70.09**	.67	.08
out_D_conc	.86	.01	97.27**	.74	.09
out_D_prac	.86	.01	92.15**	.74	.19
out_D_cont	.85	.01	83.13**	.72	.20
Second-order of learning					
proc_K	.83	.01	58.20**	.68	.05
out_K	.89	.01	183.56**	.81	.06
proc_D	.99	.01	74.99**	.56	.08
out_D	.96	.01	607.65**	.94	.01
Third-order of learning					
L2K	.96	.01	399.55**	.93	.01
L2D	.98	.01	785.70**	.96	.01
Chi-square (15, N=1619) = 22.32; p = .10; RMSEA = .02; SRMSR = .01; CFI = 1.00					

The analysis results of third-order confirmatory factor analysis model revealed that the goodness-of-fit index of the measurement model of student learning was appropriate and fitted with empirical data collected as shown in the Table 4.10.

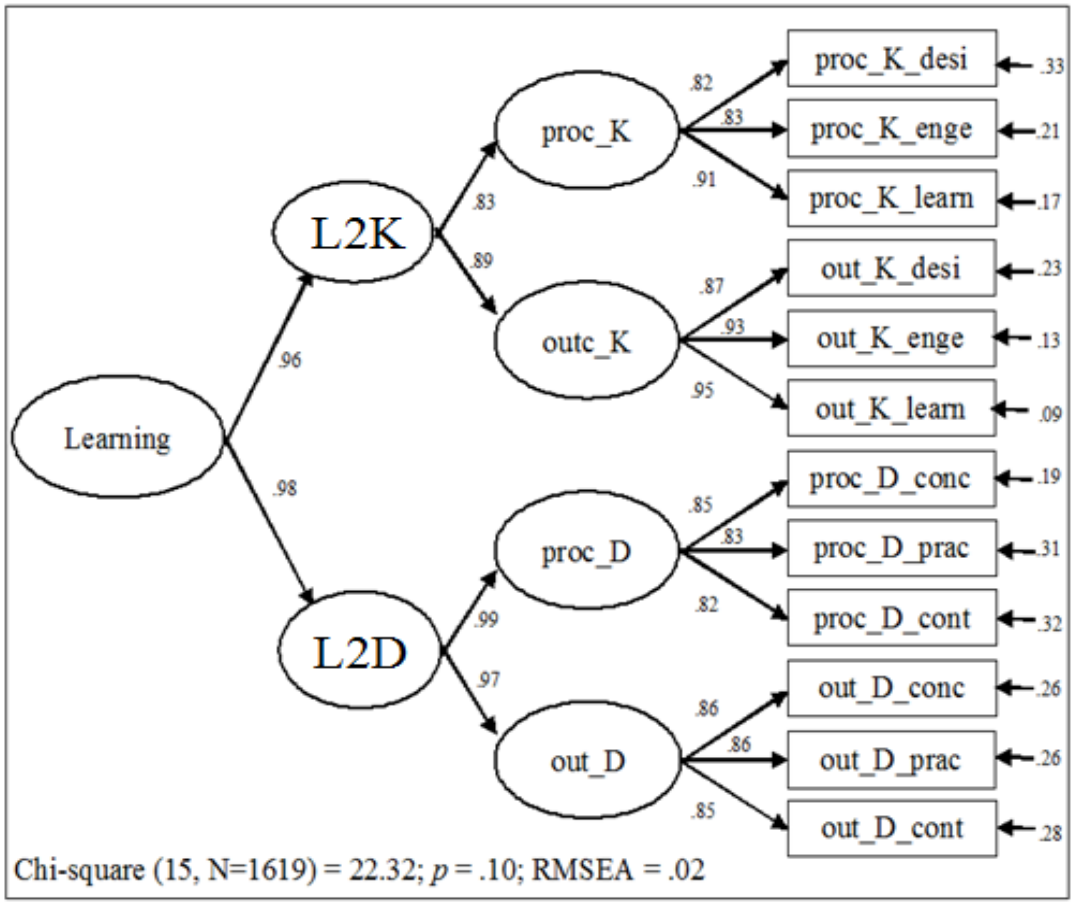

Figure 4.3: Measurement Model of Student Learning

1.2.5. Reliability

Reliability coefficients were examined, Cronbach's Alpha Coefficients (Gliem & Gliem, 2003), by a pilot study processes of 25 Cambodian high school students on a measurement model of student learning.

Whole internal consistency reliability coefficient of the student learning measurement model was .98, while the internal consistency reliability coefficients of L2K and L2D was .97. Additionally, all indicators of the questionnaire were analyzed to calculate the reliability coefficients. The analysis results revealed that instrument quality in terms of internal consistency were high which meet the accepted criteria. The reliability coefficients of this study were ranged between .83 and .93, respectively, thus,

the highest reliability of all indicators fall on learning to learn with the reliability coefficient value of .93, and the lowest reliability indicator was concern as the real world of work with the reliability coefficient value of .83. The reliability coefficients were presented in two separated components—L2K and L2D.

The reliability coefficients of the first component, L2K, were ranged between .80 and .91 while the reliability coefficients of the sub-components were ranged between .94 and .96, and whole component reliability coefficient was .97 (Table 4.11).

Table 4.11: Reliability Coefficients by Items (L2K =32 Items)

No of Items	Cronbach' s Alpha if item deleted	No of Items	Cronbach' s Alpha if item deleted	No of Items	Cronbach' s Alpha if item deleted
1.	.85	12.	.91	23.	.77
2.	.86	13.	.92	24.	.87
3.	.86	14.	.92	25.	.89
4.	.84	15.	.91	26.	.90
5.	.84	16.	.92	27.	.90
6.	.86	17.	.76	28.	.90
7.	.91	18.	.70	29.	.90
8.	.84	19.	.76	30.	.90
9.	.92	20.	.79	31.	.89
10.	.92	21.	.75	32.	.91
11.	.93	22.	.83		

proc_K_desi (item1 – item4)	α = .89
proc_K_enga (item5 - item8)	α = .89
proc_K_learn (item9 – item16)	α = .93
out_K_desi (item17- item20)	α = .80
out_K_enga (item21- item24).	α = .85
out__learn (item25 – item32)	α = .91
pro_K (proc_K_desi, enga, learn)	α = .96
out_K (out_K_desi, enga, learn)	α = .94
L2K (proc_K & out_K)	α = .97

The reliability coefficients of the second component, L2D, were ranged between .83 and .92 while the reliability coefficients of the sub-components were ranged between .94 and .95, and whole component reliability coefficient was .97 (Table 4.12).

Table 4.12: Reliability Coefficients by Items (L2D =24 Items)

No of Items	Cronbach' s Alpha if item deleted	No of Items	Cronbach' s Alpha if item deleted	No of Items	Cronbach' s Alpha if item deleted
33.	.80	41.	.86	49.	.88
34.	.80	42.	.80	50.	.94
35.	.74	43.	.79	51.	.90
36	.81	44.	.84	52.	.87
37.	.89	45.	.81	53.	.81
38.	.90	46.	.86	54.	.80
39.	.88	47.	.83	55.	.80
40.	.93	48.	.81	56.	.86

proc_D_conc (item33 – item36)	α = .83
proc_D_prac (item37 – item40)	α = .92
proc_D_cont (item41-item44)	α = .86
out_D_conc (item45 – item48)	α = .87
out_D_prac (item49 – item52)	α = .92
out_D_cont (item53 –item56)	α = .86
proc_D (proc_D_conc, prac, cont)	α = .94
out_D (out_D_conc, prac, cont)	α = .95
L2D (proc_K & out_K)	α = .97

In conclusion, the reliability coefficients of each component of the measurement model were almost equal. The reliability coefficients ranked between .94 - .96. This indicates that the reliability coefficients of the four components of the measurement model of student learning were very high.

On the other hand, the reliability coefficients of student learning obtaining from the third-order confirmatory factor analysis were extracted to compare with internal consistency reliability coefficients of the pilot study (Table 4.13).

Table 4.13 shows that most of the internal consistency reliability coefficients are higher than the construct reliability coefficients except the L2D component which had equal reliability coefficient (α = .97).

Table 4.13: Comparison between Internal Consistency and Construct Reliability

Indicator of learning	Internal consistency reliability coefficients	Construct reliability coefficients
1. proc_K_desi	α = .89	α = .67
2. proc_K_enga	α = .89	α = .68
3. proc_K_learn	α = .93	α = .83
4. out_K_desi	α = .80	α = .76
5. out_K_enga	α = .85	α = .87
6. out_K_learn	α = .91	α = .91
7. proc_K	α = .96	α = .68
8. out_K	α = .94	α = .81
9. L2K	α = .97	α = .93
10. proc_D_conc	α = .83	α = .72
11. proc_D_prac	α = .92	α = .69
12. proc_D_conc	α = .86	α = .68
13. out_D_conc	α = .87	α = .74
14. out_D_prac	α = .92	α = .74
15. out_D_conc	α = .86	α = .72
16. proc_D	α = .94	α = .56
17. out_D	α = .95	α = .93
18. L2D	α = .97	α = .97

1.2.6. Criterion-Related Validity

Prior to the analysis known-groups of the students, perceived by teachers, were divided into two groups—low level composite scores of student learning (12 respondents) and high level composite scores of student learning (12 respondents). Thereafter, research questionnaires were employed with two known-groups of students in order to investigate the composite scores obtaining from empirical data.

The two known-groups obtaining from teachers were used as the criterion, while the composite scores of student learning obtaining from questionnaires were used as test score. Therefore, t-test was used to compare between the criterions and test scores.

The composite scores of student learning of the two known groups were tested by t-test in order to find out whether each group of composite scores of student learning differs. Therefore, the composite scores of each factor of the two groups of student learning are presented in the Table 4.14.

t-test was conducted to explore the differences between the two groups of students scores obtaining from questionnaires. Thus, the analysis was conducted within 12 samples for each group.

The results revealed that the composite scores of student learning of low level learning group was 37.72 (SD = 3.51) while composite scores of student learning of high level learning group was 43.06 (SD = 3.34). The result of t-test analysis showed that there was a statistical significance between the means composite scores of two known-groups ($t = 3.82$, $df = 22$, $p<.05$).

Table 4.14: Mean, SD, Min, Max of Students' Composite Learning Classified by Known-Groups

Known-Group	Full score	Mean	SD	CV	Min	Max	t-test
Low level (n=12)	60	37.72	3.51	9.31	31.88	42.32	t=3.82, df=22, p<.05
High level (n=12)	60	43.06	3.34	7.76	37.25	48.63	

Table 4.14 indicates clearly that two know-groups of students produced different learning composite scores by questionnaires. While the teachers also perceived that the two known-groups of students were differences in learning scores.

In sum, the measurement of student learning perceived by teachers fitted with t-test ($t = 3.82$, $df = 22$, $p<.05$). Therefore, this research instrument had criterion-related validity using known-group technique which perceived by teachers.

Additional detailed about the levels of composite scores of student learning based on low level and high level of student learning, cut-off scores by percentile ranks were proposed in the Table 4.15.

In summarizing the above psychometric property investigations, it is confirmed that the research instrument had validity in terms of high congruence of content validity, objectivity, uncertainty, construct validity, reliability, and criterion-related validity. It was assumed that this measurement model of student learning was construct validated. Additionally, the measurement model of student learning was most appropriate for application within this study context and respondent characteristics.

1.3. Norm of Cambodian Student Learning

Table 4.15 presents individual norm of composite scores of each measurement model of student learning by percentiles. The composite scores of three models of student learning—Learning to Know, Learning to Do, and Learning were presented in percentile ranks both raw and weighted scores.

This research process measured composite scores of student learning in terms of raw composite scores, weighted composite scores, and learning index. Learning index was considered within two norms—criterion-referenced and norm-referenced.

This criterion was used to find out the thresholds of composite score levels. The percentiles of the three models—Learning to Know, Learning to Do, and Learning models of raw and weighted composite scores were calculated and presented in the above table which present learning composite scores at any level. Thus, the results of percentiles were indicated.

The values of both raw and weighted composite scores were divided by percentiles of 5-interval. The results revealed three responses of both raw and weighted composite scores of student learning. The first model dealt with Learning to Know which means raw composite scores of the model ranged from 15.00 at the 5^{th} percentile to 27.63 of the 95^{th} percentile, respectively, while the weighted composite score mean from 13.25 at the 5^{th} percentile to 24.37 at the 95^{th} percentile.

The three models have been calculated both with raw score and weighted composite scores. The second model dealt with Learning to Do which mean of raw composite scores of the model ranged from 14.50 at the 5^{th} percentile to 28.00 at the 95^{th} percentile while the weighted composite score of this model ranged from 12.25 at the 5^{th} percentile to 23.65 at 95^{th} percentile, respectively. The last model dealt with learning which means raw composite score of the model ranged from 33.63 at the 5^{th} percentile to 55.38 at 95^{th} percentile, while the weighted composite score of this model ranged from 24.42 at the 5^{th} percentile to 47.79 at 95^{th} percentile, respectively.

In conclusion in empirical practices, one could use the raw composite scores of student learning to calculate the level of student learning following the level of the percentiles. It is preferable to use raw composite scores and weighted composite scores to find out cut-off scores of student learning because it is more convenient to use and calculate. On the other hand, people may know better about raw scores that the weighted

ones. Therefore, the cut-off composite scores of student learning that would be used in the research study were the 25th, 50th, and 75th percentiles as intended in the criterion-referenced technique. Thus, the three percentile cut-off points were used as the thresholds for calculating composite scores of student learning.

Table 4.15: Norm of Student Learning Index Classified by Raw and Weighted Scores

Variables	Learning to Know		Learning to Do		Learning	
Percentile	raw score	weighted score*	raw score	weighted score*	raw score	weighted score*
5.0	15.00	13.25	14.50	12.25	30.63	26.42
10.0	16.88	14.81	16.00	13.54	33.50	28.88
15.0	17.88	15.68	17.25	14.60	35.50	30.72
20.0	18.63	16.43	18.00	15.22	36.88	31.86
25.0	19.38	17.02	18.50	15.65	38.13	32.92
30.0	20.00	17.59	19.25	16.28	39.63	34.20
35.0	20.63	18.13	19.75	16.72	40.63	35.01
40.0	21.00	18.51	20.25	17.12	41.38	35.68
45.0	21.38	18.88	21.00	17.73	42.38	36.52
50.0	21.88	19.30	21.50	18.17	43.38	37.47
55.0	22.38	19.72	22.25	18.78	44.25	38.25
60.0	22.75	20.09	22.75	19.21	45.25	39.04
65.0	23.38	20.59	23.25	19.65	46.25	39.90
70.0	23.88	21.06	24.00	20.26	47.25	40.81
75.0	24.38	21.53	24.50	20.70	48.75	42.07
80.0	25.13	22.17	25.25	21.32	50.00	43.22
85.0	25.88	22.82	26.00	21.96	51.50	44.46
90.0	26.75	23.59	27.00	22.80	53.00	45.77
95.0	27.63	24.37	28.00	23.65	55.38	47.79

Notice: Weighted score* = composite scores with factor loadings.
Maximum composite raw score of Learning to Know and Learning to Do = 30
Maximum composite raw score of learning = 60

The composite score of learning models were considered as normalization score that can be used as the criterion for evaluating individual student learning index as well. The index interval would provide information for the interpretation of student's

learning by level of learning index. Hence, the interpretation of student learning index obtained from two types of belief as mention earlier.

1.4. Learning Index

Index is increasingly recognized as a useful instrument in policy analysis and public communication (Joint Research Centre-European Commission, 2008; Saisana, 2010). Index is much easier to interpret than trying to find a common trend in many separate indicators. Index has proven to be useful in ranking or benchmarking exercises (M Nardo et al., 2005). Accordingly, learning index has been developed to measure, to interpret, to rank, and to benchmark student learning.

There are many methods used to calculate learning index such as normalization, weighting, aggregation, norm-referenced, and criterion-referenced (Giovannini et al., 2008; Nardo & Saisana, 2008). This research study preferably used norm-referenced and criterion-referenced to assess learning index, rank the student learning index, and interpret learning index of students based on the two types of belief.

The criterion-referenced and norm-referenced in this study were applied by using minimum and maximum of composite scoring of each component of student learning from measurement model to determine cut-off points of student learning composite scores (Chalmers, 2012; Giovannini et al., 2008).

Based on these two techniques, the composite scores of individual scores distribute index value between .00 – 1.00. By using composite scores, the index was calculated by individual composite score minus minimum composite scores and divided by maximum minus minimum composite score as in the following formula.

$$Index = \frac{Value - min}{Max - min}$$

The minimum and maximum individual composite scores of student learning score were 12.00 and 60.00. Hence, it allowed the previous formula to transform from factor scale into index values of student learning.

$$Students' learning\ Index = \frac{individual\ score - 12}{48}$$

As previous mentioned, student learning index of this research study have been classified into four levels such as low level index, moderate level learning index, relatively high level learning index and high level learning index based on the two approaches: criterion-referenced and norm-referenced.

The four levels of student learning index were interpreted under two types of belief—the first belief, UNESCO proposal (1996), was known that the process and outcomes of "Learning to Know" are the basis for "Learning to Do", additionally, the second belief, common ground of Cambodian context, was known that the outcomes of "Learning to Know" and "Learning to Do" are based on their learning processes.

Criterion-referenced approach was calculated by individual sub-component of student learning of measurement model composite scores divided by total composite scores of the same measurement model. In this sense, each sub-component of student learning measurement model composite scores is 15. Thus, four sub-components of student learning model composite scores is 60, meaning that, based on first type of belief, composite scores of student learning summation (topped up) 15 scores for each sub-component (Table 4.16).

Norm-referenced approach was also calculated by individual sub-component composite scores minus number of indicators that are nested in that subcomponent divided by total composite scores minus total number of indicators in the same measurement model of learning. Each sub-component comprised of three indicators, thus, four sub-components comprised of 12 indicators nested in the learning measurement model (Table 4.16).

As summarizing the above mentioned concepts, the cut-off composite scores of each sub-component of student learning were calculated by criterion-referenced and norm-referenced techniques as shown in the Table 4.16. The composite scores of each sub-components of student learning model were as a summation scoring (topped up scoring) with the value of 15, 30, 45, and 60, respectively. On the other hand, the total minimum composite scores of measurement model were 12, while the maximum composite scores of the measurement model were 60, thus the calculation criterion-referenced and norm-referenced was presented in Table 4.16.

Table 4.16: Cut-off Scores of Learning Index

Learning Level	Criterion-referenced Index		Norm-referenced Index	
	Formula	ranges	Formula	ranges
Low	15/60	.00 - .25	(15-12)/(60-12)	.000 - .062
Moderate	30/60	.26 - .50	(30-12)/(60-12)	.063 - .375
Relatively High	45/60	.51 - .75	(45-12)/(60-12)	.376 - .680
High	60/60	.76 - 1.00	(60-12)/(60-12)	.681 - 1.000

Minimum score = 12

Table 4.16 shows that the index of student learning can be used to level the student learning in terms of Learning to Know and Learning to Do individually. There are four level of student learning that can be used to interpret learning index.

To interpret student learning index, two types of belief were proposed. The first type1 of belief fall on the concept of UNESCO which proposed that "Learning to Know is the basic for the Learning to Do, additionally, the student learning appear as the laddering step starting from process of Learning to Know through outcome of Learning to Do (Table 4.17). In converse, to interpret the second type of belief that fall on the common ground of Cambodian context, is to said that outcome of Learning to Know and Learning to Do are based on their processes.

Two types of belief in interpreting student's learning could be used with both criterion-referenced and norm-referenced of the cut off scores.

Therefore student learning index can be interpreted in two types of belief. The first belief is interpreted by UNESCO proposal and the second belief is interpreted by the common ground of Cambodian context. Therefore, the interval of criterion-referenced index and norm-referenced index were compatible in terms of cut off points and interval score that were outlined previously. But for the research study, the criterion preferable used criterion is norm-referenced index to make further study on the Cambodian student learning index including explore and explain the learning index.

Table 4.17 shows that the two types of belief concerned learning as hierarchical one. Even though, two types of belief based on different concepts. These two different concept of interpreting learning index were outlined the table.

Table 4.17: Interpretation of Student Learning Index (Hierarchical Learning)

Learning Level	Criterion-referenced Index	Norm-referenced Index	Belief I **The process and outcomes of " Learning to Know" are the basis for " Learning to Do"**	Belief II **The outcomes of " Learning to Know" and " Learning to Do" are based on their learning processes**
Low	.00 - .25	.000 - .062	Having the process of " Learning to Know"	Having the process of " Learning to Know"
Medium	.25 - .50	.063 - .375	Having the process and meeting the outcomes of " Learning to Know"	Having the process of " Learning to Know" and " Learning to Do"
Relatively High	.51 - .75	.376 - .680	Having " Learning to Know" ability and the process of " Learning to Do"	Having the process of " Learning to Know" and " Learning to Do" and meeting the outcomes of " Learning to Know"
High	.76 - 1.00	.681 - 1.000	Having the process and outcomes of " Learning to Know" and ' Learning to Do"	Having the process and outcomes of " Learning to Know" and ' Learning to Do"

The first type1 of belief is to interpret each level of learning index that process and outcome of Learning to Know are the basic for Learning to Do in which first level of student learning index "low level learning index" was interpreted that students have process of Learning to Know. In the same sense, the second level of student learning index "moderate level learning index" was interpreted that students have the process and meet the outcome of Learning to Know. In accordance, third level of student's learning index "relative high level learning index" was interpreted that students have Learning to Know ability and process of Learning to Do. Lastly, the fourth level learning index "high level learning index" was interpreted that students have the processes and outcomes of both Learning to Know and Learning to Do, respectively.

Second type1 of belief is to interpret student learning index as the outcomes of "Learning to Know" and " Learning to Do" are based on their learning processes which first level of student learning index "low level learning index" was interpreted that students have process of Learning to Know. Accordingly, the second level of student learning index "moderate level learning index" was interpreted that students have

process of Learning to Know and Learning to Do. In addition, third level of student's learning index "relative high level learning index" was interpreted that students have Having the process of " Learning to Know" and " Learning to Do" and meeting the outcomes of " Learning to Know". Lastly, the fourth level learning index "high level learning index" was interpreted that students havethe process and outcomes of " Learning to Know" and ' Learning to Do".

Based on Norm-referenced Index (Table 4.17), it is indicated that Cambodian student learning index was in the relatively high. It was valued at (.649). It is believed that Cambodian students having "Learning to Know" ability and be ready to the process of "Learning to Do". Actually, Cambodian student learning index varies in a small interval values based on the 6 background variables—genders, academic stream, family incomes, school jurisdictions, school contexts, and school internet access. The student learning index was in the relatively high level ranked between .376 - .680. Thus, further study on student learning index would be conducted to find out more about the profiles of student learning index.

Phase II: Explanations of Cambodian Student Learning Index

Prior to analyzing any inference statistic, the descriptive statistics of two main background variables were conducted. The two main background variables comprises of six variables as shown in Table 4.18.

Descriptive statistical analysis was employed with two backgrounds—student and school background. The analysis results revealed that 6 variables are nested in the two background including gender, family income, academic stream, school jurisdiction, school context, and school internet access.

Table 4.18 shows that all variables were approximately equal in proportions (the frequencies of both groups were approximately 50%) except academic stream that student enrolled and school internet access were still limited, meaning that most schools did not provide any internet access for student learning and working. It was demonstrated that there were many differences between schools with internet access and schools without internet access and also science enrollment.

Internet access for students was still limited. It was found that most of students could not access the internet with the frequency of n1 = 1148, 70.90%. Accordingly,

academic stream was found that most students enrolled in science academic stream n1 = 1277, 78.90% more than the social science academic ones.

Based on these two main background variables, the student proportions were assumed that the two groups of students, advantaged (n1) and disadvantaged (n2), provide approximately equal variance distribution.

Table 4.18: Background Information of Respondents (n=1619)

Background	Variables	Group 1 Advantaged schools (n1)	%	Group 2 disadvantaged schools (n2)	%
Student	1. Gender	810	50.00	809	50.00
	2. Family income	825	51.00	794	49.00
	3. Academic stream	1277	78.90	342	21.10
School	4. School jurisdiction	715	44.20	904	55.80
	5. School context	724	44.70	895	55.30
	6. School internet	471	29.10	1148	70.90

Group 1 advantaged schools (male, higher than/equal 800,000 Riel*, science academic stream, private school jurisdiction, high competing, and internet access school)
Group 2 disadvantaged schools (female, lower than 800,000 Riel, social science academic stream, public school jurisdiction, low/non-competing school, and non-internet access school)
*800, 000 Riel = 7,017 Thai Baht

The student learning index would be studied based on the student background and school background. Thus, to find out more about student learning index, some analysis was used to aim at explaining student learning due to the selected background variables such as cross-tabulation between student learning index with student background, descriptive statistics used to explore student learning index based on background, descriptive statistics of the 2 types of belief in terms of composite scores and in terms of learning index was also studied.

The early concept used to explain student learning index was considered as Cross-tabulation in which Group1 refers to advantaged groups of samples while Group0 refer to disadvantaged groups of samples in the research study. G-norm is used to measure student learning index based on their level. G-norm1 refers to low level learning index, G-norm2 refers to moderate level learning index, G-norm3 refers to

relative high level learning index, and G-norm4 refers to high level learning index, respectively, as shown in Table 4.19.

Table 4.19: Cross-Tabulation between Student Learning Index and Background

Variables	Advantaged group	Percentage	Disadvantaged group	Percentage
G_norm	Group 1	%	Group 0	%
1. Gender	Male		Female	
1	1	.12	.00	.00
2	27	3.33	47	5.81
3	397	49.02	454	56.12
4	385	47.53	308	38.07
Total	810	100.00	809	100.00
2. Family income 1	High		Low	
1	1	.12	0	.00
2	26	3.15	48	6.05
3	446	54.06	405	51.00
4	352	42.67	341	42.95
Total	825	100.00	794	100.00
Academic Stream	Science		Social science	
1	0	.00	1	.30
2	55	4.30	19	5.60
3	667	52.20	184	53.80
4	555	43.50	138	40.30
Total	1277	100.00	342	100.00
3. School jurisdiction	private		public	
1	0	.00	1	.10
2	19	2.70	55	6.10
3	430	60.10	421	46.60
4	266	37.20	427	47.20
Total	715	100.00	904	100.00
4. School context	high competing		low/non competing	
1	1	0.12	0	.00
2	27	3.45	47	5.25
3	360	49.93	491	54.86
4	336	46.50	357	39.89
Total	724	100.00	895	100.00
5. School internet	access		not access	
1	0	.00	1	.09
2	13	2.76	61	5.32
3	237	50.32	614	53.48
4	221	46.92	472	41.11
Total	471	100.00	1148	100.00

Table 4.19 indicates that association between student learning index and student background in terms of gender, family income, academic stream, school jurisdiction,

school context, and school internet distributed as small amount of percentage differences between advantaged and disadvantaged groups of students.

All background variables were separated in two part—advantaged and disadvantaged groups. Approximately equal proportions of students responded in both groups. The percentage differences were around 93.00% - 96.00%. Thus, further explanation should be conducted. Therefore, descriptive statistics about student learning due to the two believes from Table 4.20 were also calculated.

Table 4.20 was used to describe descriptive statistics of the composite scores of student learning (M1234 model, M1324 model), learning components (M12 model, M13 model, M123 model, M132 model) and learning sub-components (M1 model, M2 model , M3 model, and M4 model) based on the two types of belief.

First type1 of belief was conducted to explore M1234 model which refers to composite scores of student learning, M12 model refers to composite scores of student learning to Know. M123 model refers to composite scores of student learning to Know and process of Learning to Do. And M1 model refers to composite scores of process of Learning to Know.

Table 4.20: Descriptive Statistics of Student Learning Scores Classified by 2 Types of Belief

Learning scores	*M*	*SD*	*Median*	*Mode*	*min*	*max*	*Sk*	*Ku*
1. M1 (procL2K)	11.46	2.01	11.63	12.63	3.00	15.00	-.674	.441
2.M2 (outL2K)	10.29	2.09	10.38	10.13	3.00	15.00	-.259	-.078
3. M3 (procL2D)	10.96	2.13	11.00	11.00	3.00	15.00	-.385	-.010
4. M4 (outL2D)	10.47	2.25	10.50	10.25	3.00	15.00	-.327	-.138
Belief I								
5. M12	21.75	3.81	21.88	22.63	6.00	30.00	-.384	.126
6. M123	32.71	5.63	32.88	31.88	9.00	45.00	-.364	.182
7. M1234	43.18	7.61	43.38	40.63	12.00	60.00	-.329	.139
Belief II								
8. M13	22.42	3.78	22.63	21.88	6.00	30.00	-.473	.282
9. M132	32.71	5.63	32.88	31.88	9.00	45.00	-.364	.182
10. M1324	43.18	7.61	43.38	40.63	12.00	60.00	-.329	.139

Second type belief was used to explore M1324 model which refers to composite scores of student learning. M13 model refers to composite scores of process of Learning

to Know and Learning to Do. M132 model refers to composite scores of composite scores of student learning to Know and process of Learning to Do.

Table 4.20 describes student learning, learning components, and learning sub-components in terms of mean, standard deviation, median, mode, min, max, skewness, and kurtosis. It shows descriptive statistics of student learning, learning components, and learning sub-components. Therefore, the mean scores of four sub-components of (M1 model, M2 model, M2 model, and M4 model) were almost similar, as well as, other values of descriptive statistic such as median, mode, min, and max values were also approximately similar.

Belief I distributed mean composite scores of (M12 model, M123 model, and M1234 model) as a summation mean scores, as well as, other values were also a summation values.

Belief II also distributed mean summation composite scores of (M13 model, M132 model, and M1324 model), and other statistical values, but the first summation composite mean scores of Belief II was higher than the mean of Belief I (M13 model = 22.42 > M12 model = 21.75).

In sum, it is clear that the two types of belief based on mean scores was a hierarchical summation between components and sub-components of the measurement model of student learning. To do more investigation on student learning index profiles, Table 4.21 would provide more information about the two types of belief. Table 4.21 would provide descriptive statistics on student learning index.

Table 4.21 was used to describe descriptive statistics of student learning index of the model (M1234_I) and the model (M1324_I), learning component index model of (M12_I), (M13_I), (M123_I), and (M132_I), accordingly, learning sub-component index model (M1_I), (M2_I), (M3_I), and (M4_I) due to two types of belief.

First type of belief was conducted to explore M1234_I model which refers to student learning index. M12_I model refers to index of student learning to Know. M123_I model refers to index of student learning to Know and process of Learning to Do. And M1_I model refers to index of process of Learning to Know.

Second type belief was used to explore M1324_I model which refers to index of student learning. M13_I model refers to index of process of Learning to Know and

Learning to Do. M132_I model refers to index of composite scores of student learning to Know and process of Learning to Do.

Table 4.21: Descriptive Statistics of Learning Index by 2 Types of Belief (n=1619)

Learning Index	***M***	***SD***	***median***	***mode***	***min***	***max***	***sk***	***ku***
1. M1_I (procL2K)	.176	.042	.180	.201	.000	.250	-.674	.441
2. M2_I (outL2K)	.152	.044	.154	.148	.000	.250	-.259	-.078
3. M3_I (procL2D)	.166	.044	.167	.167	.000	.250	-.385	-.010
4. M4_I (outL2D)	.156	.047	.156	.151	.000	.250	-.327	-.138
Belief I								
5. M12_I	.328	.079	.331	.31	.000	.500	-.384	.126
6. M123_I	.494	.117	.497	.477	.000	.750	-.364	.182
7. M1234_I	.650	.159	.654	.596	.000	1.000	-.329	.139
Belief II								
8. M13_I	.342	.079	.346	.336	.000	.500	-.473	.282
9. M132_I	.494	.117	.497	.477	.000	.750	-.364	.182
10. M1324_I	.650	.159	.654	.596	.000	1.000	-.329	.139

Table 4.21 shows that learning index of individual factors was approximately equal. The individual learning index varied in very small interval. Moreover, other values of index statistics were also similar. However, there were some changes in type1 of belief and type2 of belief.

Student learning index of type1 of belief was a summation learning index level (M12_I model = .328, M123_I model = .494, and M1234_I model = .650; SD of index was ranged between .079 - .159), as well as other index values such as median, mode, min, and max values.

Accordingly, student learning index of type2 of belief was a summation index. The three index values of type2 of belief were the summation ones. The index varied fluctuate based on the individual index itself, as well as, other values of index fluctuate (M13_I model = .342, M132_I model = .494, and M1324_I model = .650; SD ranged between .079 and .159).

Based on Table 4.21, the two type1 of belief of student learning index were not going together as mean presented the Table 4.20. Based on tyep1 belief, student learning index was confirmed to be the summation index. Accordingly, type2 of belief was also confirmed. But not yet clearly confirmed that the index is the

summation of each sub-components or not. Therefore, the concern about learning index profiles requires further study.

Student learning index profiles was examined by two backgrounds—student and school background. The two background consisted of 6 variables. Thus, student learning indices were classified based on the background variables Table 4.22.

Hence, Table 4.22 allows three models of learning index of Cambodian students to be examined based on this background information in terms of mean and standard deviation. Therefore, the individual background variable provides three models of student learning index by proportion. The mean and standard deviation of three models of student learning index varied between each group of student learning (advantaged and disadvantaged groups of students) due to the background.

Table 4.22 shows that the student learning index of the two main components (L2K and L2D) and learning index itself distributed a small variation between advantaged and disadvantaged schools background variables.

The variation in student learning indices was less than .03 comparing between every pair of advantaged and disadvantaged students groups based on all studied background variables. The analysis results also indicated that the highest variation among advantaged and disadvantaged student learning index was the "student gender" variable, in which learning index differed at .037. The lowest learning index variation among advantaged and disadvantaged student learning index was the "family income" variable in which produced the value of variation of .011.

Table 4.22: Learning Index by Background (n=1619)

Background	n	L2K		L2D		Learning	
		M	*SD*	*M*	*SD*	*M*	*SD*
1. Gender							
Male	810	.210	.077	.208	.083	.668	.152
Female	809	.196	.081	.185	.090	.631	.163
2. Family incomes							
>800,000 Riel*	794	.199	.085	.194	.092	.644	.168
<=800,000 Riel	825	.206	.074	.198	.082	.655	.149
Academic stream							
Science	1277	.204	.78	.198	.085	.652	.156
Social science	342	.202	.082	.189	.096	.641	.169

Background	n	L2K		L2D		Learning	
		M	*SD*	*M*	*SD*	*M*	*SD*
3. School jurisdiction							
Public	904	.207	.085	.200	.095	.657	.171
Private	715	.198	.071	.191	.076	.639	.139
4. School context							
High competing	724	.211	.076	.201	.087	.663	.156
Low/non competing	895	.196	.081	.192	.086	.638	.161
5. School internet							
Accessibility	471	.211	.077	.204	.085	.666	.155
Non accessibility	1148	.199	.079	.193	.087	.643	.159

Notice: *1 Thai Bath = 114 Riel

In sum, the analysis results of student learning index due to background information revealed that there was a small variation between student learning index of the different background. Thus, to clarify whether the student learning index was of statistically significant differences due to the background variables, multiple regression analysis was administered to find clear profiles of student learning index of Cambodian students. To respond to this issue, multiple regression analysis with dummy variables of those background would be conducted.

2. Regression Analysis Results

Original background variables were coded in (0, 1) dummy variables, code "0" falls on disadvantaged school background, alternatively, code "1" falls on advantaged school background. Therefore, "1" falls on male student, science enrollment, high family income student, private school students, high competing school, and internet access school students. The other variables fall on "0".

Prior to conducting multiple regression a multicollinearity diagnostics was conducted. Thus, two main statistic indices were analyzed including Tolerance and Variance Inflation Rate (VIF).

Based on the index of Tolerance (tolerances were ranged between .782 and .984) and Variance Inflation Rate (VIF were 1.017 – 1.323), it is indicated that dependent variables do not have any multi-collinearity. The assumption of this analysis are met the criteria (Hair, et. al., 2010). Therefore, multiple regression analysis was

conducted to explore the predicted variables that affect differently on student learning index due to the selected variables.

The results of multiple regression analysis were shown in the Table 4.23. The results revealed that 6 variables of student background variables statistically significantly accounted for 3.20 percentage points of student learning index variances, expect "Academic stream" variable that would not explain different learning index.

Table 4.23*:* Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.178[a]	.032	.028	.159

a. Predictors: (Constant), School internet, Family income, gender, Academic stream, School context, School jurisdiction

Table 4.24: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.294	6	.216	8.817	.000[b]
	Residual	39.425	1612	.024		
	Total	40.718	1618			

a. Dependent Variable: index

b. Predictors: (Constant), School internet, Family income, gender, Academic stream, School context, School jurisdiction

While the Beta coefficient of students' gender provided the largest value at .118 compared to the other 5 background variables. The "internet access" variable distributed the smallest Beta coefficient among the five background variable with a value of .054.

A Multiple linear regression was calculated to predict student learning index based on the background variables including student gender, family income, academic stream, school jurisdiction, school context, and school internet access. A significant regression equation was found (F (6, 1612) = 8.82, $p < .00$) with an R^2 of .032. Among six variables, there is one variable that does not predict any different prediction on student learning index (Academic stream).

Table 4.25: Regression Results of Student Learning Index

Model	Unstandardized Coefficients		Standardized Coefficients	t-test	Sig	Collinearity statistics	
	B	SE	Beta			tolerance	VIF
(Constant)	.58	.01		44.16	.00		
Gender	.04	.01	.12	4.84*	.00	.99	1.01
Family income	.02	.01	.05	2.05*	.04	.86	1.17
Academic stream	.02	.01	.04	1.75	.08	.98	1.02
Jurisdiction of school	.03	.01	.08	3.09*	.00	.83	1.21
School context (competiveness)	.03	.01	.09	3.35*	.00	.92	1.09
School internet	.02	.01	.06	2.23*	.03	.97	1.04

** $p < .05$*

The variables' explained expected student learning index is equal to .58 + (.04)* gender + (.02)* family income + (.02) academic stream + (.03)* school jurisdiction + (.03)* school context + (.02)* internet access.

Where gender is coded as 1 = male, 0 = female, family income is coded as 1 = higher than/equal to 800, 000 Riel, 0 = lower than 800, 000 Riel, academic stream is coded as 1 = science, 0 = social science, school jurisdiction is code as 1 = private school, 0 = public school, school context is coded as 1 = high competitiveness school, 0 = nonurban school, and school internet access is coded as 1 = access, 0 = not access.

The student learning index increased 3.20 percentages for each male, higher than/equal 800, 000 Riel income, private school, high competiveness school, and internet access school more than female students, lower than 800, 000 Riel income, public school, low/non competiveness school, and non-internet access school, respectively. But the academic stream between science and social science students did not provide any statistically significant different in predicting student learning index.

Hence, 3.20% of the variation in student learning index can be explained by different in gender, family income, academic stream, school jurisdiction, school context (competitiveness), and school internet access.

Phase III: Developing Guidelines for Enhancing Student Learning Index

This study objective aimed to develop guidelines for enhancing Cambodian student learning index. The guidelines were developed from the purposive classroom

practices of Kampong Cheuteal High School teachers based on the profiles of student learning index. Therefore, the guidelines were developed with teaching and learning theory to enhance student learning index.

Prior to conducting teaching and learning activities, students were selected by teachers to explore the pretest on student learning index. The pretest of student learning was presented in the table comparing with post-test of student learning index.

Teachers were introduced to read and interpret learning index of student obtaining from pre-test. Thereafter, teachers prepared and planned for new teaching and learning activities. The instruction activities conducted by teachers within 6 weeks long. All activities would be presented in the following sequences. After the course, students were asked to answer the same form of questionnaire they did before the course start. Hence, before going to the prior activities of teaching and learning aimed at enhancing student learning background information of the students were presented.

All teaching and learning activities were constructed by teachers to enhance student learning based on school facilities and extra activities. Thus, the learning and extra activities are used to form lessons learned.

3.1. Background of Case Study

This study aimed to develop guidelines for enhancing the learning index of Cambodian students. The guidelines were developed from purposive classroom practices of Kampong Cheuteal High School teachers based on the profiles of student learning index. Therefore, the guidelines were developed in accordance with teaching and learning theory aimed at enhancing student learning index.

The background information of Kampong Chueteal High School students is presented in Table 4.26. An equal proportion of students between two grades was selected. Twelve students in grade 11 studying chemistry and twelve students in grade 12 studying mathematic were selected as shown in Table 4.26.

Table 4.26 indicates that there were 24 students participated in the research process. A large proportion of students are male (n=14, 58.30 %), while most students were aged equal to or higher than 19 years old (n=15, 62.50 %).

Table 4.26: Descriptive Statistics of Kampong Chueteal Students (n=24)

Background information	**frequency**	**percentages**
Gender	**n**	**%**
male	14	58.30
female	10	41.70
Age	**n**	**%**
>= 17	1	4.20
18	8	33.30
< = 19	15	62.50
Study grade	**n**	**%**
11	12	50
12	12	50

3.2 Activities to Enhance Student Learning Index

Prior to activities that were conducted to enhance student learning, two teachers assign students into groups. Thereafter, the two groups of students were treated by some activities during 6 week courses. Every group of students was treated by both teachers' activities. The activities created by two teachers are varied due to the teachers and the appropriateness of the classroom climates and average times of each academic subject characteristic. The activities created by teachers are the extra methods which teachers provide students in order to make their learning be more effective. Therefore, some instruction activities were constructed that aimed at enhancing student learning. The activities were provided to students to help them learn both inside and outside the classroom. The detailed activities were intended to enhance student learning to Know and the Learning to Do index.

Teachers developed the activities to enhance student learning during 6 weeks in the second semester of the 2015-2016 academic year. The study was employed with the two selected groups of high school students studying in the 2015-2016 academic year at Kampong Chueteal High School.

3.2.1. Learning to Know Enhancement

Learning is a process in which student desire to, engage with, and learn actively in the learning activities, such as learning valuing, reading, writing, discussion, or problem solving that promote learning contents in which students take responsibility in order to raise up their learning index. In accordance, students are able to produce learning outcome via the learning process they conducted during their learning

development. It is important factor for student motivation and involvement in his/her learning process.

Table 4.27: Activities to Enhance Learning to Know (Teacher 1)

Activities	pre-activities	post-activities
1. Got to know individual students	1. Students identified themselves to the class in case needed.	1. Students got to know each other
2. Shared past learning experience	2. Student prepared data about past learning experiences.	2. Students shared their strength and weakness about learning.
3. Class, exam, and learning goal preparation	3. Students were asked to take part with instruction planning.	3. Students already prepared for new class environment.
4. Used extra materials/ technologies in instruction	4. Students were introduced to know new instruction materials/ technologies	4. Students could use the learning sources when they need.
5. Used extra-learning facilities.	5. Students prepared to use and practice what were learnt	5. Students could use some facilities such lab equipment, and internet tools, and computer.
6. Provided student feedback about their work	6. Students were ready for new recommendation	6. Students designed and planned for better learning activities

Furthermore, student getting through times and keep learning continuum both inside and outside of the classroom. Teaching and learning activities that promote student learning index was conducted by teachers and students were presented in the Table 4.27 and Table 4.28. These activities were believed to upgrade student learning. Table 4.27 presents the activities conducted by teacher1.

Table 4.27 shows that every activities was created by teacher than enable students to actively conduct their learning. Accordingly, teacher2 also prepare his activities to enhance student Learning to Know as in Table 4.28. The activities created in this table provided students more actively engage with learning.

Table 4.27 and Table 4.28 show that students conduct their learning activities during class time and outside class time the activities that were created by teachers to enhance their student learning. Every activity was conducted without specific learning contents. They are created to fulfilled student learning.

Table 4.28: Activities to Enhance Learning to Know (Teacher 2)

Activities	pre-activities	post-activities
1. Got to know individual	1. Students were asked to describe what they know about school.	1. Students got to know each other and school
2. Met with students who fall behind their study habit and schedule	2. Students consulted with advising member to deal with unintended learning outcome and study habit	2. Students started to make sense of the learning frame provided by teacher and program specific.
3. Assigned students to set up study groups.	3. Students managed study club activities in responding with learning needs.	3. Students knew how to describe what have been learnt or discussed with club member
4. Allowed students to comments strength and weakness of their work.	4. Students learned to identify about their own learning both process and output.	4. Students could identify strength and weakness of selves.
5. Shared past experiences and values	5. Students did self-assessment of readiness to learn. Sometimes students share their strength and weakness about learning.	5. Students shared weakness improvement technique to upgrade or promote new learning techniques.
6. Provided student concrete, real life situation to analyze.	6. Students managed time and information effectively to raise awareness of their learning and work.	6. Students could solve the problem happening to them especially learning problem.
7. Corrected students' assigned work and activities	7. Students were ready for recommendation and guiding	7. Students designed and plan for better learning activities

Beside the teaching and learning, school facilitators, technology, learning resource, and learning labs are also importance for students to develop their learning. Students were usually facilitated by these kinds of learning materials. Some learning material are available for students to access. Thus, students use those kinds of materials in effective way for improving their learning activities.

The instruction facilities were introduced to students in order to enhance them in learning activities. Students are allowed to use these kinds of facilities free of charge. The learning resource were used by teacher at first then students try to use those kind of instrument to facilitate learning.

Table 4.29: Learning Facilities

Resources	Enhancement of student learning
1. Technology	• Interest students in learning by using new technology. • Allow students to search for or present their work using technology. • Enable students to learning through-out diversified methods/instruments.
2. Learning resources	• To facilitate students in their learning by using empirical instrument in teaching and learning. • To develop happy learning environment both in school and out of school.
3. Learning Labs	• Allow students to experiment inside school labs with moderator/responsible person. • Allow students to do reports and reflect what they obtained from learning inside the labs.

It is clear that teaching and learning are fulfilled from one to another. But learning is importance for students to accompany with global changes. Hence, student self-reflection based on teaching elicit on what students should learn. When students learn they should know him/her-self position of knowledge and skills.

3.2.2. Learning to Do Enhancement

Another deeper step of student learning was the Learning to Do, it was demonstrated that when people consists of knowledge of learning to know, it enable students reach the knowledge of Learning to Do. Learning to Do means to apply learning to know and to do itself into practices.

The application of information for knowledge in learning is to understand one' own learning style, helps to understand one's own thinking, to be aware of a fit between what was learnt and what will learn, and to select the most effective and efficient mean to go about Learning to Do. The concept of Learning to Do is another step deeper than Learning to Know. It is indicated that when students fulfill Learning to Do meaning that students already fulfilled Learning to Know. Thus, to enhance Learning to Do

teachers have done some teaching guidelines for improving student Learning to Do index that would be the summation of student learning each step.

To enhance student Learning to Do, students would be provided some activities during schooling that most positively affect on student learning process and learning outcome. It is a step by step of gaining and applying knowledge that were obtained by information. Thus, Learning to Do was outlined into Table 4.30 and Table 4.31.

Table 4.30: Activities to Enhance Learning to Do (Teacher1)

Activities	pre-activities	post-activities
1. Teachers worked for students and their learning.	1. Students worked with teachers to explore what is concerned and in need for learning.	1. Students tried to fulfill the concern and need of learning to improve their learning index as intended.
2. Teachers knew their subject and teach students effectively the subject.	2. Students were brought by content and knowledge.	2. Student bridged past knowledge with the new knowledge via learning process.
3. Teachers were responsible for managing and teaching student learning.	3. Students prepared to perform the learning activities that already planned with teachers since the beginning.	3. Students learned to control their learning.
4. Teachers worked as learners.	4. Students and teachers prepared together learning activities.	4. Students designed learning environment, methods and conduction with teachers.
5. Teachers were members of learning communities.	5. Students were ready for working with peers and groups.	5. Students work individually, work in a group, work in pairs, and work with teachers.
6. Teachers provided students the learning opportunity	6. Students took the opportunity to build self-confidence.	6. Students were self-confidence in learning independently, or in a small group of learning.
7. Teachers used extra materials and technologies to facilitate student leaning.	7. Students were supported in their learning process with many facilities	7. Students could use the learning facilities provided by school.

Table 4.30 shows that students could help themselves to accompany with extra learning activities provided by teachers. Additionally, students were allowed to build

confidence and be responsible with their own learning and work. Moreover, teacher2 also provides students the learning activities in Table 4.31.

Table 4.31: Activities to Enhance Learning to Do (Teacher 2)

Activities	pre-activities	post-activities
1. Teacher attended, supported, and sponsored students in any appropriate activities.	1. Students took initiative for all stages of learning process.	1. Students could ask for support and participation from teachers in their learning activities.
2. Teachers developed students' competence of diary notes.	2. Students prepared, made diary and used diary	2. Students used diary as a source of knowledge gaining.
3. Teachers asked students to organize their own knowledge in the way that facilitates retrieval and application.	3. Students were ready for their knowledge and skill acquisition.	3. Students could order and prepare for extracting and using that kind of knowledge.
4. Teacher provided time frame to students for both public and personal learning.	4. Students managed the time effectively in doing assigned works.	4. Students finished the work on time with quality.
5. Teacher provided students some supports that are possibly responding to appropriate students' requests.	5. Students were introduced and provided the learning materials, labs, and IT equipment are available for student learning.	5. Students could use school materials and facilities perform their work.
6. Teachers set students to produce the work.	6. Students prepared for assigned work.	6. Students produced their work by teachers' advice and guidance.
7. Teachers taught students to control their own learning.	7. Student prepared for learning control.	7. Students monitored and controlled their own learning carefully.

Table 4.31 shows that students could earn and access school facilities and suggest for learning activities and facilities as they needed. On the other hand, students could build their confidences, be responsible for their learning and work assigned by teachers. Additionally, students also could find more with what they needs in learning.

As summarization above mentioned concepts, it is indicated that student Learning to Know and Learning to Do were enhanced by many activities, supports, and learning facilities. These mean that student learning was enhanced and empowered by

teachers using some kinds of learning facilities, supports, and learning resources. On the other hand, student learning appear with some activities and habit that they should conduct during schooling and beyond as shown in Table 4.32.

The activities in the following Table 4.32 were conducted by students' during their schooling time whether they are in and outside the classroom of teaching and training. Students themselves need to act these kinds of acquiring knowledge techniques in order to get more information and knowledge they need in responses to the 21st century skills. The activities that students should conduct during schooling are to help students be aware, and confident with what they are conducting especially in learning and gaining for new knowledge and the application of the knowledge into the real world of work. Hence, learning activities that students should conduct were presented in Table 4.32.

Table 4.32: Learning Activities of Students

Activities constructed to promote learning index
1. Listening
2. Watching (someone modeling, video demonstration)
3. Being observed and receiving feedback
4. Receiving learning activities and materials, lesson plans.
5. Engaging with continuous readings
6. Discussing practice with more experts/facilitators
7. Be together to join learning activities (club study)
8. Peer collaboratively plan to implement content learning/development
9. Compare own knowledge with new knowledge
10. Analysis self-learning all the time
11. Examining learning outcome and understanding
12. Analyzing current practice, revised practice and co-constructing new practice
13. Discussing self-/mutual-identified issues: student learning context.

The summarization of lessons learned from instruction activities need students to fulfill the learning needs. The lessons learned were concluded due to the learning activities within some outside classroom activities and school facilities which students were provided during their 6 week courses that means to student learning.

As summarization to the above mentioned teaching and learning activities, the lessons learned obtained were summarized into two following tables. The tables would present the learning activities provided by 2 teachers that would generate student learning. The tables would provide activities, learning process and outcome that would appear during and after students conduct those kinds of learning activities. Therefore, the activities were summarized into the following tables. The Tables would outlined the activities conducted by 2 teachers that would generate the learning desire (A), learning engagement (B), learning to learning (C), concern learning as the real world of work (D), practical engagement (E), and continuing self-development (F).

Table 4.33: Instruction Activities to Enhance L2K by 2 Teachers

	Teacher1	A	B	C	Teacher2	A	B	C
W1	Got to know individual students.	✓			Got to know individual student.	✓		
W2	Students shared past learning experience.		✓		Teacher met with students who fall behind their study habit and schedule.	✓		
W3	Students and teacher prepared/set class, exam, and learning goal.		✓	✓	Teacher assigned students to set up study groups.			✓
W4	Teacher uses extra materials/ technologies in instruction.	✓	✓	✓	Teacher allowed students to comments strength and weakness of their work.		✓	✓
W5	Teacher used extra-learning facilities in instruction.		✓	✓	Teacher corrected/provided feedback students' assigned work and activities			✓
W6	Teacher provided students learning feedback.			✓	Teacher provided student concrete, real life situation to analyze.	✓	✓	✓

Notice: A = learning desire
B = learning engagement
C = learning to learn
W = week

Table 4.33 shows the activities that 2 teachers conducted to enhance Learning to Know with the first 3 learnings including learning desire (A), learning engagement (B), and learning to learning (C).

Table 4.33 shows that 6 week activities created by 2 teachers enhanced student Learning to Know. In detailed, “Getting to know individual” activities produced learning desire from both teachers. Accordingly, “Students share past learning experience” and “Teacher meets with students who fall behind their study habit and schedule” activities also produced learning desire and have some learning engagement. However, “Students and teacher prepare/set class, exam, and learning goal” activities produced learning engagement and learning to learn while “Teacher assigns students to set up study groups” activities produced learning to learn. In addition, “Teacher uses extra materials/ technologies in instruction” activities produced all kinds of Learning to Know indicators but “Teacher allows students to comments strength and weakness of their work” activities produced learning engagement and learning to learn. To obtained learning engagement and learning to learn teachers used “Teacher uses extra-learning facilities in instruction” and “Teacher corrects/provides feedback students’ assigned work and activities” activities. Lastly, “Teacher provides students learning feedback” produced learning to learn while “Teacher provides student concrete, real life situation to analyze” produced all kinds of Learning to Know indicators.

As summarization to the above concepts, Table 4.33 shows that most of activities enhance Learning to Know in terms of learning engagement, thereafter, learning to learning and lastly, learning desire. Moreover, student Learning to Do was also enhanced by teachers’ activities while instructing. Thus, the activities to enhance student Learning to Do were presented in Table 4.34.

Table 4.34 shows that 6 week activities created by 2 teachers enable students to increase their Learning to Do. In detailed, “Teacher knows their subject and teach students effectively the subject” and “Teacher attends, supports, and sponsors students in any appropriate activities” activities produced concern learning as the real world of work. Additionally, “Teacher is responsible for managing and teaching student learning” activities produced concern learning as the real world of work while the “Teacher develops students’ competence of diary notes” activities produced practical engagement. And the “Teacher works as learners” activities produced practical engagement and continuing self-development while “Teacher asks students to organize their own knowledge in the way that facilitates retrieval and application” activities produced concern learning as the real world of work and continuing self-development.

Table 4.34: Instruction Activities to Enhance L2D by 2 Teachers

	Teacher1	D	E	F	Teacher2	D	E	F
W1	knew their subject and teach students effectively the subject.	✓			attended, supported, and sponsored students in any appropriate activities.	✓		
W2	was responsible for managing and teaching student learning.	✓			developed students' competence of diary notes.		✓	
W3	worked as learners.		✓	✓	asked students to organize their own knowledge in the way that facilitates retrieval and application.	✓		✓
W4	was a member of learning communities.		✓	✓	Some supports were possibly responding to appropriate students' requests.	✓	✓	✓
W5	provided students the learning opportunity	✓			set students to produce the work.		✓	✓
W6	Used extra materials and technologies to facilitate student leaning.	✓	✓		teached students to control their own learning.	✓	✓	✓

Notice: D = concern learning as the real world of work
E = practical engagement
F = continuing self-development
W = week

In addition, the "Teacher is a member of learning communities" activities produced practical engagement and continuing self-development while the "Some supports are possibly responding to appropriate students' requests" activities produced all kinds of Learning to Do indicators. However, the "Teacher provides students the learning opportunity" activities produced concern learning as the real world of work while the "Teacher sets students to produce the work" activities produced practical engagement and continuing self-development. Lastly, "Teacher uses extra materials and technologies to facilitate student leaning" activities produced concern learning as the real world of work and practical engagement while "Teacher teaches students to control their own learning" activities produced all kinds of Learning to Do indicators.

In sum, Table 4.34 shows that major of activities, used to enhance student Learning do Do, produced concern learning as the real world of work afterward practical engagement and lastly continuing self-development of students.

3.3. Kampong Chueteal High School Student Learning Index

To explain student learning by using quantitative method is to compare pretest and posttest of student learning index. Therefore, learning activities were implemented with two groups of students. Thus, pre-test and post-test of student learning index was analyzed. Both tests were used to compare whether learning activities created by teachers affect on student learning index.

The sample sizes of this research study were 24 students divided into two groups would be used to compare between pre-test and post-test of student learning index. The descriptive of whole class students were presented in Table 4.35. After, the learning activities, the number of students between pre- and post-test remained the same.

After six weeks of activities for enhancing student learning were conducted, a test to investigate student learning index of Kampong Chueteal High School was administered by using questionnaire in data collection. The sample sizes of this implementation 24 students. Thus, pre-test and post-test index scores of students were compared (Table 4.35).

Table 4.35: Comparing Pre-test and Post-test of Student learning Index

test	N	L2K	L2D	L2K+ L2D=Learning
pre-test	24	.19	.16	.59
post-test	24	.22	.21	.67

Based on Table 4.35, Learning Index of Kampong Chueteal High School students was changed. The three models of student learning—L2K, L2D, and Learning increased from .19, .16, and .59 to .22, .21, and .67, respectively. The highest changed index was learning with the value of .08. In contrast, the smallest changed model was L2K with the value of .03.

In addition, the total learning index of the 24 students also distributed changed between pre-activities and post-activities provided students by teachers in the instruction process. The L2K of total index changed .03, while L2D changed .05, and Learning model of total index changed .08.

3.4. Developing Guidelines for Enhancing Student Learning from Lessons Learned

The results of the case study during 6 weeks yielded the valuable lessons learned to the researcher, teachers and stakeholders. Student learning depends on their teachers'

activity management both inside and outside the classroom instruction. In common sense, students should develop their awareness on information and knowledge gaining. Thus, the information and knowledge gained should be used to adopt/adapt new knowledge and skills in the practice situation. This concept is to enhance students to grow from novice-to-expert in the field they intended to learn. Student would be enhanced to learn with confidence and be responsible with the learning the conduct.

It is concluded that teachers pay attention on students in recognizing, retrieving, practicing the new knowledge with some techniques and materials. These kinds of learning techniques and materials are used for facilitating student learning and student needs in order to place their attention subsequently to what teachers taught and facilitated to make effective and efficient student learning activities. Therefore, guidelines to enhance student learning were presented in Table 4.36 and Table 4.37. Table 4.37 shows the guideline for enhancing L2K while Table 4.38 shows guideline for enhancing L2D.

Table 4.36: Guidelines to Enhance "Learning to Know"

No.	Types of Activities	Activities done by students
1	In class (subjects)	• Students sent teacher the statement of interest and shared what they learnt. Additionally, students talked to teachers about their fall behind learning activities in order to take action on their learning habits. • Students prepared their class, exam, study group and learning goal with teachers' guidance and supports. • Students were introduced to use new learning material and tools to facilitate their learning process. On the other hand, students were provided the chances to comment on their own works and friends' works. • Students were able to explore how to use and use appropriate technology in facilitating their learning both searching and presenting work and knowledge. In addition, students were commented and provided the feedback for better works.

No.	Types of Activities	Activities done by students
		• Students obtained benefits from feedback and real life situation to analyze for better plan their next learning sessions or courses offered.
2	Out of class	• Assignment was assigned by teachers for out of class activities, as well as, the club study activities that created by students themselves. • Students were taken old ancient temples in order to be aware with fruitful ancient properties. • Students could face and solve learning and everyday life problems critically individually and in groups. • Students could conduct their learning in multi-media room, with computer and internet rooms.
3	Extra-curriculum	• Vocational training course participation. • Community meeting participation. • School meeting participation. • Sport activity participation, school and community tour guide training participation. • Students participate with community, social activities or other volunteer activities including community research activities, religious activities, and cultivating activities. • Community big cleaning day participation.

Table 4.36 shows that students try to learn and gain new information and knowledge by bridging past experiences of their own and friends' to the new information and knowledge. Accordingly, new learning techniques, technologies, multi-media, and learning facilities allowed students to reach their learning needs. These concepts are suitable for students in order to initiate students to prepare for and learn full of their potential whether students use traditional and new learning methods. Furthermore, whenever students have basic knowledge, students could put those kind

of knowledge into practices. The knowledge was put into practice named as Learning to Do. Thus, guideline for enhancing Learning to Do was presented in Table 4.37.

Table 4.37: Guidelines to Enhance "Learning to Do"

No.	Type of Activities	Activities done by students
1	In class (subjects)	• Students had done assigned work and learning activities on time with complete sense. • Students could present how to solve reading and mathematics problems due to their age interval based on teachers' attending, supports and sponsors. • Students were responsible and confident with the work they do. • Students could arrange their knowledge and skill in order to retrieve and apply in an appropriate situation. • Students competed each other in searching, reading, writing what they learned. • Students could take note as the diary of what they learned and did during the daily learning activities. • Students could use learning facilities, technologies, and multi-media in facilitating their own learning and working. • Students could do some experimental with learning theory such as Newton Force Theory and HO2 reaction. • Students could present their work in the classroom and in public. • Students could apply science in everyday life such as calculating monthly family incomes and payment.
2	Out of class	• Students could share their own knowledge to other effectively. • Students could run club study in order to help others to reach the learning goals. • Students could be the leader of some activities such as school guide, club study, and sport activities.

No.	Type of Activities	Activities done by students
		• Students could arrange field trip study inside and outside school and community. • Students jointed student camping such as boy/girl scout.
3	Extra-curriculum	• Students could work as school/community guide volunteer. • Students could help school cooperation store activities such as stock and share in retail selling. • Students applied science in learning to do accounting of stock and share. • Students helped promote vegetable/animal of school gardening and school husbandry. • Students helped school services such as building renting and meeting coordinator.

Table 4.37 indicates that students could produce their Learning to Do by applying basic knowledge of Learning to Know into practices even in academic and everyday life. Thus, some activities of Learning to Do were bridging from past experiences, Learning to Know and new learning. Additionally, learning facilities, learning equipment, learning facilities are more important to student learning.

Learning to Do builds students' responsibilities, confidences, and practical knowledge that enhance students to be full people.

In summarization to the above mentioned guidelines for enhancing student learning, it is concluded that students should be enhanced in three main concepts—academic learning, out of classroom learning activities, and extra-curriculum activities. However, academic learning activities mostly created by teachers while out of classroom learning activities created by students themselves, and lastly, extra-curriculum activities that mostly effected by communities.

Chapter 5
Conclusion, Discussion, and Recommendation

A study of a measurement model development of student learning and guidelines for enhancing student learning was conducted with three main objectives— 1. To develop a measurement model of student learning and determine the learning index of students, 2. To analyze the learning index of Cambodian students and explain the learning index profiles with selected school background at the macro level, and 3. To develop guidelines for enhancing the learning index of students by analyzing lessons learned from teachers' classroom practices at the selected school.

The research was conducted within three phases. The first phase dealt with the measurement model development of student learning and determine the student learning index. The second phase was to explore student learning index as classified by multiple regression analysis due to 6 background variables including student gender, family incomes, academic stream, school jurisdiction, school context, and school internet access. The third phase was to develop guidelines for enhancing student learning indices by lessons learned analysis of classroom practices.

The first phase was to develop a measurement instrument of student learning and determine the learning index of students. Hence, a measurement model of student learning index was conducted within 7 psychometric property validation techniques in terms of content validity, objectivity validation, uncertainty validation, construct validity, reliability validation, and criterion-related validity. The sample size used in the research study consisted of 1619 students who were selected via multi-stage random sampling. The research instrument used in the study was a questionnaire divided into two main parts. The first part was the background information of high school students consisting of 7 questions as shown in Table 4.1. The second part was the measurement model of student learning consisting of two main components; Learning to Know and Learning to Do. Learning to Know component consisted of two sub-components; process of Learning to Know and outcome of Learning to Know. Learning to Do component also consisted of two sub-components; process of Learning to Do and outcome of Learning to Do. There were a total of 56 items in the measurement model

of student learning, divided into 32 items of Learning to Know and 24 items of Learning to Do. The measurement model of student learning questionnaire was developed within a 5-point rating scale.

Data analysis was conducted with descriptive statistics. Additionally, inferential statistics were also conducted such as confirmatory factor analysis by using Mplus and reliability analysis conducted with using R version 3.2.2. Furthermore, content analysis, uncertainty analysis, and percentile criteria calculation determination of student learning index based on two approaches: criterion-related and norm-related were also conducted, and, furthermore, criterion-related validity by using t-test.

The second phase was conducted to explain the learning index profiles with selected student and school background at macro level. The measurement model of student learning and learning index obtained from the first phase were used to explain student learning index profiles at macro-level.

Data analysis was administered with descriptive statistics on school background, student background, student learning index by background, student learning index by two types of belief from the second research objective. Furthermore, multiple regression analysis was also conducted to explain student learning index profiles.

The third phase was to develop guidelines for enhancing student learning indices by analyzing lessons learned from empirical classroom practices at micro-level. Two teachers were invited to conduct this teaching for student learning activities that would enhance student learning. Two teachers created some learning activities for students both inside, outside, and extra-curriculum in order to enhance student learning. Furthermore, pretest and posttest of student learning index were employed with students in order to investigate whether activities created by teachers make any changes on student learning. The teaching and learning were conducted by two teachers within 6 weeks period.

Data analysis was conducted based on content analysis obtained from two teacher interviews and the researcher' observation. Due to this research process, it was indicated that the two teachers created and provided some activities for enhancing student learning index in which they performed during their 6 week sessions.

Research Conclusion

This research is a descriptive research concerning both quantitative and qualitative approaches to data collection and analysis in order to develop a learning index, measurement instrument, and guidelines for enhancing student learning in the context of Cambodian high schools. To response to these concepts, the results of index developments are presented as the following.

1. Learning Measurement Instrument

The literature review was the important element for developing student learning index, measurement instrument, and guidelines for enhancing student learning of Cambodian high school students. With the results of the literature review, the researcher developed learning items for Cambodian students. As a result, a measurement model of student learning was developed and validated.

1.1 Model of Student Learning

1) The instrument to measure student learning consisted of two main components: Learning to Know (L2K) and Learning to Do (L2D). Each component was composed of two sub-components: processes and outcomes of learning. Each of these sub-components was measured by three separated indicators.

2) Each of the L2K sub-components was comprised of three indicators: processes and outcomes of learning desire, learning engagement, and learning to learn.

3) Each of the L2D sub-components was comprised of three indicators: processes and outcomes of concern of learning as the real world of work, practical engagement, and continuing self-development.

4) There were a total of 56 items included within the measurement instrument for student learning with 32 items of L2K and 24 items of L2D.

With the results from the above summarization, the model of student learning comprised of 2 main components, 4 sub-components, and 12 indicators.

1.2 Psychometric Properties of the Developed Instrument

Developing and examining learning items, are important during the process of learning instrument development, but validating those of items with the intended user or stakeholders is much more important. Hence, 6 psychometric properties investigation were conducted in order to investigate learning index qualities.

1) The learning instrument had content validity (IOC ranged between 0.50 - 1.00).

2) Objectivity analysis of learning instrument revealed that all experts agreed that all items are objectively measured within terms of operational definition, language use, scoring check, and interpretative criteria.

3) Uncertainty analysis results of this instrument also revealed that the most appropriate model for developing a composite score was the third model—an additive model with factor loading obtained from third-order confirmatory factor analysis of the measurement model of student learning. Uncertainty analyses were acceptable.

4) The learning instrument also had construct validity (χ^2 *(15, N=1619) = 22.32, p =.10, CFI = 1.00, TLI = .99, SRMSR = .01, RMSEA= .02),*

5) Internal consistency reliability coefficients were analyzed by using Cronbach's Alpha. The results revealed that reliability coefficients were ranged between .83 - .94.

6) The instrument had criterion-related validity using known group technique. The result of t-test analysis showed that there was a statistical significant differences between the means of two groups (low and high level of student learning), meaning that research instrument had criterion-relation validity.

1.3 Norm of Student Learning

Prior to index calculation, norm of student learning was calculated in order to present composite scores of the student learning models in the form of unweighted and weighted scores. Thus, the percentile ranks were calculated and presented in every cut of point of student learning models.

Following the calculation of the percentile rank of Cambodian student learning, the composite learning scores of Cambodian students were stated in the form of unweighted (raw) scores or weighted scores in which could be converted to percentile rank. As for unweighted composite scores: P_{90} = 53.00, P_{75} = 48.75, P_{50} = 43.38, P_{25} = 38.13. For weighted composite scores: P_{90} = 45.77, P_{75} = 42.07, P_{50} = 37.47, P_{25} = 32.92, respectively. Additionally, the model of L2K and L2D were also calculated in both weighted and un-weighted scores.

1.4 Student Learning Index

Learning index of student was calculated by two approaches: criterion-referenced and norm-referenced. The two approaches provided complete learning levels and learning index interpretation. For the learning index interpretation, the norm-referenced approach was used, in this study, to interpret the level of Cambodian student learning index. Cambodian student learning index was classified into 4 levels: low (.000 - .062), moderate (.063 - .375), relatively high (.376 - .680), and high (.681 – 1.000).

The four levels of student learning index were interpreted based on two types of belief. The first type of belief, UNESCO proposal, was believed that learning index of students was a summated index (topped up index), meaning that the process and outcomes of "Learning to Know" are the basis for "Learning to Do". Conversely, the second type of belief was believed that learning index of student was split-summation index (split-topped up index), meaning that the outcome of "Learning to Know" and "Learning to Do" are based on their learning processes.

2. Learning Index of Cambodian Students

To interpret student learning index, there are two types of belief which still entangle with index summation concepts (topped up index). The learning index of Cambodian student did not provide clearly confirmation whether the index go with first type of belief or second type of belief. It sometimes happens parallel between process and outcome indices, as well as, between L2K and L2D, but sometimes, it appears as the summated learning index meaning that L2K appeared then followed by L2D.

Index of Cambodian student learning varied in a small interval separating by background variables: students' background and schools' background.

At the macro level study, the mean of Cambodian student's learning index was .649. A Multiple linear regression analysis was conducted to explain student learning index based on the background variables including student gender, family income, academic stream, school jurisdiction, school context, and school internet access. A significant regression equation was found (F (6, 1612) = 8.82, $p < .00$) with an $R^2$of .032. Among six variables, there is one variable that does not explain any statistical different explanation on student learning index (Academic stream).

This result indicated that the learning index of Cambodian students could be explained by backgrounds of students and school contexts. It was found that the male students, higher than/equal 800, 000 Riel family incomes, private schools, high competiveness schools, and internet access schools accounted for 3.20% of student learning variations.

3. Guidelines for Enhancing Cambodian Student Learning Index

Results of Kampong Chueteal High School as the case study of this research indicated that student learning index was highly changed after implementing designed activities by the two teachers to enhance student learning based on their instructional activities. Lessons learned from this study, for example interactive instructional activities between teachers and students both inside and outside the classrooms, were developed to create guidelines for enhancing student learning. The guidelines of the case study were categorized into two main guidelines—guidelines to enhance L2K and guidelines to enhance L2D. Therefore, the first guidelines may go with Learning to Know as presented in Table 5.1. Thereafter, another guideline was used to enhance Learning to Do Table 5.2 following the first guideline.

Table 4.38: Guidelines to Enhance "Learning to Know"

No.	Type of Activities	Activities done by students
1	In class (subjects)	• Students sent teacher the statement of interest and shared what they learnt. Additionally, students talked to teachers about their fall behind learning activities in order to take action on their learning habits. • Students prepared their class, exam, study group and learning goal with teachers' guidance and supports. • Students were introduced to use new learning material and tools to facilitate their learning process. On the other hand, students were provided the chances to comment on their own works and friends' works.

No.	Type of Activities	Activities done by students
		• Students were able to explore how to use and use appropriate technology in facilitating their learning both searching and presenting work and knowledge. In addition, students were commented and provided the feedback for better works. • Students obtained benefits from feedback and real life situation to analyze for better plan their next learning sessions or courses offered.
2	Out of class	• Assignment was assigned by teachers for out of class activities, as well as, the club study activities that created by students themselves. • Students were taken old ancient temples in order to be aware with fruitful ancient properties. • Students could face and solve learning and everyday life problems critically individually and in groups. • Students could conduct their learning in multi-media room, with computer and internet rooms.
3	Extra-curriculum	• Vocational training course participation. • Community meeting participation. • School meeting participation. • Sport activity participation, school and community tour guide training participation. • Students participated with community, social activities or other volunteer activities including community research activities, religious activities, and cultivating activities. • Community big cleaning day participation.

Table 4.39: Guidelines to Enhance "Learning to Do"

No.	Type of Activities	Activities done by students
1	In class (subjects)	• Students have done assigned work and learning activities on time with complete sense. • Students could present how to solve reading and mathematics problems due to their age interval based on teachers' attending, supports and sponsors. • Students were responsible and confident with the work they do. • Students could arrange their knowledge and skill in order to retrieve and apply in an appropriate situation. • Students competed each other in searching, reading, writing what they learned. • Students could take note as the diary of what they learned and did during the daily learning activities. • Students could use learning facilities, technologies, and multi-media in facilitating their own learning and working. • Students could do some experimental with learning theory such as Newton Force Theory and HO2 reaction. • Students could present their work in the classroom and in public. • Students could apply science in everyday life such as calculating monthly family incomes and payment.
2	Out of class	• Students could share their own knowledge to other effectively. • Students could run club study in order to help others to reach the learning goals. • Students could be the leader of some activities such as school guide, club study, and sport activities. • Students could arrange field trip study inside and outside school and community. • Students jointed student camping such as boy/girl scout.

No.	Type of Activities	Activities done by students
3	Extra-curriculum	• Students could work as school/community guide volunteer. • Students could help school cooperation store activities such as stock and share in retail selling. • Students applied science in learning to do accounting of stock and share. • Students helped promote vegetable/animal of school gardening and school husbandry. • Students helped school services such as building renting and meeting coordinator.

In sum, guidelines for enhancing student learning were categorized into three main activities including in-classroom, out-of classroom, and extra-curriculum activities. The three main activities produce interactive learning activities between students and teachers.

Discussion

This research aimed to develop learning index, measurement instrument, and guidelines for enhancing student learning in order that it would become more effective for educational stakeholders, especially, teachers to assess student learning. Therefore, the discussion following each research objective was employed.

The discussion of this research study was presented into three separated terms including methodology innovation, research instrument psychometric property investigation, interpretation of index, and guidelines for enhancing student learning.

1. Measurement Instrument of Student Learning

The research instrument was developed under the concepts of UNESCO (1996) on the four pillars of education, of which this study focused on the first two as extracted based on the research scope. The research instrument was comprised of one latent variable (learning), which covered two components (Learning to Know and Learning to Do). Each of the two components were comprised of two sub-components—the processes and outcomes of learning, wherein each sub-component consisted of three indicators. Each indicator was comprised of four items, except the third indicator of the

process of Learning to Know and the third indicator of outcome of Learning to Know, which consisted of eight items. Hence, the total number of items developed in this research study was 56.

As previously mentioned, each of the components of Learning to Know and Learning to Do consisted of two sub-components. The two sub-components were first formed by the process indicator, then followed by the outcome indicator. In the same sense, the 56 items were developed following a parallel concept. One item was developed in the process of indicators, with one corresponding item also developed in responding to the process of indicator in the outcome of indicator, respectively.

Learning was composed of two components—L2K and L2D. L2K consisted of two sub-components—process of L2K and outcome of L2K. The process of L2K consisted of three indicators. The outcome of L2K consisted of three indicators. Each indicator consisted of 4 items, except the third indicator—process of L2K, and third indicator of outcome of L2K which each consisted of 8 items. Thus, the total items of this component were comprised of 32 which are 16 items developed in the process indicators and other 16 items developed in the outcome indicators.

L2D also consisted of two components—process of L2D and outcome of L2D. The process of L2D consisted of three indicators. The outcome of L2D consisted of three indicators. Each indicator consisted of 4 items. Thus, the total items of L2D consisted of 24 which 12 items are developed in process of L2D and other 12 items are developed in the outcome of L2D. This concepts of development of items enables researcher to identify the qualities of item responses.

In fact, if students or respondents could highly agree with the processed items, accordingly, the outcome items would be whatever respondents agreed. But if students highly agreed with outcome items, as well as, respondents need to highly agree with processed items. This concept indicated that student poorly or unintentionally responded to the questionnaire would be identified. This is an innovative concept that is used to investigate whether respondents intend to respond the questionnaire tentatively. This questionnaire could be used to control over-claimed agreement of respondents on each pair of item (process and outcome items). In other word, this technique is also used to screen for qualified respondents in data collection process. In addition, it is believed that student learning index should be fulfilled as a summation of

a laddering path (UNESCO, 1996). It is believed that the process and outcomes of "Learning to Know" are the basis for "Learning to Do". Hence, if respondents could not pass the first laddering (process of learning), the respondent should not be able to pass the next laddering step (outcome of learning). In the same sense, if respondent could not complete L2K, automatically, he/she could not reach L2D.

2. Psychometric Property Investigation of Research Instrument

The development of this research instrument was validated by 6 psychometric property processes: content validity, objectivity, uncertainty, construct validity, reliability, and criterion-related validity.

Content validity was validated in terms of content based on four experts in the field. Content analysis was conducted to investigate for the error of wordings, fragments, sentences, and content intended for measurement due to the operational definition. This concept was considered based on the principles of educational measurement and evaluation which proposed that at least more than one piece of evidence should be proofed before confirming that the research instrument had content validity. Thus, the concept of this investigation go a long with (Drost, 2011).

Objectivity was investigated by 15 experts in the field and in the context of empirical data collection atmosphere. The investigation was conducted in terms of language use, scoring check and interpretive criteria of the research instrument. The results revealed that measurement model of student learning objectively measure the measurement model of student learning.

Uncertainty analysis was also conducted to investigate the changeable learning index based on the analysis technique. The four models of index calculation was analysis in terms of correlation coefficients. The results revealed that there is a small change in learning index due to calculation methods. Therefore, the uncertainty analysis result revealed that the most appropriate model for calculating student learning index was an additive model with factor loading of third-order confirmatory factor analysis. This additive model was easy to calculate and sensible to the situation of indicators of the constructed model. Additionally, it is easy to understand for all audiences that it was harmonized with the work of Saisana (Saisana, 2010).

Construct validity of this study was also analyzed by using third-order confirmatory factory analysis. The results revealed that the measurement model of

student learning was well-fitted with empirical data. Factor loading of all indicators of learning model were high with similar values (Muthén & Muthén, 1998).

Reliabilities of the developed items were ranged between .83 - .93, meaning that each item in the components, sub-components, and indicators are highly internally consistent, even though some small amount of items were found to be highly separated.

Criterion-related validity was also validated. The results revealed that the raw composite scores of low level student learning group was 37.72, while that of the high-level group was 43.06. The result of t-test analysis showed that there was were statistically significant differences between the means of two groups of the known-group sample. This t-test result shows that the learning index, measurement instrument of Cambodian students had criterion-related validity using known-group technique.

To interpret student learning index, four levels of norm-referenced approach of student learning were provided within two types of belief. The first type of belief is based on UNESCO' proposal on four pillars of education and the second type of belief due to the general view of Cambodian educational context.

For the first type of belief, the learning index of student were interpreted that if students have the process of Learning to Know, the value of the index was between .000 – .062. In the same sense, if students have the process of Learning to Know and outcome of Learning to Know, the value of the index was between .063 – .375. Additionally, if students can meet the component of Learning to Know plus the process of Learning to Do, the value of the index was between .376 – .680. Lastly, if students have the learning that consisted Learning to Know and Learning to Do, the value of the index was between .681 – 1.000. This interpretation was conducted with the norm-referenced index criteria.

For the second type of belief, student learning index was also interpreted due to the four levels of student learning. Hence, the index interpretation demonstrates that whenever students have the process of Learning to Know, the value of the index was ranged between .000 – .062. In the same sense, if students have process of Learning to Know and Learning to Do, the values of student learning level was ranged between .063 – .375. In addition, if students have process of L2K and L2D plus outcome of L2K, the values of student learning level was ranged between .376 – .680. Lastly, if students

have process and outcome of L2K and L2D, the value of the index was ranged between .681 – 1.000, respectively.

Following the learning index levels, the interpretation of the student learning index was also considered due to the two types of belief. The interpretation of student learning index is still entangled with unclear interpretation beliefs. Hence, the research results did not confirm yet whether the first type of belief or the second type of belief is the most appropriate for interpreting learning index of Cambodian student.

3. Explanations of Cambodian Student Learning Index

To interpret learning index based on these two types of belief still entangled with unclear confirmation. The index summation (topped up index) was approximately the same whether using first type of belief or second type of belief.

Based on the analysis of the multiple regression model, it was revealed that student learning index statistically significantly explained the learning index of students due to the background variables except the "academic stream" variable. The advantaged student background and school background explained highly the student learning index compared to disadvantaged students and school background. The total explanations of the 6 background variables accounted for 3.20% on student learning index variations. Even though the index of student learning explained differently based on the background variables, but, the amount of predication was very small (R-square changed) between each variable. Hence, these static background variables did not guarantee the change of student learning index to higher level whenever students switch to access the advantaged student and school backgrounds. It was clearly indicated that student learning index varied in a small interval, meaning that despite different students' gender, family incomes, school jurisdictions, school contexts, and school internet accesses, the learning index explained only 3.20 % of differences.

In other word, the variables' explained expected student learning index is equal to .58 + (.04)* gender + (.02)* family income + (.02) academic stream + (.03)* school jurisdiction + (.03)* school context + (.02)* internet access.

Where gender is coded as 1 = male, 0 = female, family income is coded as 1 = higher than/equal to 800, 000 Riel, 0 = lower than 800, 000 Riel, academic stream is coded as 1 = science, 0 = social science, school jurisdiction is code as 1 = private school,

0 = public school, school context is coded as 1 = high competitiveness school, 0 = nonurban school, and school internet access is coded as 1 = access, 0 = not access.

The student learning index increased 3.20 percentage points for each male, higher than/equal 800, 000 Riel income, private school, high competiveness school, and internet access school more than female students, lower than 800, 000 Riel income, public school, low/non competiveness school, and non-internet access school, respectively. But the academic stream between science and social science students did not provide any statistically significant different in predicting student learning index.

Hence, 3.20% of the variances in student learning index can be explained by different in gender (male), family income (higher/equal 800,000 Riel), academic stream, school jurisdictions (private school), school context (high competitiveness school), and school internet access (school with internet access).

In sum, Cambodian student learning index may exhibit small levels of differences due to the 6 background variables. Even if, the advantaged background students and schools seem provide higher learning index, but it was not clearly confirmed in terms of implementation. Accordingly, to produce higher level student learning index some activities should be created to enhance student learning index.

4. Guidelines for Enhancing Cambodian Student Learning

Guidelines for enhancing student learning index level were invented by two teachers. The guidelines proposed that teachers should teach, guide, promote, and initiate students to conduct their learning in mixed common sensed learning activities. There is no specific guidelines or teaching methods in responding to which learning components or sub-components that would produce ideal student learning. Thus, the guidelines of this study did not provide clear information on which items or learning components should be enhanced and promoted, but they provided common information that would help improve student learning index.

The learning index of Kampong Chueteal students was calculated, and the results revealed that index of student learning was .67, an increase from .59 prior to the treatment of learning activities created by two teachers. The result indicated that the activities conducted by two teachers of Kampong Chueteal helped enhance student learning index within only six weeks of the teaching courses.

In sum, it is confirmed that instructional activities created by two teachers affected on student learning. But some concerns still exist if these activities and equipment required in other schools, because the case study was conducted in Kampong Chueteal High School. This high school was well-structured, fully decorated, fully equipped, and fully facilitated in terms of learning facilities and learning resources, additionally, the students of this high school were usually trained both inside and out-side classroom learning activities. It seems easy for students to participate in any learning and extra-curriculum activities while other high school students do not get used to with these kinds of learning activities and facilities.

Research Recommendations

Based on the research findings and discussion, the learning index, measurement instrument, and guidelines for enhancing student learning are suitable for the context of Cambodian high school students even though there have been big challenges and constraints that entangle the effectiveness of the implementation of this learning index. Hence, some recommendations are made for research utilization in terms of policy making, academic and practical implementation, and further research studies.

1. Research Utilization

1.1. Policy Level

Based on the measurement model of student learning and learning index, Ministry of Education Youth and Sport of Cambodia should set specific policy aimed at implementing student learning index, therefore, teachers and stakeholders could use learning index to measure student learning as alternative measurement systems, meaning that policy makers should enhance teachers and stakeholders to use in learning index to assess student learning in the instruction.

Based on the analysis results of multiple regression model. The learning index of Cambodian students could be explained by the backgrounds of students and school contexts. It was found that gender and family incomes of students, academic stream, school jurisdictions, school contexts (competing/non-competing schools), and school internet access accounted for 3.20% of the learning variation. All background variables could not be manipulated except school internet access. Thus, the benefits of computer and internet access should be provided to students in conducting for their learning.

To provide high school student the computer and internet access, the policy makers and stakeholders should also consider cost-effect of school internet access utilizations. Educators and policy makers should provide students the orientation, how to access, how use the facilities in effective ways. Students should be provided by computer-assisted instruction if it is possible. Students' should be introduced to some learning resources throughout internet services. It is believed that whenever students are able to use computer and internet for their learning goals, it will provide fruitful student learning.

Guidelines for enhancing student learning should be offered to teachers in order to enhance student learning to meet the learning goals. E.g. interactive instructional activities between teachers and students.

1.2. Academic Level

There are two main instruments that can be useful for readers of this dissertation—the first one is the measurement instrument of student learning. It cannot only be used to assess composite scores of student learning but also the learning index of students that would provide students themselves and teachers the detailed information on student learning. In addition, teachers could use this kind of instrument as a part of assessment tools in which enable teachers to enrich student information about learning. Thereafter, teachers could decide and plan for effective teaching and guiding students.

The second benefit of this research instrument is to be used as guidelines for enhancing student learning index. Based on the guidelines, teachers could individual enhance student learning such as "Sharing past learning experience" would enhance student learning engagement. In other word, the benefit of the readers of this research study would be presented in the following paragraphs.

1. Based on the analysis result, it was indicated that measurement model of student learning had goodness-of-fit between construct and empirical data. Hence, this instrument is appropriate for student, teacher, and educational stakeholder to assess the measurement model of student learning. It can be a measurement model of student learning that could provide teachers and students themselves to investigate intrinsic learning both process and outcome, unlike other tests or assessment tools that provide only a snapshot of learning achievement at a specific point of time or specific

curriculum needed. Using this measurement model may help guarantee that students could improve their knowledge and skills systematically. Moreover, the measurement instrument of student learning was converted to be an index of student learning by using two main methods—criterion-related and norm-related. These methods enable stakeholders to be aware of scaling methods that would be convenient for audiences in interpreting student learning. Additionally, this research process provide readers many methods or scores could be converted into one standardized scale even if the methods and scores are from different sources and scales. It is easy to interpret and understand for any audiences.

2. Student learning index of this study was in the moderate level, meaning that Cambodian student learning could fulfill only the first pillar of education (Learning to Know) proposed by UNESCO. This information provides readers, teachers, and audience the basic information of student learning. It would benefit, especially, teacher to make decision and plan for next instruction. In the sense, it is indicated that student do not have full learning index as intended. Thus, could find out more that which component or sub-component of student learning was missed by every day teaching and learning activities. On the other hand, students could use this instrument to reflect his/her-self in approaching learning to reach the ultimate learning goals.

3. Based on the study at the macro level, there were statistically significant predictions of student learning index by different kinds of background variables, such as gender, family incomes, academic stream, school jurisdiction, level of competition in enrollment, and internet access. Students who study in the advantaged of these variables exhibit higher levels of student learning index compared to the disadvantaged background students. It provides readers and educational stakeholders to be aware with the capacity of student learning based on background of themselves and school, when implementing new educational policies and strategies.

4. Lessons learned for enhancing student learning index were developed based on the case study of a qualified high school. The lessons learned were extracted to be guidelines for enhancing student learning. The implementation of the guidelines made some positive change in student learning index. Therefore, educational stakeholders could use these guidelines to enhance student learning index in other school contexts. It would be preferable if the school context that will be used is similar to the case study.

However, adaptation is the most appropriate technique that will enable these guidelines to be meaningfully utilized in other kinds of school contexts.

1.3. Practical Level

High school teachers and educational stakeholders could use learning index, the measurement instrument, and guidelines for enhancing student learning to implement, monitor, assess, improve, and enhance all educational activities and school performance in order to decide that students meet the learning goal.

Teachers should pay more attention to quality of student learning, educational programs and facilities in order that student learning is guaranteed with learning index.

2. Further Study

1). This research study considered only the first two pillars of student learning as proposed by UNESCO due to respondent age interval and context of Cambodian students. Further studies should consider all pillars of education nested in the learning construct, if the respondents are adults studying higher education and beyond.

2). As shown in the research results, index interpretation is still entangled with the two types of belief. The interpretation is not clearly confirmed. Thus, further study should explore the true type of belief that could be used to interpret student learning index clearly.

3). Guidelines that were developed in Kampong Chueteal High School provided positive change in student learning index within only six week period. It is because this high school is fully facilitated in terms of learning resources, materials, and extra-learning activities. Thus, to implement guidelines in a short time period, it could produce good student learning index changes. Therefore, it could be generalized to a schools with similar context as Kampong Chueteal High School. Hence, further study should be conducted with variety of school contexts which could be generalized to a wider context of schools.

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APPENDIX

Appendix A: Experts' Names

1. Assistant Professor Nattaporn Lawthong, Ph.D.
   A lecturer in educational measurement and evaluation.
2. Associate Professor Kamonwan Tangdhanakonond. Ph.D.
   A lecturer in educational measurement and evaluation.
3. Associate Professor Charoonsri Madiloggovit, Ph.D.
   A lecturer in educational policy, management, and leadership.
4. Assistant Professor Jurairat Sudrung, Ph.D.
   A lecturer in educational policy, management, and leadership

Appendix B: Experts of Translation Check

1. Sokhum Chan, a teacher of Khmer Literature in Kampot Province. He also graduated master degree of educational measurement and evaluation, Chulalongkorn University. He is now awarded Ph.D. degree in Teaching Innovative and Technology in Education, King Wong Khut Thonbury University.
2. Keopanha Soeng, a lecturer of Pharmacy at Puthisastra University in Phnom Penh. She also graduated master degree in Physical Education, Chulalongkorn University.
3. Chantheng Meak, a vice president of vocational orientation department, Ministry of Education Youth and Sport. He was a former high school director. He is pursuing his Ph.D. degree in educational policy, management, and leadership, Faculty of Education, Chulalongkorn University.

Appendix C: Khmer Language Reading Check

To ensure the understanding of target participants, the reading of the questionnaire has been investigate. Three experts were asked to determine the reading difficulty of the items created. This process was conducted to ensure that reading of the questionnaire objectively matches the target participants of the research.

List of Experts

1. Sarat Sem, a secretarial officer in the faculty of health science (FHS), Puthisastra University, Phnom Penh.
2. Mol Vi, a master degree graduate in the field of environmental management, Chulalongkorn University.
3. Lida Pang, a high school student.

Appendix D: Data Collection Network and Data Analysis Assistants

Sovan Khleang, data collection network assistant. He is a principle of Sovannaphumi School.

Panida Marungruang, data analysis assistant. She is a lecturer, Department of Educational Measurement and Research, Srinakharinwirot University.

Chaiyut Kleebbau, data analysis assistant. He is Ph.D graduate of Educational Research Methodology.

Appendix E: Experts of Khmer-English Validation Check

1. Chantheng Meak, a vice president of vocational orientation department, Ministry of Education Youth and Sport. He is pursuing his Ph.D. degree in educational policy, management, and leadership, Faculty of Education, Chulalongkorn University.
2. Kimcheang Hong, a president of Kampong Spue Institute of Technology. He graduated master degree in Teaching English as foreign language, faculty of education, Chulalongkorn University. He also graduated Ph.D. degree in educational management, faculty of education, Burapha University.

Appendix F: Research Instrument

Research Questionnaire

I am Mr. Bunhe Harth, a Ph.D. Student in an educational research methodology program, Chulalongkorn University. I am currently conducting a research for my dissertation titled "Developing Learning Index, Measurement Instrument, and Guidelines for Enhancing Student Learning: Macro-and Micro-level Studies in Cambodia". I would like to ask for your assistance in responding the questionnaire items attentively. I will report only general findings and your individual answers will remain private, as I will not be referring to anyone by name in it.

I am very thankful for your time and participation.

Notice: This questionnaire consists of two parts—the first part asks for the information regarding background information of the respondents (10 questions) and the second part seeks the opinion of the respondents on each item provided (56 items).

Part I: Background information

Please mark (✓) in the box for your intended answers.

1. Gender
   □ 1. Male □ 2. Female
2. Age .....years old.
3. Academic stream
   □ 1. Social sciences □ 2. Sciences
4. Parents' monthly incomes
   □ 1. Less than 600,000 Riel □ 2. 600,000- 790,000 Riel
   □ 3. 800,000-990,000 Riel □ 4. 1,000,000-1,190,000 Riel
   □ 5. 1,200,000-1,390,000 Riel □ 6. 1,400,000- 1,790,000 Riel
   □ 7. 1,600,000-1,790,000 Riel □ 8. 1,800,000-2,000,000 Riel
   □ 9. More than 2,000,000 Riel
5. School location
   □ 1. Urban area □ 2. Rural area
6. Type of school
   □ 1. Public □ 2. Private
7. School size
   □ 1. Small (1-500 students) □ 2. Medium (501-1000 students)
   □ 3. Large (1001-1500 students
8. Availability of school computers for students
   □ 1. Yes □ 2. No
9. Availability of school internet for students
   □ 1. Yes □ 2. No
10. School context
    □ 1. Famous school with high enrolment rate and high competition.
    □ 2. Famous school with medium enrolment rate and medium competition.
    □ 3. Famous school with low enrolment rate and low or no competition.

Part II: Opinion of Respondents

1. Notice: all items provided here are 56 items
2. Please respond to each of the following statement using the scale below.

From 0-20% agree from 21-40% agree form 41-60% agree
From 61-80% agree from 81-100% agree

Items	opinion				
	1	2	3	4	5
1. I know good learning requires clearly-desired goals.					
2. Learning happens everywhere, every time regardless inside/outside the school or at home.					
3. It is important to provide myself with opportunity to learn new knowledge.					
4. I believe that effective learning emerges from my own efforts.					
5. I try to inspire and enhance myself to learn new things all the time.					
6. I manage myself to have learning discipline and concentration.					
7. I pay attention to my learning so that I can gain knowledge and use it for real benefits.					
8. I focus on my learning and participate in activities both inside and outside the classroom.					
9. I like searching for good remembering techniques and I apply those techniques in my learning.					
10. I like using a variety of taking-note strategy so that it helps me to remember the lesson easily.					
11. I use a various strategies to practice reading.					
12. I learn to clearly understand the sequence of work as well as the procedure to do the calculation or to solve the mathematic problem.					
13. I have different methods to gain knowledge and use it for maximized benefits.					
14. I have techniques to control myself for effective learning.					
15. I try to analyze my own weakness, strength and method to deal with learning problems I encounter.					
16. I try to find new learning methods to gain fundamental knowledge for achieving of my ultimate goal.					
17. Currently, I have clear learning goals. I know what I want to learn and what I learn for.					
18. I am happy with such learning environment: at school, at home and other places.					
19. I always provide myself with opportunity to join learning activities organized by schools and other organizations.					
20. Being a student, I spend much of time on learning as it is consider to be the most prioritized thing.					
21. Everyone commented that I love learning and being enthusiastic to seek new knowledge.					

Items	opinion				
	1	2	3	4	5
22. I am responsible for my study (e.g. attend classes on time, submit all assignment on time).					
23. I can link and integrate between existing and newly-gained knowledge together for the use any particular situations.					
24. I am the one who have broad knowledge from reading and doing activities in addition to what teachers teach.					
25. I am good at remembering what is taught and I am able to apply it in any circumstances.					
26. I have techniques for quick writing and taking note.					
27. I can a good reader.					
28. I am skillful in calculation and mathematic.					
29. I can search for knowledge by using a variety of methods such as using ICT-assisted device or asking experts in the field.					
30. I can learn effectively what I want to learn without any concerns.					
31. I know my strength and weakness and I can improve my weakness.					
32. I have academic achievement at satisfactory level.					
33. I realize that the only theoretical knowledge embedded in the course is not enough for practical work.					
34. I know what fundamental concept I should have.					
35. I am well-realized that basic knowledge is important for practical and real-life work.					
36. I am well-realized that in this real world, those who are successful are the ones who have clear and achievable learning goal.					
37. I am well-planned and well-prepared for my work.					
38. I try to analyze the work so that it would flow orderly as planned.					
39. I need to control myself well and train myself to work with diligent and tolerant manner.					
40. I see the importance of regular monitor and restructure of the work					
41. I try to train the skills in working of myself to be skillful.					
42. I always exchange my learning method and work with others that enable my work to be used in real situation.					
43. I try to develop working method to improve to reach better achievement.					
44. I find, adjust, integrate or apply new method in my work.					
45. I intent to study both theory and practices.					
46. I have all necessary knowledge for practical work.					
47. Before doing practical work, I evaluate my own foundation knowledge and enrich it as necessary.					
48. I have clear learning goal. I also know the knowledge and skill needed to use in future.					

Items	opinion				
	1	2	3	4	5
49. I can plan and prepare what is needed for perfectly-operated work.					
50. My teachers told me that most of my works are well systematic and orderly correct.					
51. The work I am responsible for is completed smoothly as planned.					
52. I try to improve my weakness and strength through various methods such as self-assessment, teacher-assessment, and peer-assessment.					
53. I finish my work with quality on time.					
54. My working achievement can be applicable for maximum benefits.					
55. Teachers and others appreciate my work as it is widely applicable.					
56. My working achievement is much appreciated as it is innovative and applicable.					

Appendix G: Sample of the Analysis Results

Reliability code (R)

```
##RELIABILITY##
setwd("C:\\Users\\bunhe\\Desktop\\all analysis code\\")
data<-read.csv(file.choose(), header=T)
head(data)
require(psych)
describe (data)
dataI14<-data[,19:22]     #i1-i4
dataI58<-data[,23:26]     #i5-i8
dataI916<-data[,27:34]    #i9-i16 # 8 items #
dataI116<-data[,19:34]    ##i1-i16##
dataI1720<-data[,35:38]   #i17-i20
dataI2124<-data[,39:42]   #i21-i24
dataI2532<-data[,43:50]   #i25-i32
dataI1732<-data[,35:50]   ##i17-i32##
dataKnow<-data[,19:50]   ###i1-i32###
##-----
dataI3336<-data[,51:54]    #i33-i36
dataI3740<-data[,55:58]    #i37-i30
dataI4144<-data[,59:62]    #i41-i44
dataI3344<-data[,51:62]   ##i33-i44##
dataI4548<-data[,63:66]   #i45-i48
dataI4952<-data[,67:70]   #i49-i52
dataI5356<-data[,71:74]   #i53-i56
dataI4556<-data[,63:74]   ##i45-i56##
dataDo<-data[,51:74]     ###i33-i56###
##----------
alpha(dataI14)
alpha(dataI58)
alpha(dataI916)
alpha(dataI116)  ##process of Know##
alpha(dataI1720)
alpha(dataI2124)
alpha(dataI2532)
alpha(dataI1732) ##all outcomes##
alpha(dataKnow) ###factor Reliability###
##----
alpha(dataI3336)
alpha(dataI3740)
alpha(dataI4144)
alpha(dataI3344) ##process of Do##
alpha(dataI4548)
alpha(dataI4952)
alpha(dataI5356)
alpha(dataI4556) ##all outcomes##
alpha(dataDo)   ###factor Reliability###
```

Measurement model of students' Learning to Know

```
TITLE:  CFAKNOW

DATA:
  FILE IS
"C:\Users\bunhe\Desktop\codemodel\CFA_KNOW\data_1619.txt"
;

VARIABLE:
  NAMES ARE pk1-pk3 ok1-ok3 pd1-pd3 od1-od3;
  USEVARIABLES ARE pk1-pk3 ok1-ok3 ;

ANALYSIS:
  TYPE IS GENERAL;
  ESTIMATOR IS ML;
  ITERATIONS = 1000;
  CONVERGENCE = 0.00005;

model:
    prok by pk1 pk2 pk3;
  outk by ok1 ok2@ ok3;
  k by prok outk;

  prok@0.03;
  pk1@0.2;
  PK3      WITH PK1;
  OK3      WITH OK2;
  PK3      WITH PK2;
  pk3@0.25;
  OK1      WITH PK1;
  OK2      WITH PK1;
  OK3      WITH PK1;
  OUTK@0.01;
  OK3      WITH PK3;
  OK2      WITH PK3;
  OK1      WITH PK3;
  OK1      WITH PK2;



  OUTPUT:  SAMPSTAT MODINDICES(0) RESIDUAL STANDARDIZED
FSCOEFFICIENT TECH1 TECH3;
```

Measurement model of students' Learning to Do

```
TITLE:  cfa_do

DATA:
  FILE IS "data_do.txt";

VARIABLE:
  NAMES ARE pk1-pk3 ok1-ok3 pd1-pd3 od1-od3;
  USEVARIABLES ARE pd1-pd3 od1-od3;

ANALYSIS:
  TYPE IS GENERAL;
  ESTIMATOR IS ML;
  ITERATIONS = 1000;
  CONVERGENCE = 0.00005;

 model:
        prod by pd1 pd2 pd3;
        outd by od1 od2 od3;
        d by prod outd;

OD3      WITH OD2;
prod@0.05;
outd@0.08;
pd1@0.15;
PD3      WITH PD1;
PD2      WITH PD1;
OD1      WITH PD1;
OD3      WITH PD1;
PD3      WITH PD2;
OD2      WITH PD1;



  OUTPUT:  SAMPSTAT MODINDICES(0) RESIDUAL STANDARDIZED;
!FSCOEFFICIENT TECH1 TECH3;
```

Measurement model of student learning's learning.

```
TITLE:  CFALEARNING

DATA:
  FILE IS
"C:\Users\bunhe\Desktop\codemodel\CFA_LEARNING\data_learn
ing.txt";

VARIABLE:
  NAMES ARE pk1-pk3 ok1-ok3 pd1-pd3 od1-od3;
  USEVARIABLES ARE pk1-pk3 ok1-ok3 pd1-pd3 od1-od3;
ANALYSIS:
  TYPE IS GENERAL;
  ESTIMATOR IS ML;
  ITERATIONS = 1000;
  CONVERGENCE = 0.00005;
model:
prok by pk1 pk2 pk3;
outk by ok1 ok2 ok3;
prod by pd1 pd2 pd3;
outd by od1 od2 od3;
k by prok outk;
d by prod outd;
l by k d;

OUTK@0.1;
k@0.02;
PK1@0.2;
PD1@0.18;
OK1@0.16;

OK3      WITH OK1;
PD3      WITH PD1;
PD2      WITH PD1;
OK1      WITH PK1;
OK2      WITH PK1;
OK3      WITH PK1;
PK3      WITH PK2;
OK2      WITH OK1;
OD3      WITH PD1;
OD2      WITH PD1;
OD1      WITH PD1;
OD3      WITH OD2;
PK2      WITH PK1;
PD3      WITH PD2;
OK3      WITH PK2;
```

```
OK3       WITH PK3;
OK3       WITH OK2;
PK3       WITH PK1;
pk2@0.2;
pk3@0.1;
OK2       WITH PK2;
OK2       WITH PK3;
ok3@0.05;
PD1       WITH PK1;
PD3       WITH PK3;
OD3       WITH OK1;
OD1       WITH PD3;
PD1       WITH OK3;
pd2@0.2;
PD1       WITH OK1;
PD1       WITH OK2 ;
OD3       WITH PK2;
OD3       WITH PK1;
OD2       WITH PK1;
OD1       WITH PK1;
OUTD@0.03;
OUTK      WITH PROK;
PD3       WITH PK1;
PD2       WITH PK1;
PD1       WITH PK3;
PD1       WITH PK2;
PROD@0.2;
d@0.02;
OD1       WITH OK3;
OD1       WITH PD2;
PD2       WITH OK2;
D         WITH PROD;
OUTD      WITH PROD;
OD2       WITH PK3;
OUTD      WITH OUTK;
PD2       WITH PK3;
OD1       WITH PK3;
!outd@0.01;


OUTPUT:  SAMPSTAT MODINDICES(0) RESIDUAL STANDARDIZED
FSCOEFFICIENT TECH1 TECH3;
```

Appendix H: Analysis Results (Mplus Outputs)

Measurement Model of Student Learning to Know

CFAKNOW
SUMMARY OF ANALYSIS

Number of groups 1
Number of observations 1619

Number of dependent variables 6
Number of independent variables 0
Number of continuous latent variables 3

Observed dependent variables

Continuous
PK1 PK2 PK3 OK1 OK2 OK3

Continuous latent variables
PROK OUTK K

Estimator ML
Information matrix OBSERVED
Maximum number of iterations 1000
Convergence criterion 0.500D-04
Maximum number of steepest descent iterations 20
Input data file(s)
C:\Users\bunhe\Desktop\codemodel\CFA_KNOW\data_1619.txt
Input data format FREE

SAMPLE STATISTICS

SAMPLE STATISTICS

Means

	PK1	PK2	PK3	OK1	OK2
1	4.123	3.805	3.535	3.564	3.354

Means

	OK3
1	3.376

Covariances

	PK1	PK2	PK3	OK1	OK2
PK1	0.599				
PK2	0.350	0.634			
PK3	0.312	0.446	0.598		
OK1	0.253	0.404	0.436	0.676	

OK2	0.238	0.366	0.422	0.431	0.640
OK3	0.225	0.312	0.374	0.365	0.453

Covariances

	OK3
OK3	0.547

Correlations

	PK1	PK2	PK3	OK1	OK2
PK1	1.000				
PK2	0.568	1.000			
PK3	0.522	0.724	1.000		
OK1	0.397	0.617	0.686	1.000	
OK2	0.384	0.575	0.683	0.655	1.000
OK3	0.394	0.531	0.654	0.600	0.766

Correlations

	OK3
OK3	1.000

THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION
Number of Free Parameters 25
Loglikelihood
H0 Value -8495.131
H1 Value -8493.610
Information Criteria
Akaike (AIC) 17040.263
Bayesian (BIC) 17175.002
Sample-Size Adjusted BIC 17095.581
(n* = (n + 2) / 24)
Chi-Square Test of Model Fit
Value 3.043
Degrees of Freedom 2
P-Value 0.2183
RMSEA (Root Mean Square Error Of Approximation)
Estimate 0.018
90 Percent C.I. 0.000 0.056
Probability RMSEA <= .05 0.909
CFI/TLI
CFI 1.000
TLI 0.999
Chi-Square Test of Model Fit for the Baseline Model
Value 5844.851
Degrees of Freedom 15
P-Value 0.0000
SRMR (Standardized Root Mean Square Residual)

Value 0.010

STANDARDIZED MODEL RESULTS
STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
PROK BY				
PK1	0.816	0.007	113.216	0.000
PK2	0.716	0.014	50.251	0.000
PK3	0.762	0.010	78.864	0.000
OUTK BY				
OK1	0.794	0.011	71.503	0.000
OK2	0.824	0.012	71.642	0.000
OK3	0.759	0.016	46.422	0.000
K BY				
PROK	0.962	0.002	465.167	0.000
OUTK	0.988	0.001	1857.590	0.000
PK3 WITH				
PK1	-0.246	0.042	-5.848	0.000
PK2	0.389	0.022	17.481	0.000
OK3 WITH				
OK2	0.375	0.037	10.220	0.000
PK1	-0.520	0.063	-8.251	0.000
PK3	0.238	0.028	8.604	0.000
OK1 WITH				
PK1	-0.601	0.064	-9.385	0.000
PK3	0.283	0.029	9.604	0.000
PK2	0.171	0.037	4.617	0.000
OK2 WITH				
PK1	-0.780	0.075	-10.460	0.000
PK3	0.220	0.031	7.082	0.000

R-SQUARE

Observed Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
PK1	0.666	0.012	56.608	0.000
PK2	0.512	0.020	25.126	0.000
PK3	0.581	0.015	39.432	0.000
OK1	0.631	0.018	35.751	0.000
OK2	0.680	0.019	35.821	0.000
OK3	0.575	0.025	23.211	0.000

Latent Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
PROK	0.925	0.004	232.583	0.000
OUTK	0.977	0.001	928.795	0.000

Measurement model of student Learning to Do

SUMMARY OF ANALYSIS

Number of groups	1
Number of observations	1619
Number of dependent variables	6
Number of independent variables	0
Number of continuous latent variables	3

Observed dependent variables

Continuous

PD1 PD2 PD3 OD1 OD2 OD3

Continuous latent variables

PROD OUTD D

Estimator	ML
Information matrix	OBSERVED
Maximum number of iterations	1000
Convergence criterion	0.500D-04
Maximum number of steepest descent iterations	20

Input data file(s)

C:\Users\bunhe\Desktop\codemodel\CFA_DO\data_do.txt

Input data format FREE

SAMPLE STATISTICS

SAMPLE STATISTICS

Means

	PD1	PD2	PD3	OD1	OD2
1	3.831	3.561	3.565	3.568	3.518

Means

	OD3
1	3.382

Covariances

	PD1	PD2	PD3	OD1	OD2
PD1	0.638				
PD2	0.390	0.646			
PD3	0.381	0.504	0.689		
OD1	0.388	0.471	0.497	0.638	
OD2	0.341	0.456	0.468	0.471	0.639
OD3	0.350	0.489	0.506	0.511	0.528

Covariances

	OD3
OD3	0.769

Correlations

	PD1	PD2	PD3	OD1	OD2

PD1	1.000				
PD2	0.608	1.000			
PD3	0.575	0.755	1.000		
OD1	0.608	0.733	0.750	1.000	
OD2	0.534	0.710	0.705	0.738	1.000
OD3	0.499	0.693	0.695	0.729	0.754

Correlations

	OD3
OD3	1.000

THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION

Number of Free Parameters	23
Loglikelihood	
H0 Value	-8231.854
H1 Value	-8228.150
Information Criteria	
Akaike (AIC)	16509.707
Bayesian (BIC)	16633.667
Sample-Size Adjusted BIC (n* = (n + 2) / 24)	16560.601
Chi-Square Test of Model Fit	
Value	7.407
Degrees of Freedom	4
P-Value	0.1159
RMSEA (Root Mean Square Error Of Approximation)	
Estimate	0.023
90 Percent C.I.	0.000 0.048
Probability RMSEA <= .05	0.961
CFI/TLI	
CFI	1.000
TLI	0.998
Chi-Square Test of Model Fit for the Baseline Model	
Value	7194.722
Degrees of Freedom	15
P-Value	0.0000
SRMR (Standardized Root Mean Square Residual)	
Value	0.009

STANDARDIZED MODEL RESULTS

STDYX Standardization

				Two-Tailed
	Estimate	S.E.	Est./S.E.	P-Value
PROD BY				
PD1	0.827	0.006	127.253	0.000

PD2	0.871	0.009	101.093	0.000
PD3	0.868	0.009	99.398	0.000
OUTD BY				
OD1	0.833	0.009	93.094	0.000
OD2	0.878	0.008	110.997	0.000
OD3	0.863	0.008	102.863	0.000
D BY				
PROD	0.953	0.002	394.636	0.000
OUTD	0.965	0.002	556.663	0.000
PD3 WITH				
PD1	-0.464	0.052	-8.910	0.000
PD2 WITH				
PD1	-0.372	0.052	-7.178	0.000
OD3 WITH				
PD1	-0.514	0.053	-9.747	0.000
OD2 WITH				
PD1	-0.458	0.055	-8.340	0.000
OD1 WITH				
PD3	0.303	0.032	9.441	0.000
PD2	0.239	0.033	7.288	0.000

R-SQUARE

Observed Variable	Estimate	S.E.	Two-Tailed Est./S.E.	P-Value
PD1	0.684	0.011	63.627	0.000
PD2	0.759	0.015	50.547	0.000
PD3	0.754	0.015	49.699	0.000
OD1	0.694	0.015	46.547	0.000
OD2	0.770	0.014	55.498	0.000
OD3	0.744	0.014	51.432	0.000

Latent Variable	Estimate	S.E.	Two-Tailed Est./S.E.	P-Value
PROD	0.907	0.005	197.318	0.000
OUTD	0.932	0.003	278.331	0.000

Measurement model of student Learning

SUMMARY OF ANALYSIS

Number of groups	1
Number of observations	1619
Number of dependent variables	12
Number of independent variables	0
Number of continuous latent variables	7

Observed dependent variables

Continuous

PK1	PK2	PK3	OK1	OK2	OK3
PD1	PD2	PD3	OD1	OD2	OD3

Continuous latent variables
PROK OUTK PROD OUTD K D
L
Estimator ML
Information matrix OBSERVED
Maximum number of iterations 1000
Convergence criterion 0.500D-04
Maximum number of steepest descent iterations 20
Input data file(s)
C:\Users\bunhe\Desktop\codemodel\CFA_LEARNING\data_learning.txt
Input data format FREE
SAMPLE STATISTICS
SAMPLE STATISTICS
Means

	PK1	PK2	PK3	OK1	OK2
1	4.123	3.805	3.535	3.564	3.354

Means

	OK3	PD1	PD2	PD3	OD1
1	3.376	3.831	3.561	3.565	3.568

Means

	OD2	OD3
1	3.518	3.382

Covariances

	PK1	PK2	PK3	OK1	OK2
PK1	0.599				
PK2	0.350	0.634			
PK3	0.312	0.446	0.598		
OK1	0.253	0.404	0.436	0.676	
OK2	0.238	0.366	0.422	0.431	0.640
OK3	0.225	0.312	0.374	0.365	0.453
PD1	0.286	0.287	0.322	0.317	0.344
PD2	0.260	0.335	0.390	0.389	0.438
PD3	0.248	0.332	0.408	0.390	0.428
OD1	0.251	0.326	0.384	0.388	0.427
OD2	0.239	0.335	0.393	0.394	0.419
OD3	0.236	0.319	0.400	0.387	0.460

Covariances

	OK3	PD1	PD2	PD3	OD1
OK3	0.547				
PD1	0.356	0.638			
PD2	0.409	0.390	0.646		

PD3	0.419	0.381	0.504	0.689	
OD1	0.422	0.388	0.471	0.497	0.638
OD2	0.404	0.341	0.456	0.468	0.471
OD3	0.439	0.350	0.489	0.506	0.511

Covariances

	OD2	OD3
OD2	0.639	
OD3	0.528	0.769

Correlations

	PK1	PK2	PK3	OK1	OK2
PK1	1.000				
PK2	0.568	1.000			
PK3	0.522	0.724	1.000		
OK1	0.397	0.617	0.686	1.000	
OK2	0.384	0.575	0.683	0.655	1.000
OK3	0.394	0.531	0.654	0.600	0.766
PD1	0.464	0.452	0.521	0.482	0.538
PD2	0.418	0.524	0.628	0.588	0.681
PD3	0.386	0.502	0.635	0.572	0.644
OD1	0.405	0.513	0.621	0.590	0.668
OD2	0.387	0.527	0.635	0.600	0.655
OD3	0.348	0.457	0.590	0.536	0.656

Correlations

	OK3	PD1	PD2	PD3	OD1
OK3	1.000				
PD1	0.602	1.000			
PD2	0.688	0.608	1.000		
PD3	0.682	0.575	0.755	1.000	
OD1	0.715	0.608	0.733	0.750	1.000
OD2	0.684	0.534	0.710	0.705	0.738
OD3	0.677	0.499	0.693	0.695	0.729

Correlations

	OD2	OD3
OD2	1.000	
OD3	0.754	1.000

THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION

Number of Free Parameters 75

Loglikelihood

H0 Value -15615.784

H1 Value -15604.625

Information Criteria

Akaike (AIC)	31381.568
Bayesian (BIC)	31785.785
Sample-Size Adjusted BIC (n* = (n + 2) / 24)	31547.524

Chi-Square Test of Model Fit

Value	22.318
Degrees of Freedom	15
P-Value	0.0997

RMSEA (Root Mean Square Error Of Approximation)

Estimate	0.017	
90 Percent C.I.	0.000	0.032
Probability RMSEA <= .05	1.000	

CFI/TLI

CFI	1.000
TLI	0.998

Chi-Square Test of Model Fit for the Baseline Model

Value	15273.843
Degrees of Freedom	66
P-Value	0.0000

SRMR (Standardized Root Mean Square Residual)

Value	0.010

STANDARDIZED MODEL RESULTS

STDYX Standardization

		Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
PROK	BY				
PK1		0.817	0.007	114.560	0.000
PK2		0.828	0.007	124.122	0.000
PK3		0.913	0.003	285.965	0.000
OUTK	BY				
OK1		0.874	0.005	186.191	0.000
OK2		0.933	0.012	75.680	0.000
OK3		0.953	0.002	563.627	0.000
PROD	BY				
PD1		0.847	0.006	144.433	0.000
PD2		0.831	0.007	126.829	0.000
PD3		0.822	0.012	70.091	0.000
OUTD	BY				
OD1		0.858	0.009	97.274	0.000
OD2		0.860	0.009	92.154	0.000
OD3		0.846	0.010	83.127	0.000
K	BY				
PROK		0.827	0.014	58.200	0.000
OUTK		0.898	0.005	183.556	0.000

D	BY			
PROD	0.997	0.013	74.997	0.000
OUTD	0.967	0.002	607.654	0.000
L	BY			
K	0.963	0.002	399.547	0.000
D	0.978	0.001	785.707	0.000
OUTK	WITH			
PROK	0.509	0.052	9.784	0.000
D	WITH			
PROD	-1.558	0.096	-16.310	0.000
OUTD	WITH			
PROD	1.416	0.077	18.411	0.000
OUTK	0.049	0.076	0.645	0.519
OK3	WITH			
OK1	-1.526	0.089	-17.145	0.000
PK1	-1.626	0.125	-12.993	0.000
PK2	-0.881	0.094	-9.381	0.000
PK3	-0.883	0.115	-7.696	0.000
OK2	-1.175	0.215	-5.477	0.000
PD3	WITH			
PD1	-0.404	0.058	-6.966	0.000
PD2	0.228	0.034	6.645	0.000
PK3	0.259	0.046	5.652	0.000
PK1	-0.380	0.059	-6.448	0.000
PD2	WITH			
PD1	-0.336	0.047	-7.133	0.000
PK1	-0.333	0.058	-5.735	0.000
OK2	0.121	0.041	2.933	0.003
PK3	0.168	0.047	3.570	0.000
OK1	WITH			
PK1	-0.760	0.067	-11.342	0.000
OK2	WITH			
PK1	-1.332	0.178	-7.476	0.000
OK1	-0.854	0.144	-5.944	0.000
PK2	-0.436	0.099	-4.395	0.000
PK3	-0.397	0.117	-3.383	0.001
PK3	WITH			
PK2	-0.115	0.040	-2.865	0.004
PK1	-0.943	0.072	-13.086	0.000
OD3	WITH			
PD1	-0.754	0.063	-11.925	0.000
OD2	0.092	0.043	2.131	0.033
OK1	-0.213	0.039	-5.449	0.000
PK2	-0.210	0.036	-5.783	0.000
PK1	-0.559	0.066	-8.409	0.000
OD2	WITH			

	PD1	-0.697	0.064	-10.913	0.000
	PK1	-0.475	0.066	-7.149	0.000
	PK3	0.205	0.046	4.459	0.000
OD1	WITH				
	PD1	-0.414	0.069	-6.025	0.000
	PD3	0.166	0.038	4.399	0.000
	PK1	-0.385	0.065	-5.915	0.000
	OK3	0.173	0.058	2.990	0.003
	PD2	0.086	0.039	2.172	0.030
	PK3	0.162	0.048	3.375	0.001
PK2	WITH				
	PK1	-0.325	0.046	-7.005	0.000
PD1	WITH				
	PK1	-0.228	0.064	-3.558	0.000
	OK3	-0.532	0.095	-5.580	0.000
	OK1	-0.487	0.064	-7.597	0.000
	OK2	-0.676	0.117	-5.786	0.000
	PK3	-0.361	0.084	-4.279	0.000
	PK2	-0.275	0.057	-4.790	0.000

R-SQUARE

Observed Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
PK1	0.667	0.012	57.280	0.000
PK2	0.685	0.011	62.061	0.000
PK3	0.834	0.006	142.983	0.000
OK1	0.764	0.008	93.095	0.000
OK2	0.870	0.023	37.840	0.000
OK3	0.908	0.003	281.813	0.000
PD1	0.717	0.010	72.216	0.000
PD2	0.690	0.011	63.414	0.000
PD3	0.675	0.019	35.046	0.000
OD1	0.736	0.015	48.637	0.000
OD2	0.739	0.016	46.077	0.000
OD3	0.716	0.017	41.563	0.000

Latent Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
PROK	0.684	0.024	29.100	0.000
OUTK	0.807	0.009	91.778	0.000
PROD	0.561	0.021	26.153	0.000
OUTD	0.936	0.003	303.827	0.000
K	0.927	0.005	199.774	0.000
D	0.956	0.002	392.853	0.000

VITA

Mr. Bunhe Harth was born on the 1st January 1985 in Kampong Thom province, Cambodia. In 2005, He graduated an associate's degree of physics and chemistry from Kampong Cham Regional Teacher Training Center. In 2010, he graduated his bachelor's degree of physic from Western University. In 2013, he earned his master's degree in Educational Measurement and Evaluation, Faculty of Education, Chulalongkorn University, Thailand. In 2013, he continued his Ph D's degree in Educational Research Methodology, Faculty of Education, Chulalongkorn University, Thailand. The two continuum scholarships were offered by The Royal Project Contribution in Education to the Kingdom of Cambodia.

He is currently teaching physic at Kampong Chheuteal High School, Kampong Thom province, Cambodia.