การพัฒนาโมเดลการใช้ประโยชน์ทางการศึกษา: เคียงมือและวิธีการระดับการใช้ประโยชน์และโมเดลการวัดของพัฒนาการที่มีตัวแปรแบบความแปรปรวนของความคาดเคลื่อนไม่เท่ากัน วัดการใช้ประโยชน์ทางด้วยพหุตัวแปรชี้

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บทคัดย่อ

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คำนำ:
การใช้ประโยชน์ทางการศึกษา ได้รับการบันทึกถึงการใช้ประโยชน์ทางการศึกษา ได้รับการพิจารณาให้เป็นการศึกษาในระดับการใช้ประโยชน์และโมเดลการวัดของการพัฒนาการที่มีตัวแปรแบบความแปรปรวนของความคาดเคลื่อนไม่เท่ากัน วัดการใช้ประโยชน์ทางด้วยพหุตัวแปรชี้

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215
The Development of Research Utilization Models:
Instrument, Measurement Method and Latent Growth Curve
Multi-Indicators Measurement Models of Research Utilization
with Unequal Disturbance Variance

Theeraphat Phetsalaksil
Sirichai Kanjanawassee
Nongjak Wiratcharit

ABSTRACT

The main objective of this research was to develop models, measurement methods and instruments for the investigation of how to utilize research into practice, provide an international perspective by adopting measurement evaluation techniques and latent growth curve (structural equation modeling) analysis. The purpose of the research work: 1) to study research utilization level and utilization patterns of graduate students with different individual, environmental and background factors. 2) To develop instruments and measures for research utilization; 3) to develop and validate the 5 research utilization measurement models with the application of latent growth curve analysis: the measurement model of overall research utilization and the measurement model of overall research utilization achieving a high level of research utilization (direct, indirect and precautionary research utilization). The sample consisted of 370 graduate students selected by means of multi-stage sampling from 5 master and doctoral programs at 3 universities in the public university in Bangkok. The research instrument is a self-response questionnaire consisting of four parts: direct, indirect and precautionary research utilization; part two: overall research utilization (RUO); part three: overall research utilization (RUO); part four: research utilization (RUO); and part five: overall research utilization (RUO). Data collection and research measurement for each stage of the research process. Descriptive statistics, correlation analysis, analysis of variance, and multiple regression analysis were employed for data analysis by using SPSS. Model validation was used by using LISREL 8.72.

The main findings were: first, the research utilization level of the graduate students was quite high in all four measurements (mean range 5.710-3.827). The students indicated that 60.50%-74.94 percent of the students indicated that the utilization level of overall research was high. The utilization frequency was found approaching equal for each stage of the research process. The highest one was the research proposal stage, followed by the research implementation stage. The lowest one was the research identification stage. Classifying by pattern of research utilization, it was revealed that the graduate students typically select research directly, then they utilize indirect utilization and precautionary utilization respectively. Second, the research instruments consisted of four parts: self-response questionnaire developed based on literature reviews with total reliability (Cronbach's alpha) and index of congruence (GPA) and (GPA). Measurement model is repeated measure implemented in process of investigating 5 stages of research process that overall and pattern utilization with the level of reliability identified by percentage of frequency of research-based knowledge and information using. Third, the first measurement model (latent growth curve multi-indicators measurement model with unequal disturbance variance) was used to evaluate the empirical data (x² = 52.50, p = 0.001; 6.71 - 8.68; ADF = 0.03) whereas the second measurement model (latent growth curve multi-indicators measurement model with equal disturbance variance adding 4 patterns of research utilization) was not fitted to the empirical data. The LGC measurement models validated gave advantage compared to other models and improved the model's accuracy. Measurement development will shed more light to understand research utilization, give enlightenment of practical process to save quantity and quality of research using.

Keywords
Origin and Rationale Background

Nearly half of century that trial of the studies concerning research utilization has been begun. The use of research or "research utilization" was discussed as important issue for decades about how to make the practice of research-based, so the evaluation and structure of research utilization were proposed. Researchers investigated the process of research utilization and divided into stages of use (Stetler and Marram, 1978; Horsley, Crane and Bingle, 1978; Rodgers, 1983, 2000, Horsley, et al, 1983, Stetler, 2003). Lasen (1980) considered research utilization as knowledge utilization comprised of complex process. In addition to the specific information or knowledge, Lasen proposed that research utilization can be categorized into instrumental and conceptual. Rich (1975, 1977 cited in Estabrooks, 1998) and Weiss (1979) also discussed the instrumental and conceptual utilization of research. Subsequently, Beyer and Trice (1982) added symbolic utilization to be the third type of use and be referred in many literatures later. Estabrooks (1998, 1999, 2003) developed conceptual structure of research utilization, she found that within a simplex-common cause model that permitted only direct effects and controlled for instrumental (direct utilization), conceptual (indirect utilization) and persuasive research utilization. The research-based evidences indicated that research utilization could be described in the form of integrated model and needed to be investigated for better understanding which be advantages for researchers and users in practising research in their works.
Global Development

Thai Development

Figure 1 Comparative diagram of research utilization studies to build frontier of development in form of timeline of selected publications and events
Methodology Development

Latent Growth Curve is one of the most important analyses which has been rapidly and continuously improved for decades. It's used to analyze development, change or growth rate in any research. Initial works relied on difference evaluation that is the reason of 2 times of measurement. Then many academicians have developed the method by changing the number of measurement; based on this aspect, they have changed from 2 times of measurement to 3 or more times of measurement. The later analysis was called “growth measurement” which then developed into “growth curve analysis” by LISREL. Growth curve analysis is known as new evaluation for change which classified by its method and result of measure. At least 3 times of measurement helps the analysts to get more information for analyze, and also enable to study growth model characteristics of each unit correctly.

Growth Curve model (LGM) was firstly developed by Tucker and Rao in 1958 (cited in Wiratchai, 1999) and was improved into structural equation model by McArdle and Epstein (1987), McArdle and Aber (1990), McArdle and Hamagami (1991, 1995) then Raykov (1994 cited in Wiratchai, 1999) made the model more better with latent variable which relevant to reality of data, that was evolved into latent growth curve model in present (Wiratchai, N., 1999).

![Diagram](image)

**Figure 2** Latent growth curve model measured 5 times with single indicator
Latent growth Curve analysis began as figure 2 that the latent variable was measured repeatedly for 3 times with single indicator or one observable variable (Y1, Y2 and Y3). The model consisted of 2 parts: latent true score (T) and specific component (e), while latent true score were affected by two important components. First component was determined as initial factor or level (L) and the second component was determined as growth rate or change factor or slope (S). Model characteristic was developed in form of second-order factor analysis that all factor loading affected to latent true score (T) from L component equal to 1 while factor loading of S component defined as a1—a3 respectively (a1 = 0 since first evaluation was no change). This prior LGM was initiatively assessed the interesting latent by single indicator.

Raykov (1994 cited in Wiratchai, 1999) applied this model to analayse the change or growth measurement. Chaiyakam (1996) used LGM to study change score of Mathematics class in upper elementary schools under jurisdiction of Bangkok Authority with three-time measurement, he compared the analysis of one-indicator model to two-indicator model of measurement; the result indicated that two-indicators model was more efficiency than one-indicator model. Nevertheless, this longitudinal factor analysis model has a limitation because the exclusion of the intercept or average score from the model that make factor loading showed only relative effects; in addition, 2-3 times of measurement gives low reliability and validity when compares to more than 3 times measurement (Collins & Horn, 1991, 1995; McArdle & Hamagami, 1991, 1995 cited in Tangsakunnuangai, L., 1998).

From the limitation of Raykov's model along with the first development model present in three-time measurement that the first factor loading from slope component equaling zero restricts only 2 values of factor loading left to characterize model's pattern. To solve this restriction, group of statisticians (McArdle & Epstein, 1987; Meredith & Tisak, 1990; McArdle & Hamagami, 1995 cited in Wiratchai, N., 1999) has developed better models from ordinary one in 5 ways: 1) analyse in raw score in observable measure unit adding the constant (+1) as parameter matrix for mean or intercept in LISREL model 2) use basis coefficient as parameter to characterize curve of growth feature and enabled researcher to define coefficient's value relying on evidence from theories or related research.
or free the value to be calculated by LISREL program, this allows more reflexivity and variety of growth curve analysis 3) autoregressive model 4) mistake reduction when the construction of model has too many latent and observable variables using command series of reticular action model (RAM notation) which adjust model in only BE matrix 5) similar and distinct from longitudinal factor analysis as 5.1) permission error relation between latent level and slope component 5.2) latent common factor (level and slope component) do not have to relate to error term of indicator or specific factor 5.3) path analysis of error term demonstrated by sling or span implies the assumption that each error term have no relation 5.4) error term has normal distribution. New LGM which could reveal dynamic of change, group and individual development was shown in figure 3.

![Figure 3 Latent growth curve model measured 5 times with single indicator](image)

From the qualification of basis coefficient which is flexible to fix or free for identifying curve characteristic in LGM. McArdle and Hamagami (1995) described that it is very useful to analyse growth curve diversely and could be present in 5 examples: Baseline Growth Model (BAS Model) which defines basis coefficient zero value, Linear Growth Model (LIN Model) which basis coefficient value is defined linearity, Fixed Curve Parameter Growth Model (FIC Model) which basis coefficient value is defined curvilinear, Free Parameter Growth Model (FRE Model) which frees basis coefficient value to be calculated by program and Unequal Disturbance Variance Growth Model (UDV Model), which release restriction of basis assumption from the mentioned 4 models.

221
that variance of measure error must treat equally (similar to basis assumption of repeated
measure analysis of variance whereas the LGM, the restriction can be released). One of
introduced 5 model helps researchers to analyze data and identify pattern of relevant
model and the growth rate could be approximated.

Although model development is being continually employed by many researchers
(Tangsakunruanglai, I., 1998, Ruajantuek, S., 1999, Chaikaew, M., 1999, Sithikunthorn,
A., 2000, Wijitwanna, S., 2000, Amatacheewin, S., 2003) but LGM models has been
analysed the effect of level and slope component to indicator directly as second-order
confirmatory factor analysis; and most of the models measured by single indicator.

The advancement of this research is multi-indicator measurement analysing the
effect of level and slope component to research utilization as latent variable (four-times
RUO was measured by 5 indicators from 5 stages of dissertation/theses process) instead
of considering its direct effect on indicators. This makes the model feature a third-order
factor analysis model; the first order, latent variable of level’s error (L*) and slope’s error
(S*), the second order, latent variable of level (L) and slope (S) and the third order, the
latent variable of research utilization. The first proposed measurement model is called
“latent growth curve multi-indicators measurement model with unequal disturbance
variance” (as shown in conceptual framework below).

One interesting point in this research is that LGC has been employed to validate
model from data that measured continually in the same variable instead measured as
longitudinal data because of 2 reasons: 1) applying method of longitudinal data into
repeated measurement data which will provide better analysis information in the aspect
that an repeated action will guide the respondents to reflex more correctly 2) improving
the conceptual structure of research utilization (Estabrook, 1998, 2003), which analysed
the data considered as chain reaction between prior RUO to next RUO (longitudinal
simplex model mixed with common cause model) as shown in figure 4 whereas proposed
model in figure 5-6, which not only exhibiting clarified detail but also demonstrating
advantages of method that the influence of initial value (level) and change rate (slope) to
a latent overall research utilization could be analysed.
Figure 4 Conceptual structure of research utilization by Estabrooks (1998)

**Objectives**

The objectives of this research were 1) to study research utilization level and utilization pattern of graduate students with different individual, contextual and background factors 2) to develop instruments and method for measure research utilization 3) to develop and validate the 2 research utilization measurement models with the application of latent growth curve analysis: the measurement model of overall research utilization and the measurement model of overall research utilization adding 3 patterns of research utilization (direct, indirect and persuasive research utilization).

**Conceptual Frameworks**

Proposed measurement models applied LGC analysis of research utilization could be explained here in 2 structures: the measurement model of overall research utilization and the measurement model of overall research utilization adding 3 patterns of research utilization.
Figure 5  Latent growth curve multi-indicators measurement model of overall research utilization with unequal disturbance variance
Figure 6 Latent growth curve multi-indicators measurement model of overall research utilization with unequal disturbance variance adding 3 patterns of research utilization (direct, indirect and persuasive RU)
Methods

This quantitative research of model development methodology was orderly described as follows.

Samples and Sampling Method: the sample size was 478 graduate students according to 5–20 samples per path or parameter (Hair, Tatham, Anderson & Black, 1998) selected by means of multi-stage sampling from 61 master and doctoral programs that have to conduct the research in graduate course in 15 departments of 2 governmental universities in Bangkok.

Research Instruments and Development: the developmental processes of questionnaire consisted of 3 phases. Phase 1: Instruments construction, in this phase the variables in models were theoretical and operational defined, next the specification tables were developed and then the questionnaires were constructed based on the specification tables. Phase 2: in the second phase, the questionnaires were administered to 3–5 graduate students not in the samples to check for face validity. Then, its index of congruence was checked by 7 experts in research methodology. Final phase, the questionnaires were administered with 36 graduate students excluding the samples. The result of which were analyzed to obtain Cronbach's alpha reliability and confirmatory factor analysis (CFA) in order to check construct validity.

Data Collection: the questionnaires were collected by researcher and via email.

Analysis: comprised of three types of analysis. Firstly, preliminary analysis were conducted to describe the characteristic of the samples and to study the distribution of the variables in the models. Secondly, the statistical assumption testing used in this investigation were examined through scatter diagram, normality check, multicollinearity check, homoscedasticity check. Finally, CFA and SEM using LISREL program were employed to validate the two measurement models of research utilization.
Results and finding

Part 1: Level and pattern of research use of graduate student.

1.1 Ladder of research progression distribution

Analysis of samples distribution is presented in Table 1 invented in the form of "ladder of research progression distribution" which shows amount of users distributed to semester in 5 stages of research process (major curriculum study, statistics and research study, problem identification, research operation and research dissemination). The amount of samples is distributed in stage 4, 3, 5, 2 and 1 respectively; in terms of starting-ending semester and time usage of each stage, we found that stage 1 always begins at 1\textsuperscript{st} semester (93.80\%) and mostly ends at 3\textsuperscript{rd} semester (41.03\%) with time usage equals 3.02, stage 2 always begins at 1\textsuperscript{st} semester (73.29\%) and ends at 3\textsuperscript{rd} semester (34.40\%) with time usage equals 2.42, stage 3 begins at 3\textsuperscript{rd} semester (37.18\%) and ends at 4\textsuperscript{th} semester (30.11\%) with time usage equaling 2.12, stage 4 mostly begins at 4\textsuperscript{th} semester (28.63\%) and ends at 6\textsuperscript{th} semester (25.85\%) with time usage equals 2.83, stage 5 begins almost equally at 4\textsuperscript{th} or 6\textsuperscript{th} semester (19.44\%, 20.94\%) and ends at 5\textsuperscript{th} or 8\textsuperscript{th} semester (23.50\%, 21.79\%) with time usage equals 1.33.
Table 1 Frequencies of samples distribution classified by average semester when start–finish of research development stage and time usage of each stage, beginning and ending semester of all stages of research development in form of ladder of progression

<table>
<thead>
<tr>
<th>Stage</th>
<th>Average Semester when start stage 1 - 1.56</th>
<th>Average Semester when finish stage 4 - 2.42</th>
<th>Average Semester when start stage 2 - 1.30</th>
<th>Average Semester when start stage 3 - 1.02</th>
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228
1.2 Level of overall research utilization

By crossing tabulation between mean of research utilization level and measure time and stage of research process integrated with factor loading from CFA in table 2. It is found that samples utilized research quite high (mean range of 3.513-3.657). It is indicated that 60.00-79.99 percent of total frequency in utilizing of overall knowledge was research utilization. At 1st - 3rd measurement; the analysis shows that the highest utilization score occurred in problem identification stage (3.647, 3.821 and 3.861) while the highest factor loading of all measurement appears in research operation stage (.557, .273, .297 and .651), while the highest score at 4th measurement was in research operation stage (3.927). From grand mean comparison of all stages indicates that there was growth during the times of measurement (from 3.513 to 3.657). When considering grand mean of all measure comparison between each stage, the samples utilized research most highly in problem identification stage (3.793).

Table 2 Average score of overall research utilization in each stage of research development measured 4 times

<table>
<thead>
<tr>
<th>Stage</th>
<th>1st measurement</th>
<th>2nd measurement</th>
<th>3rd measurement</th>
<th>4th measurement</th>
<th>Grand mean of all measure at each stage</th>
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<td>3.821</td>
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</table>

Grand mean of all stages at each measure: 3.513 3.618 3.618 3.657 3.601

RUO3
Mean = 3.616

RUO4
Mean = 3.607

RU
Mean = 2.966

Overall Research Utilization 1 (RUO1) Overall Research Utilization 2 (RUO2) Overall Research Utilization 3 (RUO3) Overall Research Utilization 4 (RUO4) Research Utilization (RU)
1.3 Level of pattern research utilization

When considering pattern of research utilization, the highest score of 3 pattern research utilization insistly appears in the problem identification stage (3.865, 3.726 and 3.331). Mostly, graduate students used research directly, the next is using indirectly and using persuasively as the last. The factor loading of direct and indirect utilization are found the highest value in problem identification stage (.847 and .840) but persuasive utilization factor loading was highest in research operation stage (see table 3).

Table 3 Average score of overall research utilization in each stage of research development process.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Direct Research Utilization</th>
<th>Indirect Research Utilization</th>
<th>Persuasive Research Utilization</th>
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<tbody>
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<td>3.333</td>
</tr>
<tr>
<td>5</td>
<td>3.162</td>
<td>0.663</td>
<td>3.522</td>
</tr>
</tbody>
</table>

Grand mean of all stage at each measure:

- RUDIR Mean = 3.690
- RUINDIR Mean = 3.630
- RUPERSUA Mean = 3.174
Part 2: research utilization measurement instruments and method.

2.1 Special-structured questionnaire and LGC application

*How to measure and evaluate exact value of research utilization?* This question leads to the application of latent growth curve (LGC) concept into measuring and analysing method, special-structured questionnaire is shown in figure 7. Firstly, the respondents would be enlightened by "the meaning and example of research utilization" then, the first research utilization was asked. Secondly, respondents had to response their opinion to "prompt questions" which are series of questions that the readers have to self-reflect by answering "yes" or "no" to behavior identified as research utilization. Thirdly, it is pattern utilization measurement, followed repeatedly by "the meaning and example of research utilization" and questions for measuring research utilization for 3 times. The advantage of this tool development is "revision of learning and response", this leads to the clearer concept about "what research utilization is" and could reflect exact value of it.

*Figure 7* Explanation picture shows the mechanism of self-learning response questionnaire for measuring latent variable (research utilization)
2.2 Scale and asking question

Each item was asked to identify from research use frequency of respondents by pondering "...in this stage, how many percent of total frequency in utilizing of overall knowledge were research utilization...", the answer relies on Likert's summated rating scale which is operational defined as below.

<table>
<thead>
<tr>
<th>Level</th>
<th>Score</th>
<th>Frequency percentage</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000–1.499</td>
<td>0.80–19.99</td>
<td>scarcely / never use</td>
</tr>
<tr>
<td>2</td>
<td>1.500–2.499</td>
<td>20.00–39.99</td>
<td>slightly / sometimes use</td>
</tr>
<tr>
<td>3</td>
<td>2.500–3.499</td>
<td>40.00–59.99</td>
<td>averagely use</td>
</tr>
<tr>
<td>4</td>
<td>3.500–4.499</td>
<td>60.00–79.99</td>
<td>rather highly use</td>
</tr>
<tr>
<td>5</td>
<td>4.500–5.000</td>
<td>80.00–100.00</td>
<td>highly / always / every time use</td>
</tr>
</tbody>
</table>

2.3 Instrument quality check

For quality checking, researchers tried out the questionnaire with 36 students and calculated Conbrach's alpha of 35 items, sent to 9 experts to review each items to find out index of congruence (IOC). Finally, the complete questionnaire were employed to samples for gathering data. The reliability of all questionnaire displayed appropriate value (.836–.945) while indices from second-order CFA of overall research utilization were fitted well to empirical data with construct reliability varied from .210 to .797. In addition, the CFA of 3 pattern research utilization also fitted well to empirical data with construct reliability varied from .149 to .827 as shows in table 4.

Table 4 Quality indices of questionnaire's quality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of items</th>
<th>Index of congruence</th>
<th>Reliability (n=36)</th>
<th>Reliability (n=49)</th>
<th>Construct validity</th>
<th>Construct reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUD</td>
<td>20</td>
<td>1.000</td>
<td>0.021</td>
<td>0.046</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUDIR</td>
<td>5</td>
<td>1.000</td>
<td>0.714</td>
<td>0.836</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUNDR</td>
<td>5</td>
<td>1.000</td>
<td>0.873</td>
<td>0.837</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUPERSJA</td>
<td>5</td>
<td>.925</td>
<td>0.878</td>
<td>0.897</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

232
Figure 8  Fitted second-order CFA measurement model of overall research utilization

Figure 9  Fitted first-order CFA measurement models of 3 pattern research utilization
Part 3: latent growth curve measurement model measured by multi-
indicators with unequal disturbance variance

This part is derived from latent growth curve measurement model with unequal
disturbance variance which mentioned above, the models were progressively developed
as "third-order factor analysis" as shown in figure 5 and 6. The benefits of applying LGC
into measurement and analysis were: 1) measure more than 3 times 2) measured research
utilization as latent variable 3) measure values with multiple indicators 4) solve the
problems in longitudinal data collection.

In procedure of development, researchers conducted 5 models validation from
data collected to find out what model characteristic best fitted to empirical data. Researchers
studied the way that McArdle and Hamagami (1991; 1995) and Tansaksunruanglai, I.(1998)
have developed; then tested the models respectively by these following procedures: 1) no
slope baseline growth model (NSB model) 2) latent growth curve model with defined
basis coefficient linearity (LIN model) 3) latent growth curve model with fixed parameter
(FIC model) 4) latent growth curve model with free parameter (FRE model) and finally
5) latent growth curve model with unequal disturbance variance from best fitted to
empirical of 4 model above (UDV model). Lastly, added 3 pattern research utilization
into best fitted model and validated again by LISREL.

The first measurement model (latent growth curve multi-indicators measurement
model with unequal disturbance variance of research utilization) had 29 variables in
structure with well fitted to empirical data, $\chi^2 = 95.508; p = .001; GFI = .981; AGFI = .925$
whereas the 2nd model latent growth curve multi-indicators measurement model with
unequal disturbance variance of research utilization adding 3 patterns of research utilization
was not fitted to the empirical data.

Result from model validation indicated that graduate students had highest growth
between 1st and 2nd measurement ($r = .103$) and the lowest growth occurred between 2nd
and 3rd measurement. From parameter estimation (maximum likelihood estimation), we
found RUO1 had positive relation to RUO2 with statistic significance at .01 (effect size
$= 25.530$, standard error $= 7.721$) and RUO3 also had positive relation to RUO4 at
significant level of .05 (effect size= 9.702, standard error= 4.578), while there is no significant relationship between RUO2 and RUO3. The same relationship appeared at indicators level that the last indicators of 1st measurement (RUO1_S5) affected significantly to first indicator of next measurement (RUO2_S1) at significant level of .01, and also between last indicator of 3rd measurement (RUO3_S5) and 4th measurement (RUO4_S1) at significant level of .01.

When focusing on factor loading, this UDV measurement model revealed that latent research utilization could be measured well by this multiple indicator approach. Most factor loadings were found positively at significant level .01; and factor loading of indicators were found equally in same measure. 1st measurement (RUO1) had factor loading between .855-.1.013 and the greatest factor loading was found in the problem identification stage (RUO1_S3). 2nd measurement (RUO2) had factor loading between .033-.041 and the greatest factor loading was found in the major curriculum study stage (RUO2_S1). The 3rd measurement (RUO3) had factor loading between .678-.853 and greatest factor loading was found in major curriculum study stage (RUO3_S1). The 4th measurement (RUO4) had factor loading between .054-.082 and the greatest factor loading was found in the problem identification stage (RUO4_S3), the research operation stage (RUO4_S4) and the research dissemination stage (RUO4_S5).
Figure 10  Fitted latent growth curve-indicators measurement with unequal disturbance variance fixed parameter growth rate by real difference of data (FIC parameter): 1 measure of overall research utilization considered chain effect between ending stage indicators to beginning to beginning state indicator.
Conclusion and Discussion

First conclusion is derived from “ladder of research progression” which is useful for administrators and staffs in graduate education management to plan, make policy and consider about starting-ending and usage time of stage of thesis/dissertation process. The suitable value is now showing in table 5.

### Table 5  Appropriate starting-ending and usage semester from analysis.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Starting semester</th>
<th>Ending semester</th>
<th>Appropriate usage semester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>master</td>
<td>doctoral</td>
<td>master</td>
</tr>
<tr>
<td>1. Major curriculum study</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2. Research and Statistics study</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3. Problem Identification</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4. Research operation</td>
<td>3</td>
<td>3-4</td>
<td>4</td>
</tr>
<tr>
<td>5. Research dissemination</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

* * Notice: this suggestion relies on samples from 2 semester annual year (1 vacation semester) curriculum.

Second point of conclusion is about level and pattern of research utilization; although graduate students utilized research at quite a great level when computed all stages but when scrutinized into the detail, we found that graduate students identified highest level of using in stage 3 and 4 but lowest in stage 5. This finding guides the learners and concerning teachers that they should concentrate more at these stages and spend more time to seek and search research information. In addition, at the stage of lowest research utilization (research dissemination); they have to raise the quantity and quality of research using too. These finding push duty on shoulders of responsive stakeholders to “focus on relevant research in the right time and duration.

Next advancement is the instrument of measurement, question, scale, structure and method development. The multi-indicators of 4-times measurement questionnaire can be used widely with other samples and contexts, the repeated measure (came from
LGC application) also gives more valid value of research utilization. Development and measurement approach would be advantage to future developers.

Finding from model validation gives useful information to prove the strength and limitation of UDV model as 1) LGM is better fit to empirical data compare to simplex-common cause model 2) analysis from multiple indicators instead of single indicators displays brighter information because a more number of indicators and the analysis could be considered at both latent variable level and indicator level 3) RAM notation command adjustment enables the researcher to validate model easily, reduce the confusion if adjusting in other commands. But this application also has limitation because of number of BETA matrix dimension will increase rapidly from a more number of indicators; when the number of variables in model is too many, it will lead to higher chi-square that makes this such a model does not fit to empirical data.

Academic advancement and methodology development in this research

1) Variables measurement, instrument and method developed by applying latent growth curve analysis. The evaluator will get better relevant value and reliability of variable. This aspect can be applied to make higher learning in other science and context.

2) Quantitative measure technique development of research utilization in many aspects. Measurements in this research are overall measurement, measure classified by pattern of use and by special structure of questionnaire (be enlighten during response). This approach builds clearer comprehension along the assessment process (giving definition, example of use, defining level from frequency of use in 5 stage of research process).

3) Latent growth curve measurement model measured by multi-indicators with unequal disturbance variance. The model is advantageous to analyse thoroughly both latent and observable variable level. This quality makes it to be potential technique to better inspect relationship between variables, analyse clearer of growth rate and initial value effect.
References


