

EFFECT OF RESEARCH TRAINING ENVIRONMENT ON DOCTORAL STUDENTS' RESEARCH INTENTIONS

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Abstract

The research training environment (RTE) is an important factor for enhancing doctoral students' research intentions (RI). This study aims to develop and validate the casual relationship model of the RTE and RI, mediated by research self-efficacy (RSE) and research engagement (RE), and examine differential RTE effects in years 1-3 of the doctoral program. The research sample consisted of 246 doctoral students in years 1-3 of their doctoral program, with the respondents randomly selected from 13 universities in Thailand. Data were collected via questionnaire and analyzed using an integrated generalized structured component analysis (IGSCA) with multigroup analysis. The findings have shown that there was no mediation effect of RE or RSE between the RTE and RI in the first year. In contrast, mediation effects of RE and RSE were found in the second ($\beta = .097$) and third years ($\beta = .723$) of the doctoral program. Based on the results, it is suggested that the RTE component associated with RSE should be established (e.g., allowing students to engage with their projects early and minimally) in the first year. Furthermore, it is recommended that RSE and RE be developed concurrently (e.g., encouraging students to share research ideas with others) in the second and third years.

Keywords: doctoral student; research intentions; research training environment, integrated generalized structured component analysis

1. INTRODUCTION

In general, most universities offer graduate programs based on curriculum structure and require students to complete a thesis. However, considering the results of curriculum management in the past, especially regarding doctoral students in the field of education, there has been no clear evidence that each graduate program places an

importance on promoting research engagement, which can affect the willingness of students to conduct further research after their graduation. It is possible that postgraduate students may not contribute to national research development according to the intent of producing higher-education graduates. Thus, the production of doctoral graduates must focus on improvement of educational management and place more emphasis on

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training in research skills (Davis & Sandifer-Stech, 2006).

Producing higher-education graduates with appropriate research skills is an important issue, and focuses on the importance of encouraging students to take up more research studies (Hutchinson & Lovell, 2004; Gutlerner & Vactor, 2013). Many scholars have used the theory of Research Training Environment (RTE) to develop students' research skills. This theory focuses on stimuli generated by the course environment that can affect students' attitudes toward research and lead to greater research engagement on their part (Gelso et al., 2013; Kahn, 2001, Seivert et al, 2022; Tung et al., 2023).

Only a limited number of research studies have supported the idea of separately examining research engagement (RE) and research intentions (RI). For instance, one research study explored the influences of environmental factors within the institution on RE (Hall, 2010; Salguero et al., 2012), while another examined the impacts of RE on RI (Koyuncu et al., 2006; Snelgrove & James, 2010). Additionally, certain studies have indicated that the RTE has an effect on RI (Eke et al., 2012; Snelgrove & James, 2010). Furthermore, previous proposals have suggested an association between the RTE and research self-efficacy (RSE) (Brown et al., 1996; Law & Gou, 2011; Livingi et al., 2021; Lynch et al., 2009). Moreover, RSE has been found to be associated with both RE (Eginli & Dikilitas, 2022; Hall, 2010; Heng et al., 2020; Jorgensen & Ducan, 2015; Salgueira et al., 2012; Pachler et al., 2019; Wu et al., 2020) and RI (Livingi et al., 2021; Pachler et al., 2019; Wu et al., 2020). Notably, all of these research studies were conducted in a non-educational context, for example psychology (Bruke et al., 2019), counselling (Jorgensen & Duncan, 2015), and medication (Black et al., 2013), employing a research framework that focused on examining each variable individually rather than collectively within a single study.

Thus, a conceptual framework focused on the RTE, RSE, RE, and RI has been developed. These four variables were inte-

grated together within the field of education in order to obtain results that would be beneficial in determining and planning student-development policies and strategies for the future. Therefore, the main objective of this study is aimed at developing and validating the casual relationship model of the RTE and RI, which would then be mediated by RSE and RE in order to investigate the differential effects of the RTE on doctoral students in the field of education across years 1-3.

Two statistical representations of constructs, rooted in scientific theory, have been established: factor-based models and component-based models. The factor-based model, also known as the reflective model, pertains to constructs that generate the correlation pattern among observed variables. It considers the construct as a latent variable that underlies the observed variables. In contrast, the component-based model, or formative model, defines the construct as a summary or index of observed variables. It regards the construct as a combination or summary of the observed variables (Cho et al., 2022a). This particular concept aligns well with the model used in this study, where the RTE serves as a component that creates an ideal environment for graduate students through observed variables. On the other hand, RSE, RE, and RI, are psychological variables that can be considered factors because they are measured through observed variables that reflect students' traits.

As a result, the study employed integrated generalized structured component analysis (IGSCA) to address potential biases arising from mixed factor-component measurement models (Hwang et al., 2020). It was also considered an appropriate estimator due to its capability to incorporate extensive information and its characteristic of not being influenced by distribution (Hwang et al., 2023). Furthermore, IGSCA provides enhanced flexibility for the mixed constructs in social science research, such as those identified in recent studies, both in the international context (e.g., Cho et al., 2022b; Richter et al, 2022; Qamar at al., 2022) and within the specific context of Thailand (e.g.,

Fakfare & Wattanacharoensil, 2023; Napontun & Senachai, 2023; Senachai et al., 2023).

2. LITERATURE REVIEW

2.1 Research Training Environment

The research training environment (RTE), developed by Gelso (1979), refers to student support from the curriculum on various factors. The RTE helps develop graduate students in order to establish their positive attitude towards research or academic activities during studying and after graduating. The RTE can be categorized into two main components. The first of these is the interpersonal factors, with the following sub-components: 1) faculty modelling of appropriate scientific behavior and attitudes, 2) positive reinforcement of scholarly activities, 3) early and minimally challenging student involvement in research, and 4) science as a social experience. The second component is the instructional factors, with the following sub-components: 5) teaching of relevant statistics and the logic of research designs, 6) encouraging students to look inward for research questions and ideas, 7) emphasizing the inherent imperfection of research studies, 8) teaching varied research methodologies and 9) demonstrating science-practice integration with a focus on completing research relevant to all types of professional settings (Burke & Prieto, 2019; Gelso et al., 1996; Kahn & Miller, 2000). The RTE theory is very helpful in enhancing the resolve of graduate students' intentions to conduct research by using 9 main components as strategies, which are highly practical and can be clearly managed. It was found that researchers in psychology and other related fields have paid close attention to the use of the RTE and continued to develop the RTE within their own contexts (Brown et al., 1996; Gelso et al., 2013; Kahn, 2001; Kahn & Scott, 1997; Lynch, et al., 2009).

The RTE is one of the theories that aims to create a favorable atmosphere for the development of graduate students, especially

doctoral students to have a positive attitude towards research. The RTE has continuous development and has been researched for over 30 years. Early in this period, Gelso (1979) proposed the RTE with the main objective of encouraging students to develop research interests. Over the years, nine aspects of the RTE were adapted to fit the context, and the addition of variables beyond research interest was regularly studied. In addition, the nine RTE aspects of Gelso's model were accepted for practical application and are listed in guidelines for undergraduate psychology majors: Version 2.0. (APA, 2016).

Consequently, the RTE theory has been applied in the context of postgraduate education. There are articles supporting the idea of using the RTE to enhance students' research abilities, such as by building a learning community for doctoral students (An et al., 2008), developing research self-efficacy (Kahn & Gelso, 1997; Overall et al., 2011; Pasupathy & Siwatu, 2014; Lambie et al., 2014), and improving research productivity (Quimbo & Sulabo, 2014). In addition, a preliminary study also suggested that the RTE theory can be applied in the context of Thai education. It was found that Thai postgraduate students in the Faculty of Education were influenced by the RTE and that the RTE had a significant effect on students' research interests through research self-efficacy and research outcome expectations (Chumwichan and Siriparp, 2016). Apart from applying the RTE theory in the context of psychology, findings from many RTE research studies suggest the possibility and need for using the RTE theory to develop students' skills in the context of education. Moreover, research self-efficacy, which is an important mediator, should also be the subject of further study as it can significantly explain the goal of creating the RTE, which will be in the best interests of the conduct of research.

2.2 Research Self-Efficacy

Research self-efficacy (RSE) is a variable applied from self-efficacy according to Bandura's social cognitive theory (SCT)

(1997). RSE represents a person's beliefs about his or her abilities to accomplish specific activities. Later, SCT was studied in a career context and developed into the social cognitive career theory (SCCT) (Lent et al., 1994) which discusses the influence of environmental factors on occupational choice, organizational commitment and job satisfaction. Therefore, RSE developed under the SCCT framework refers to self-confidence or an individual's personal beliefs about their own capabilities to perform research from start to finish (Black et al., 2013; Livingi et al., 2021; Pasupathy, 2014; Petko et al., 2020). RSE is an important antecedent variable to academic career. Previous study has shown that a person with higher RSE levels is more likely to seek opportunities to learn and perform research-related tasks (Livingi et al., 2021). RSE is positively correlated with research publications and positive attitudes toward research, while it is negatively correlated with research anxiety (Gelso, 1979, Rezaei & Zamani-Miandashti, 2013).

Pillips and Russell (1994) examined correlational research and found a significant correlation between RTE and RSE. Later, a causal relationship was discovered. RTE has been proposed to be associated with RSE, as supported by many studies (Brown et al., 1996; Law & Gou, 2011, Livingi et al., 2021; Lynch et al., 2009). Over the past 30 years, RSE is one variable that has been continuously studied with RTE (Gaoat et al., 2023; Gelso et al., 2013; Livingi et al., 2021; Sunal & Kemer, 2022). Therefore, RSE is a key mediator variable linking the relationship between RTE and other dependent variables.

2.3 Research Engagement

Research engagement (RE) was developed from the engagement variable. This variable has been studied in many contexts, e.g., commitment to work, commitment to learn, and commitment to school. In the context of the field of education, engagement is divided into three parts: 1. behavioral engagement, which is a person's

positive behavior towards a stimulator (e.g., giving time on tasks), 2. emotional engagement, which is the attitude towards the stimulator (e.g., attention and valuing), and 3. cognitive engagement, which is the dedication of one's thoughts to a stimulator (e.g., self-regulation and study plan) (Fredricks & McColskey, 2012; Fredricks et al., 2004).

In the context of research engagement, many studies have focused on determining behavioral engagement. These studies have investigated and measured the corresponding components of research engagement, categorized by dimensions, involving three levels: reading, applying, and doing research (Borg, 2010; Del Mar et al., 2004; Heng et al., 2020). The definition of RE is the perception of a person regarding their own behavioral level in research-related activities, including reading research, applying research, and doing research, with a focus on these activities.

RE and RTE are associated with the Theory of Planned Behavior, proposed by Ajzen (1991) which uses the educational environment to foster attitude toward behavior. It teaches students as a model for being a researcher (subjective norm) and encourages students to believe that they can do research (perceived behavioral control) (Eke & Hayward, 2012). In addition, a number of studies have examined the relationship between RE and RSE according to SCCT and showed that RSE has a significant positive influence on RE (Heng et al., 2020; Pachler et al., 2019; Wu et al., 2020).

2.4 Research Intention

The study of research intentions (RI) extends from research interests. It is a variable which has been studied in conceptual frameworks together with the RTE variable since the theory was first developed (Royalty et al., 1986). Later, there were a number of studies supporting its influence in counselling psychology students and beyond (Bieschke et al., 1996; Khan, 2001; Khan & Scott, 1997; Law & Guo, 2011), including doctoral students in the field of education (Lambie et al., 2014;

Quimbo & Sulabo, 2014). There is a definition and tool to measure research interests during and after study via the same variable. Thus, it is not known whether graduate students will continue to conduct research after graduation or not.

The present research investigates research interests both for conducting research during study (measured by research engagement variable) and the research interests after graduation. Therefore, RI has been developed by linking relationships in the SCCT (Lent et al., 1994) conceptual model developed from Bandura's SCT (1977). It refers to the student's intention to conduct research in the future (Francis et al., 2004) which relates to being interested in participating in research activities after graduation (Bieschke et al., 1996; Gelso et al., 2013; Khan & Scott, 1997). RI is a consequence variable influenced by the RTE (Livinți et al., 2021) RSE (Livinți et al., 2021; Pachler et al., 2019; Wu et al., 2020), and research engagement behavior (Koyuncu et al., 2006; Snelgrove & James, 2010).

graduation (Koyuncu et al., 2006; Livinți et al., 2021; Snelgrove & James, 2010). To promote RE, students must be given support in a research-related learning environment and other factors, e.g., from teacher, teaching content (Hall, 2010; Jorgenen & Ducan, 2015; Racheal & Abdullah, 2019, Salgueira et al., 2012), and extracurricular activities (Brooks & Schramm, 2007; Hunter et al., 2014).

Previous research studies showed that RSE increases as RTE increases in accordance with the SCCT theory (Lent et al., 1994). The environmental effect can stimulate students to develop RSE (Bieschke, et al., 1996; Eke and Hayward, 2012, Gaoat et al., 2023; Gelso, et al., 2013; Khan & Scott, 1997; Livinți et al., 2021; Suna & Kemer, 2022), whereby RSE resulted in learning engagement and RE (Eginli & Dikilitas, 2022; Hall, 2010; Heng et al., 2020; Jorgenen & Ducan, 2015; Salgueira et al., 2012; Pachler et al., 2019; Wu et al., 2020). RTE serves RI, a tendency for students to conduct research after graduation, including conducting research to develop the field, conducting research for career advancement, and conducting social research (Burke & Prieto, 2019; Livinți et al., 2021; Snelgrove & James, 2010). Past studies also suggest that RSE influences RI (Petko et al., 2020; Livinți et al., 2021).

2.5 The Conceptual Model Development

A related research study showed that RE refers to reading behavior in research, applying research results, and conducting research. RE is an important variable indicating the future research trends of students after

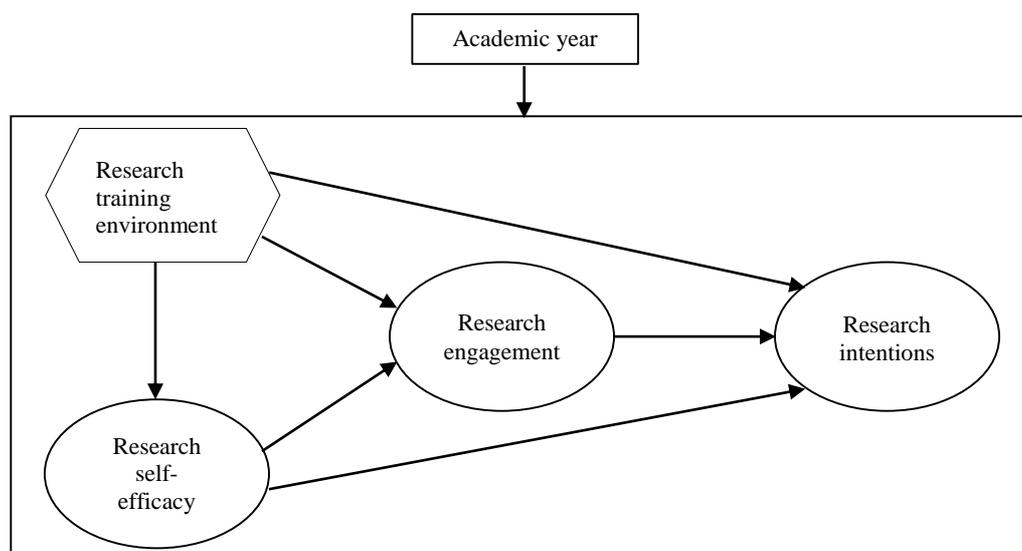


Figure 1 Conceptual Model

Note: Hexagon denotes component whereas eclipse indicates factors

In addition, the relevant research reveals that the learning context of doctoral studies varies from year to grade. This is because the curriculum aims to support learners according to their individual needs with emphasis on content in the first year and practice in the later years (Seloni, 2012). Thus, the relationship among 1) RTE, 2) RSE, 3) RE, and 4) RI has a correlated influence in a causal relationship, as summarized in the Figure 1.

3. METHODOLOGY

3.1 Population and Sample

The population of the present research consisted of the first- to third-year doctoral students, who had already passed two academic semesters and had enough experience to share comments and suggestion regarding the RTE, which they experienced when studying compulsory courses. The target universities of the present research were 13 public and private universities offering doctoral programs in education. Data collection was carried out during the second semester, of the academic year 2016. A total of 500 questionnaires were sent and 246 questionnaires were returned and deemed valid for analysis. The sample consisted of 96 first-year students, 82 second-year students, and 68 third-year students.

3.2 Measures

The RTE for the study was measured using the Research Training Environment Scale (Gelso et al., 1996). The original scale questions in English were translated to Thai by the authors. The 27-item RTE scale consisted of 2 components. The first component was the interpersonal factors, with the following sub-components 1) faculty modeling of appropriate scientific behavior and attitudes ($\alpha = .88$) (6 items, e.g., “Many of your faculty do not seem to be very interested in doing research.”), 2) positive reinforcement of scholarly activities ($\alpha = .76$) (6 items, e.g., “Your graduate program rarely acknowledges the scholarly achievements of

students.”), 3) early and minimally challenging student involvement in research ($\alpha = .76$) (7 items, e.g., “You were encouraged to get involved in some aspects of research early in your graduate training.”), and 4) emphasis on science as a partly social experience ($\alpha = .84$) (6 items, e.g., “There is informal sharing of research ideas and feelings about research ideas in my program.”). The second component was the instructional factors, with the following sub-components: 5) teaching of relevant statistics and the logic of research designs ($\alpha = .76$) (6 items, e.g., “Students in your program receive sound training in how to design and logically analyze research studies.”), 6) encouraging students to look inward for research questions and ideas ($\alpha = .81$) (6 items, e.g., “You have felt encouraged during training to find and follow your own scholarly interests.”), 7) emphasizing the inherent imperfection of research studies ($\alpha = .80$) (8 items, e.g., “Your advisor understands and accepts that any piece of research will have its methodological problems.”), 8) teaching varied methodology of research ($\alpha = .85$) (6 items, e.g., “During coursework, graduate students are taught a wide range of research methodologies, e.g., field, laboratory, survey approaches.”), and 9) demonstrating science-practice integration with a focus on completing research relevant to all types of professional settings ($\alpha = .91$) (6 items, e.g., “Your training program faculty tends to produce research that is educationally relevant.”). In addition, a third component was developed, and adopted from the concept proposed by Brooks and Schramm (2007) and Hunter et al. (2014). The third dimension was the service training factors, with the following sub-components 1) service inside the university ($\alpha = .93$) (6 items, e.g., “You assist other students by consulting about research.”) and 2) service outside the university ($\alpha = .94$) (6 items, e.g., “You assist people outside the university by consulting about research.”). All items were scored using a five-point rating scale from “strongly disagree” (1) to “strongly agree” (5).

To measure RSE, a Thai version of the RSE scale was developed from the concept

proposed by Pasupathy and Siwatu (2014), and Black et al. (2013). The 27-item RSE scale consisted of five components: 1) defining research problems ($\alpha = .93$) (6 items e.g., "You are able to develop a research question."), 2) research design ($\alpha = .93$) (5 items, e.g., "You are able to determine the adequate sample size in your research."), 3) data gathering ($\alpha = .92$) (4 items, e.g., "You are able to collect data in your research."), 4) data analysis ($\alpha = .92$) (6 items, e.g., "You are able to use statistical software."), and 5) reporting findings ($\alpha = .96$) (6 items, e.g., "You are able to report the findings of your research."). All items were scored using a five-point rating scale from "strongly disagree" (1) to "strongly agree" (5).

To measure RE, a Thai version of the RE scale was developed from the concept proposed by Borg (2010). The 29-item RE scale consisted of three components: 1) research reading ($\alpha = .94$) (9 items, e.g., "You work hard in reading for research."), 2) applying research ($\alpha = .93$) (10 items, e.g., "You adopt ideas from research to your own work/project."), and 3) initiating research ($\alpha = .94$) (10 items, e.g., "You work hard in your research"). All items were scored using a five-point rating scale from "strongly disagree" (1) to "strongly agree" (5).

To measure RI, a Thai version of the RI scale was developed from the concept proposed by Wright and Holttum (2012). The 18-item RI scale consisted of three components: 1) research for one's own career growth ($\alpha = .87$) (6 items, e.g., "You will conduct research for professional growth.") 2) research for academic purposes ($\alpha = .92$) (6 items, e.g., "I will conduct research to fulfil knowledge gaps."), and 3) research for social purposes ($\alpha = .92$) (6 items, e.g., "I will conduct research to serve the needs of society."). All items were scored using a five-point rating scale from "strongly disagree" (1) to "strongly agree" (5).

3.3 Analysis

The measurement's reliability and validity were assessed using the Average

Variance Extracted (AVE) value, which should be higher than 0.5; the alpha (α) value, which should be higher than 0.6; and the DG-rho (ρ) value, which should be higher than 0.7 (Benitez et al., 2020; Hair Jr et al., 2020). Furthermore, in order to evaluate discriminant validity, HTMT (heterotrait-monotrait) values were examined, with a criterion of being less than 0.85 (Henseler et al., 2015), and an acceptable criterion of being less than 0.90 (Gold et al., 2001; Teo et al., 2008). Additionally, the Variance Inflation Factor (VIF) was assessed, indicating that a value below 5 was considered acceptable (Hair et al., 2015).

The structural equation modelling was conducted to examine the causal relationships among latent variables with an integrated generalized structured component analysis (IGSCA) framework, accounting for the bias from mixed factor-component measurement models (Hwang et al., 2020). Furthermore, IGSCA was deemed suitable as an estimator due to its ability to incorporate comprehensive information and its distribution-free nature (Hwang et al., 2023). The IGSCA with multigroup analysis was carried out using the procedure outlined by Fakfare et al. (2021), which involved comparing two models: 1) The constrained model, where all parameters of the 1st year to 3rd year models were fixed to be equal, and 2) The unconstrained model, which allowed all parameters between 1st year to 3rd year models to be freely estimated. The choice between constrained and unconstrained models depended on the difference in FIT with bootstrap samples, the model with higher FIT values being preferable.

4. RESULTS

4.1 Measurement Model

The validity of the construct was evaluated using convergent validity and discriminant validity techniques, which were supported by analyzing the α and ρ values as presented in Table 4 (Benitez et al., 2020; Hair Jr et al., 2020). The reliability measurements surpassed the recommended thresholds

proposed by scholars ($\alpha > .6$; $\rho > .7$; $AVE > .5$) (Benitez et al., 2020; Hair Jr et al., 2020), providing compelling evidence for the reliability of the construct (see Table 1).

In terms of establishing discriminant validity, the HTMT (heterotrait-monotrait) values displayed in Table 1 fall within the acceptable range: less than .85 according to a strict interpretation (Henseler et al., 2015) and less than .90 in an acceptable sense (Gold et al., 2001; Teo et al., 2008). According to Rasoolimanesh (2022), HTMT is suitable for

assessing discriminant validity in reflective constructs or factor-based models, which do not apply to the RTE which consists of composite-based variables. In such cases, Rasoolimanesh et al. (2017) recommends employing a comprehensive collinearity test to determine discriminant validity. The analysis conducted on the components using the variance inflation factor (VIF) yielded values below 5 (refer to Table 2), indicating the absence of significant multicollinearity concerns (Hair et al., 2015).

Table 1 Reliability and Validity

Construct	Total sample			1 st academic year (n = 96)			2 nd academic year (n = 82)			3 rd academic year (n = 68)		
	AVE	α	ρ	AVE	α	ρ	AVE	α	ρ	AVE	α	ρ
RTE (Component)	.700	.674	.875	.600	.674	.818	.748	.830	.899	.757	.842	.903
RSE (Factor)	.819	.958	.958	.824	.958	.959	.820	.957	.958	.812	.954	.956
RE (Factor)	.783	.903	.915	.772	.903	.910	.785	.910	.916	.795	.912	.921
RI (Factor)	.739	.901	.894	.773	.901	.910	.727	.883	.889	.724	.873	.886

Note: RTE = research training environment; RSE = research self-efficacy; RE = research engagement; RI = research intentions

Table 2 HTMT and VIF of component and factors

HTMT	Total sample		1 st academic year (n = 96)		2 nd academic year (n = 82)		3 rd academic year (n = 68)	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
RTE <-> RSE	.736	[.638;.803]	.856	[.679; 1.006]	.599	[.365;.766]	.826	[.701;.935]
RTE <-> RE	.681	[.521;.786]	.678	[.515;.855]	.664	[.490;.865]	.724	[.518;.879]
RTE <-> RI	.574	[.417;.686]	.675	[.515;.836]	.437	[.265;.684]	.656	[.424;.827]
RSE <-> RE	.689	[.587;.772]	.636	[.489;.792]	.611	[.398;.833]	.844	[.576;.930]
RSE <-> RI	.585	[.450;.691]	.493	[.247;.667]	.601	[.405;.729]	.733	[.531;.836]
RE <-> RI	.606	[.504;.725]	.472	[.297;.682]	.639	[.437;.795]	.769	[.546;.897]

VIF

RI as response variable				
RTE	1.978	2.275	1.714	2.480
RSE	2.285	2.498	1.707	4.359
RE	2.048	1.740	1.885	3.218
RE as response variable				
RTE	1.802	2.160	1.424	2.460
RSE	1.802	2.160	1.424	2.460

Note: RTE = research training environment (component); RSE = research self-efficacy (factor); RE = research engagement (factor); RI = research intention (factor)

The IGSCA measurement model presented in Table 3 shows that all indicator weights and loadings are statistically significant based on 95% confidence intervals.

4.2 Multigroup Analysis and Structural Model

Fit indices were estimated and compared between the constrained model (Model 1) and the unconstrained model (Model 2) in order to examine the moderating effect of the student's academic year. The results indicated the $FIT = .794$, $GFI = .980$, $FIT_s = .353$, $FIT_m = .920$ and $SRMR = .082$ for the constrained model. Meanwhile, $FIT = .797$, $GFI = .984$, $FIT_s = .366$, $FIT_m = .921$ and $SRMR = .074$ for the unconstrained model. These findings indicate that the overall model accounts for 79.4% of the variance in the constrained model and 79.7% in the unconstrained model. Furthermore, the structural model explains

35.3% of the variance in the constrained model and 36.6% in the unconstrained model. Additionally, the measurement model accounts for 98.0% of the variance in the constrained model and 98.4% in the unconstrained model. Based on Cho et al. (2020, 2022c), the recommended criteria state that GFI should be equal to or higher than .93, while SRMR should be lower than .08. The results indicate that the unconstrained model does not fit well because the SRMR value exceeds the recommended threshold, while the GFI does not meet the criteria. However, the unconstrained model satisfies both the GFI and SRMR criteria.

The difference in FIT between the constrained and unconstrained models was tested using a bootstrap sample of 100. The findings indicated that the FIT difference was .003, which was statistically significant at a 95% confidence interval (CI) ranging from .00368 to .00372, with a standard error (SE) less than 0.00001. Hence, based on empirical evidence,

Table 3 Estimates of Weights, Loadings, and their 95% CI

Indicator	1 st academic year (n = 96)				2 nd academic year (n = 82)				3 rd academic year (n = 68)			
	w	CI _w	λ	CI _{λ}	w	CI _w	λ	CI _{λ}	w	CI _w	λ	CI _{λ}
1. Research training environment (RTE) (component)												
1.1 RTE1	.365	[.297;.466]	.802	[.720;.875]	.362	[.222;.231]	.919	[.875;.953]	.301	[.193;.378]	.888	[.798;.935]
1.2 RTE2	.399	[.245;.461]	.748	[.574;.850]	.395	[.318;.548]	.863	[.776;.932]	.399	[.331;.474]	.859	[.754;.913]
1.3 RTE3	.529	[.420;.667]	.773	[.677;.845]	.403	[.323;.455]	.809	[.706;.873]	.451	[.388;.554]	.863	[.781;.912]
2. Research self-efficacy (RSE) (factor)												
2.1 RSE1	.209	[.194;.221]	.860	[.776;.922]	.212	[.200;.231]	.871	[.803;.937]	.223	[.207;.247]	.904	[.818;.947]
2.2 RSE2	.229	[.214;.249]	.943	[.902;.970]	.229	[.211;.235]	.940	[.901;.974]	.232	[.216;.269]	.944	[.898;.977]
2.3 RSE3	.221	[.208;.233]	.909	[.850;.956]	.223	[.201;.236]	.915	[.860;.956]	.220	[.206;.246]	.895	[.812;.977]
2.4 RSE4	.225	[.213;.244]	.929	[.892;.964]	.217	[.201;.236]	.890	[.800;.964]	.219	[.205;.235]	.890	[.788;.948]
2.5 RSE5	.217	[.203;.235]	.896	[.826;.964]	.222	[.208;.236]	.910	[.862;.955]	.215	[.198;.230]	.871	[.733;.934]
3. Research engagement (RE) (factor)												
3.1 RE1	.379	[.356;.404]	.877	[.836;.919]	.366	[.344;.394]	.861	[.776;.938]	.377	[.338;.437]	.899	[.767;.965]
3.2 RE2	.422	[.384;.447]	.977	[.943;.988]	.398	[.366;.439]	.938	[.872;.976]	.385	[.350;.441]	.917	[.833;.987]
3.3 RE3	.333	[.203;.235]	.770	[.826;.964]	.364	[.332;.397]	.857	[.760;.936]	.360	[.198;.230]	.858	[.701;.946]
4. Research intentions (RI) (factor)												
4.1 RI1	.326	[.299;.346]	.757	[.633;.880]	.386	[.352;.449]	.841	[.746;.915]	.343	[.282;.397]	.745	[.563;.922]
4.2 RI2	.423	[.383;.473]	.981	[.949;.993]	.390	[.348;.455]	.850	[.734;.938]	.443	[.374;.500]	.964	[.877;.985]
4.3 RI3	.382	[.354;.413]	.885	[.800;.929]	.397	[.349;.457]	.867	[.753;.968]	.382	[.332;.451]	.830	[.704;.929]

Note: RTE1 = interpersonal; RTE2 = instructional; RTE3 = service training; RSE1 = defining research problems; RSE2 = research design; RSE3 = gathering data; RSE4 = data analysis; RSE5 = reporting findings; RE1 = reading research; RE2 = applying research; RE3 = initiating research; RI1 = research for personal career growth; RI2 = research for academic purposes; RI3 = research for society-related purposes

the unconstrained model (Model 2) was favored. The details of this analysis are shown in Table 2.

When comparing the results of the multigroup analysis of the causal relationship model, it was found that the causal relationship model of each academic year had different effect values. The different effect in the paths can be described as follows.

Effects found among the first-year doctoral students: There was no statistically significant direct effect or indirect effect of the RTE on RI. However, the RTE demonstrated a significant direct effect on RI ($\beta = .382$). Additionally, RSE exhibited a significant effect on RE ($\beta = .440$). Moreover, the RTE also had a significant effect on RSE ($\beta = .733$).

Effects found among the second-year doctoral students: The indirect effect of the RTE on RI was statistically significant, while the direct effect was not found to be significant. Almost all of the indirect effects were also observed to be statistically significant. The RTE had an indirect impact on RI

through RSE and RE ($\beta = .097$). Additionally, the RTE demonstrated a positive direct effect on other variables, specifically RSE ($\beta = .546$) and RE ($\beta = .392$). Furthermore, there was an indirect effect of the RTE on RE through RSE ($\beta = .213$).

Effects found among the third-year doctoral students: The RTE had an indirect effect on RI at a significant level but there was no significant direct effect. The RTE had a direct effect on RSE ($\beta = .770$). RSE had a direct effect on RE at a significant level ($\beta = .768$). RE had a significant effect on RI ($\beta = .466$).

According to the analysis results of the second and third academic years, it was found that a mediation effect exists for RE and RSE between the RTE and RI, whereas such a mediation effect was not observed in the first year. In all academic years, RSE and RE exhibited the strongest direct effects. The causal relationship model's outcomes, included in Figure 2 and Table 4, present the findings of the multigroup analysis.

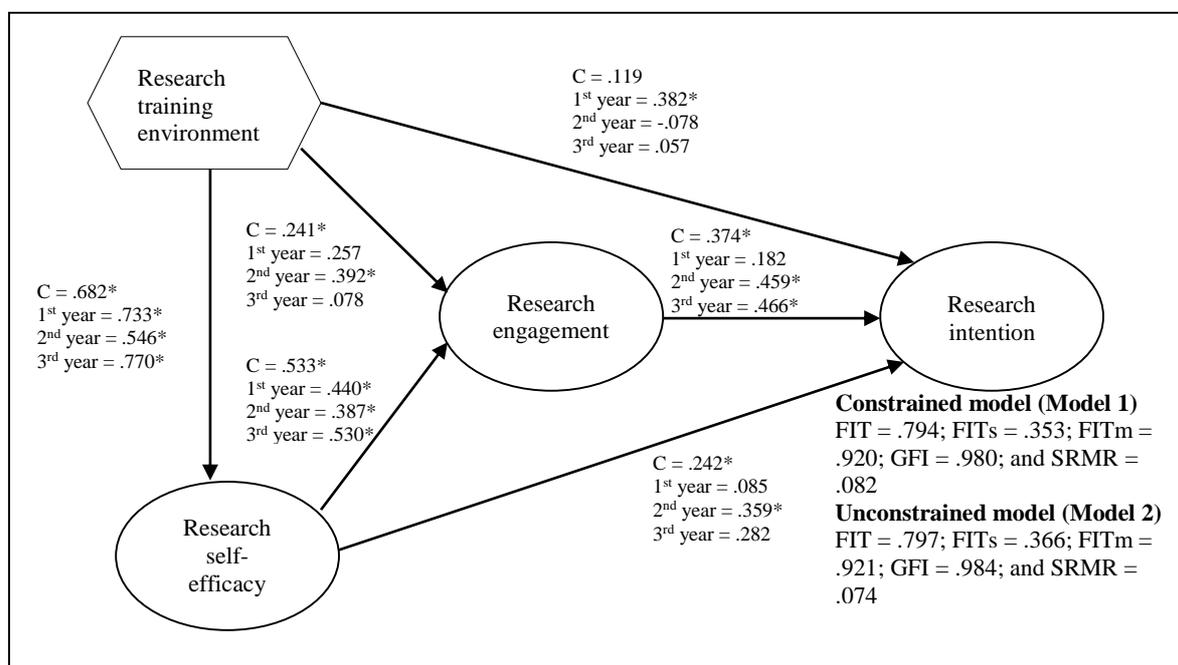


Figure 2 Causal Relationship Model (multigroup analysis across academic years)

Note: Hexagon denotes component whereas eclipse indicates factors;
 * = Regression coefficient significant at .05 level

Table 4 Parameters in Multigroup Analysis Across Academic Years

Relationship	Model 1: Constrained model				Model 2: Unconstrained model			
	β	95% CI	1 st academic year (n = 96)		2 nd academic year (n = 82)		3 rd academic year (n = 68)	
			β	95% CI	β	95% CI	β	95% CI
Direct effect								
RTE->RSE	.682*	[.580;.754]	.733*	[.620;.835]	.546*	[.331;.700]	.770*	[.679;.857]
RTE->RE	.241*	[.083;.383]	.257	[-.010;.497]	.392*	[.114;.672]	.078	[-.165;.309]
RSE->RE	.533*	[.377;.678]	.440*	[.151;.710]	.387*	[.114;.717]	.768*	[.530;.948]
RTE->RI	.119	[-.105;.311]	.382*	[.099;.612]	-.078	[-.263;.186]	.057	[-.177;.439]
RSE->RI	.242*	[.054;.454]	.085	[-.196;.414]	.359*	[.106;.546]	.282	[-.113;.640]
RE->RI	.374*	[.194;.542]	.182	[-.120;.416]	.459*	[.171;.749]	.466*	[.089;.804]
Indirect effect								
RTE -> RSE -> RE -> RI	.135*	[.044;.208]	.059	[-.005;.154]	.097*	[.021;.277]	.275*	[.052;.547]
RTE -> RSE -> RI	.166*	[.058;.298]	.059	[-.201;.293]	.196	[-.017;.325]	.217	[-.065;.529]
RTE -> RE -> RI	.087*	[.023;.148]	.047	[-.001;.168]	.178*	[.041;.356]	.038	[-.090;.170]
RTE -> RSE -> RE	.365*	[.238;.469]	.088*	[.157;.490]	.213*	[.082;.448]	.591*	[.378;.745]
RSE -> RE -> RI	.199*	[.063;.292]	.059	[-.007;.223]	.178*	[.045;.385]	.357*	[.068;.720]
Fit indices								
FIT	.794				.797			
FITs	.353				.366			
FITm	.920				.921			
GFI	.980				.984			
SRMR	.082				.074			
Model comparison	Fit difference = .003*; SE = 0.00001; 95% CI [.00368; 0.00372] with 100 bootstrap samples							

Note: * significance level of .05; RTE = research training environment; RSE = research self-efficacy; RE = research engagement; RI = research intentions

DISCUSSION

The analysis results suggested that the concept of the RTE of Gelso (1979), which was aimed at creating an atmosphere conducive to the development of graduate students and which was initially focused on psychology students, could be applied to graduate students in the field of education. The RTE was found to have a direct influence on the interest in research of education students in the same way that it has influenced the interest in research of psychology students. Combining the two variables of RE and RI, in this study enabled a better understanding of the target variable of the RTE theory. This target variable was RI, expressed in a clearer format. The findings of

the present research can broaden understanding of the RTE theory in different contexts, especially in terms of RE, which is often studied as a dependent variable (Borg, 2010; Del Mar & Askew, 2004; Heng et al., 2020). The present research further demonstrated the role of RE as a significant mediator of RI after graduation.

Furthermore, the implementation of IGSCA with multigroup analysis provided additional insights, enabling a deeper comprehension of the model as mixed factor-component measurement models, and shedding light on the moderation effect of academic year. This approach allowed the extraction of more information and the gaining of a better understanding of the underlying dynamics.

The causal relationship model of the present research showed that the RTE has a high positive effect on RSE in all academic years. The size and direction of the related coefficients were consistent with the data shown in previous research, the coefficients had a positive direction and statistical significance. The effect of the RTE on RSE in the model was significant in the first year ($\beta = .733$), second year ($\beta = .546$), and third year ($\beta = .770$). This direction was consistent with the correlation research of Gelso et al. (1996), Brown et al. (1996), Lambie and Vaccaro (2011), Pachler et al (2019), and Wu et al., (2020). It is also similar to the study on graduate students at the Faculty of Education in the Thai context (Chumwichan and Siriparp, 2016).

The RTE had a significant positive direct effect on RE in first year ($\beta = .440$), second year ($\beta = .387$), and third year ($\beta = .768$). This result is consistent with findings from previous studies, which suggested that the current environment of the students has an effect on their RE (Hall, 2010; Livingi et al., 2021; Salgueira et al., 2012). In addition, it was found that RE had a significant positive effect on RI in the second year ($\beta = .459$), and third year ($\beta = .466$). This outcome was similar to that of previous studies conducted by Koyuncu et al. (2006), Livingi et al., (2021); and Snelgrove and James (2010), which indicated that RE had an effect on future RI. Furthermore, it was also found that RSE had a significant positive effect on RE in the first year ($\beta = .440$), second year ($\beta = .387$), and third year ($\beta = .768$). This outcome was similar to that of previous studies conducted by Hall (2010), Jorgenen and Ducan (2015), Salgueira et al., (2012), Pachler et al., (2019), and Wu et al., (2020).

The effectiveness level of the model varied according to the number of academic years. In the model developed from data obtained from first-year doctoral students, there was no mediation effect of RSE and RE between the RTE and RI. The RTE had a direct effect on RI. However, for the models of the second- and third-year education doctoral students, a mediation effect was

found for RSE and RE on the relationship between the RTE and RI. The RTE had an indirect effect on RI in term of RSE and RE. The relationships may begin to develop at a variable level during the first academic year and then become clearly visible during the second and third academic years. This idea was supported by the study of Robnett et al. (2015), which suggested that curriculum environments that students have experienced do not cause a sudden change. Those variables tend to have an effect on the students at a later time during their second and third academic years.

CONCLUSION AND RECOMMENDATION

Considering applying the causal relationship model and the RTE theory (Gelso & Baumann, 2013; Gelso et. al., 1996), it is recommended that faculty members provide support in establishing a research training environment suitable for students in each academic year. To maximize effectiveness, it is crucial for faculty members to assess the specific needs of students in each academic year. By doing so, they can ensure an optimal learning environment and facilitate the students' research training experience.

1) In the first academic year, the RTE had a significant direct effect on RI, while the indirect effect did not show significance. It is crucial to promote the development of students' RSE and RI. Specifically, building RSE, which strongly influences variables such as RE and RI in subsequent academic years, should be a priority. Faculty members should serve as role models by displaying a positive attitude towards their own research projects, showcasing appropriate scientific behavior and attitudes (component: faculty modelling of appropriate scientific behavior and attitudes). Furthermore, students should be encouraged to engage with faculty projects early on, in a manner that minimizes anxiety and stress (component: early and minimally challenging student involvement in research). Faculty members should also impart knowledge about various research designs,

teaching different methodologies, and their statistical implications (component: teaching varied methodology of research and teaching of relevant statistics and the logic of research designs). Additionally, they should emphasize the limitations inherent in research studies, highlighting the imperfections that may arise (component: emphasizing the inherent imperfection of research studies).

2) In the second academic year, there was a full mediation effect of RSE and RE between the RTE and RI. It is recommended to establish an RTE component that focuses on fostering RSE and RE, as these variables have the potential to enhance students' RI upon graduation. Faculty members play a crucial role in this process by encouraging students to actively engage in scholarly activities, thereby strengthening their RSE and RE (component: positive reinforcement of scholarly activities). Moreover, it is important for students to have the freedom to explore their own research questions, without being confined to their faculty's specific areas of interest (component: encouraging students to look inward for research questions and ideas). Additionally, students should be encouraged to share their research ideas with others, emphasizing the social nature of science (component: emphasis on science as a partly social experience). These measures will contribute to enhancing students' research engagement and overall participation in the research process.

3) In the third academic year, there was a full mediation effect observed, wherein RSE and RE served as mediators between the RTE and RI. It is advisable to prioritize the development of the RTE component associated with RSE during this phase, as the RTE does not have a direct impact on research engagement or RI. Instead, it exerts an indirect influence on RI through its effects on RSE and RE. Enhancing RSE is crucial as it subsequently influences RE and RI. To foster RSE, students should be provided with opportunities to apply their knowledge and training experience to real-world tasks. This can be achieved by emphasizing the integration of science and practice, with a focus on

completing research projects relevant to various professional settings both within and outside the university (component: demonstrating science-practice integration with a focus on completing research relevant to all types of professional settings, service inside the university, and service outside the university).

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