Measuring Educational Research Literacy: Development and Validation of Educational Research Literacy Scale

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ABSTRACT

The present study aimed to develop and validate an instrument to measure educational research literacy. An exploratory sequential mixed method design was used with conveniently sampled six participants for interviews, five content experts for instrument content validation, and eighty-nine faculty members for the pilot testing of the instrument. Confidentiality of data was assured and informed consent from respondents was secured. Qualitative data were thematically analyzed. Data from content experts were analyzed to obtain Content Validity Indices (CVIs) of the items (I-CVIs) and the scale (S-CVI). Quantitative data from pilot testing were subjected to reliability and factor analyses. A 24-item Educational Research Literacy Scale (ERLS) measuring four dimensions, namely knowledge of research concepts, data literacy, information literacy, and evidence-based reasoning was developed and validated. Furthermore, ERLS had sound psychometric properties with established evidence of validity and reliability. Moreover, this study recommended that other evidences of instrument validity should be established.

Introduction

Background of the Study

Research plays various roles in educational institutions. Action research, for instance, serves as a mechanism for educational improvement and contributes to the pedagogical skills of educators (James & Augustin, 2017; Uztosun et al., 2018).

Likewise, institutional research helps determine or describe the status quo of the educational system. Institutional researchers contribute a lot to the assessment of institutions and their programs (Webber, 2012). In practice, educators utilize various types of research to gather empirical shreds of evidence of effective institutional and pedagogical approaches, and practices. Thus, educators are consumers of research. To be

an effective consumer of research, as Shank et al. (2014) stressed the educators need to be critical of research that requires them to be literate of research.

The contribution of research to educational practices has been recognized worldwide. In the Philippines, the Commission on Higher Education (CHED), which supervises Higher Education Institutions or HEIs in the country, is mandated to develop plans and programs for research. Consequently, HEIs in the country are mandated to consider research as one of its primary functions (Higher Education Act, 1994). To address concerns pertaining to research, the commission ordered HEIs to improve the research capabilities of faculty, instill a research culture among faculty, upgrade physical resources and research infrastructure, increase research productivity and raise research quality and impact (CHED Memorandum Order No. 52, 2016). Hence, educators of HEIs in the country should possess the ability to conduct research, or at least participate in certain research activities. With this, they are necessitated to be educational research literate professionals. Shank et al. (2014) defined educational research literacy as an ability to understand research concepts, access, understand, evaluate research articles, conduct research, and share its outputs.

Assessing this literacy of educators is the foundation for the plans and programs of HEIs for research. However, limited studies were conducted to develop an assessment tool to measure the literacy. Although, the educational research literacy assessment by Groß Ophoff, Wolf, Schladitz, and Wirtz (2017) is among few studies conducted, but the assessment may not be appropriate to any contexts. With the limited literature on the assessment of educational research literacy and the necessity of valid instrument to measure the literacy, this study was conducted. The present study aimed to develop an instrument with sound psychometric properties to measure educational research literacy of Filipino professionals. The instrument may be utilized as research instrument and for institutional use of higher education institutions.

Purposes of the Research

This study aimed to develop and validate an instrument to measure the educational research literacy of Filipino professionals. Specifically, the following research questions were addressed in the study:

1. What are the underlying dimensions of educational research literacy?

2. What are the developed items to measure each dimension of educational research literacy?

3. Does the instrument possess evidence of internal consistency reliability?

4. Does the instrument possess evidences of validity such as content validity and construct validity?

Literature Review

Educational Research Literacy (ERL)

What is meant by *educational research literacy*? This is a pivotal question to be addressed in the study. This section presents some literature on how educational research literacy is conceived. It is acknowledged though that literature about the concept is limited, thus the presentation may not be exhaustive enough.

Educational research literacy is research literacy specific to the field of education. Research literacy refers to

"the ability to locate, understand, discuss, and evaluate different types of research; to accurately communicate about them; and to use the findings for academic and professional purposes" (Beaudry & Miller, 2016, p. 4). Shank et al. (2014) pointed out that research literacy refers to the ability to "develop a complete and comprehensive picture of how research functions" (p. 2). Research literacy also refers to acquiring information for research purposes, that is knowing how to find information for research, evaluating information, and using the information in the research process (Besseah et al., 2017).

Research literacy involves information/technological literacy, verbal literacy, numeracy, and visual literacy. A research-literate individual possesses the ability to use and access information; understand and communicate written texts; understand and apply mathematical calculations and symbols; and read and use non-verbal text, like graph, table, etc. (Beaudry & Miller, 2016).

The meaning of the educational research literacy is derived from the aforementioned definitions of research literacy. Educational research literacy refers to "the ability to purposefully access, comprehend, and reflect scientific information as well as apply the resulting conclusions to problems concerning educational decisions" (Groß Ophoff et al., 2017, p. 39). This ability allows educators to become critics of research (Shank & Brown, 2007).

Dimensions of Educational Research Literacy

What are the dimensions of *educational research literacy*? The development of instrument is founded on the knowledge of the essential dimensions of educational research literacy. Since educational research literacy is relatively a new concept, it is acknowledged that literature haven't provided exhaustive discussion on the dimensions of the literacy.

Brody et al. (2012), Groß Ophoff et al. (2017), Beaudry and Miller (2016), and Shank et al. (2014) presented relevant information that contributed to the rationalization of the dimensions of educational research literacy. The present study rationalized educational research literacy to consist four dimensions, namely knowledge of research concepts, data literacy, information literacy, and evidence-based reasoning.

First dimension is knowledge of research concepts. This is considered as one key dimension of the literacy (Are et al., 2017; Brody et al., 2012; Dow & Sutton, 2014; Shank & Brown, 2007; Shank et al., 2014). *Knowledge of research concepts* refers to the understanding of the nature and concepts in research. To be knowledgeable of the nature and concepts of research is one defining competency of an educational research literate individual (Brody et al., 2012; Shank & Brown, 2007; Shank et al., 2014;).

Second dimension is *data literacy.* This is considered another dimension of the literacy. Groß Ophoff et al. (2017) stressed on *statistical literacy* as one of the elements of literacy. Statistical literacy held true to research used numbers as data evidence, which are treated statistically. However, data in research are not always in the form of numbers, but they may be texts, images, time, and places (Gould, 2017) and *data literacy* is argued the appropriate term to use. Data literacy refers to an individual's ability to locate, analyze, organize, present, and evaluate research data in its context which involves skills such as identifying scope, planning, storing, protecting, evaluating, managing, and providing data (Schneider, 2013).

The third dimension is *information literacy.* Groß Ophoff et al. (2017) considered

information literacy as another dimension of the literacy. It is required among research literate individuals (Beaudry & Miller, 2016; Groß Ophoff & Rott, 2017). Information literacy refers to the ability to access, evaluate, use, and communicate information (Pati & Majhi, 2019).

The fourth dimension is *evidence-based reasoning.* On ground that educational research literate professionals must be critical of research (Shank & Brown, 2007; Shank et al., 2014), they should develop evidence-based reasoning. It is integral to the decision-making process involving imaginative and critical reasoning (Tecuci et al., 2016), *Evidence-based reasoning* is considered as another factor of ERL. It refers to the ability to substantiate reasoning or critically evaluate given conclusions concerning scientific quality criteria (Groß Ophoff et al., 2017).

The aforementioned dimensions of educational research literacy served as the baseline information in the development of

the instrument to measure the literacy. As such, the items of the instrument would be developed to along these dimensions.

Study Framework

Based on the aforementioned conceptions of educational research literacy and the process of the development and validation of assessment instrument, this study followed the research framework presented in Figure 1. The study is methodological in nature that involved the processes of developing and validating the instrument to measure educational research literacy.

The study involved two phases. The first phase was item development and the second phase was the instrument validation. The first phase commenced by identifying and rationalizing the dimensions of educational research literacy. As reviewed from literature, the study rationalized four dimensions of the literacy, namely: knowledge of research concepts, data literacy, information literacy, and evidence-based

Figure 1
Research Framework
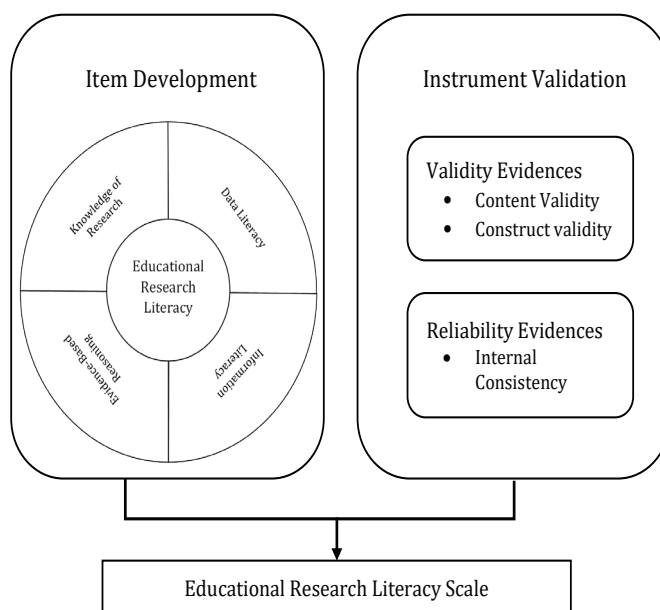
reasoning. Further qualitative investigation of the contextual understanding of each dimension of educational research literacy would be conducted and the result would be compared against the conceptions in literature. As a result of result of first phase, items would be developed to measure each dimension of the literacy.

Upon the conclusion of the first phase of the study, the second phase of the study would proceed for the validation process of the instrument. The validation process would establish the psychometric properties of the instrument that is validity and reliability. This study focused on validity evidences limited to content validity and construct validity, while reliability evidence was delimited to internal consistency reliability.

The output of the two phases of the study would be Educational Research Literacy Scale (ERLS). ERLS would be the valid and reliable instrument to assess educational research literacy.

Methodology

The study employed an exploratory sequential mixed methods design. This design used qualitative and quantitative methods sequentially for data collection and considered to be the suitable design for studies on instrument development (Creswell, 2014). Qualitative data from literature review and interviews were analyzed to explore dimensions of educational research literacy and to establish the operational definitions of the dimensions. This served as the epistemological foundation of the development of items for the instrument. Quantitative procedures would follow for the validation process of the instrument. Qualitative data were analyzed to establish the validity and reliability evidences of the instrument.

Participants

The participants involved in the study varied relative to the purposes of the study. To obtain more contextualized understanding of the dimensions of educational research literacy. Six (6) higher education faculty members were invited for the interviews. For the content validation of the instrument, five (5) content experts were invited to evaluate the relevance of the instrument developed items to measure the corresponding dimensions. Content experts were from selected colleges and universities in Visayas and Mindanao region in the Philippines who possessed expertise in research and had adequate experience in research instrumentation and in conducting research. Summary of content experts' evaluation of item relevance to the constructs or dimensions is shown as Content Validity Index (CVI).

Further, a total of 89 faculty members of higher education institutions (HEIs) participated in the pilot testing of the instrument. They are full-time faculty members of two state universities and one private HEIs in Tawi-Tawi province of the Philippines. The participants were selected using the convenience sampling method.

All participants were informed of the background and purpose of the study and consented to voluntarily participate in the study. Further, the confidentiality of their responses was guaranteed.

Data Analyses

The qualitative procedure was conducted during the first phase of the study. Qualitative data (e.g., transcripts of interview) were analyzed using thematic analysis. Thematic analysis focused on extracting the participant conceptions of the four dimensions of educational research literacy.

Quantitative procedure was employed in the later phase of the study – instrument validation phase. To establish content validity evidences, Content Validity Indices (CVI) – Item Level (I-CVI) and Scale Level (S-CVI) were examined. Reliability evidences of the instrument, Cronbach's *alpha* (α) was utilized to examine the internal consistency of the items in the scale and the subscales. The item-total correlation analysis was employed prior to factor analysis. To establish the construct validity of the instrument, factor analyses – exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) was employed. Exploratory Factor Analysis (EFA) was utilized to determine the appropriateness of items of the instrument to measure the constructs (dimensions of ERL) by examining the factor loadings of the EFA. Principal axis factoring method of extraction with varimax rotation was employed. The number of factors to be extracted was delimited to four. To meet the assumptions of factor analysis and to determine the factorability of the data, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were examined. Confirmatory Factor Analysis (CFA) succeeded the EFA. CFA was employed to test the hypothesized model. The maximum likelihood parameter estimation method with standard errors and a mean-adjusted chi-square test statistic, which is considered robust to non-normality, was employed. The goodness of fit was examined using the following statistics: chi-square statistic ($\chi2/df$), comparative fit index (CFI), Tucker–Lewis index (TLI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA). The criteria utilized for model fit were $\chi2/df$ to be less than three, CFI and TLI greater than 0.90, SRMR less than 0.11, and RMSEA less than 0.08 (Xie et al., 2021).

Results

Contextual Understanding of the Dimensions of Educational Research Literacy

As presented in the previous sections, educational research literacy is rationalized to comprise four dimensions, namely: knowledge of research concepts, data literacy, information literacy, and evidence-based reasoning. The conceptions of these dimensions found in literature served as baseline information for further steps in the development of items of the instrument.

To obtain contextual understanding of the aforementioned dimensions, interviews with some faculty members, who may be the prospective respondents, were carried out. The transcripts from interviews were analyzed thematically that started with coding process to be categorized and until finally arrived to themes. The result of the analyses of the qualitative data from interviews is presented in Table 1.

As presented in Table 1, the contextual understanding of the four identified dimensions of educational research literacy can be summarized into different themes. Knowledge of research of research concepts is understood as knowledge of key elements of research process, of reporting research using a writing style, and of research ethics. This dimension is conceived as understanding of various elements of the research process. Data literacy refers to the knowledge of data, its type, data collection process and data analysis, and the ability to read and interpret data, and evaluate data analysis. Information literacy refers to the knowledge of relevant information and research gaps, and ability to access information and evaluate its credibility. Evidence-based reasoning refers to the ability to evaluate findings and conclusions based on data evidences and to evaluate the research articles based on observance of research ethics and proper review process.

Table 1

Thematic Analysis of Interview Transcripts

ERL Dimensions	Codes	Categories	Themes
Knowledge of Research Concepts	Research problem Research methodology Elements of research	Elements of Research	Knowledge of key elements of research process
	Research process	Research Process	
	Writing style	Research Reporting	Knowledge of reporting research using a writing style
	Research Ethics	Research Ethics	Knowledge of research ethics
Data Literacy	Data type Know data Familiar with data	Knowing data and its type	Knowledge of data, its type and data collection process
	Data collection	Data collection process	
	Read data Interpret data	Reading and interpreting data presented	Ability to read and interpret data
	Data analysis tools Evaluate tools Know statistical tools	Knowing and evaluating data analysis	Knowledge of data analysis and ability to evaluate data analysis
Information Literacy	information relevance	find information relevance and gap	Knowledge of relevant information and research gaps
	information gap		
	sources of information access information	access information and sources	Ability to access information and evaluate its credibility
	information media	use information media	
	evaluate information credible information	evaluate information credibility	
Evidence-Based Reasoning	data match conclusion data evidence-based conclusion based on data claims data supported	Congruence of findings and conclusion with data evidences	Ability to evaluate findings and conclusions based on data evidences
	data based findings data support findings		
	observe research ethics ethics in data collection	Observance of research ethics	Ability to evaluate the research articles based on observance of research ethics and proper review process
	review process	Proper review process	

Development of Items and Design of the Instrument

The items of the instrument were developed based on the formulated operational definitions and indicators of each dimension presented in Table 2.

Moreover, to provide respondents with more contextualized experience in responding to the instrument, the developed items were anchored on the context scenarios. The context scenarios were brief statements about the published articles. These were the articles by Chularut and DeBacker (2004), Davis et al. (2004), Minor et al. (2002), and Prado and Grayoso (2011). Figure 2 shows an example of a context scenario.

As a result, the thirty-six items were initially developed to comprise the instrument. Thirteen items measure

Table 2

Operational Definitions and Indicators of the Dimensions of the ERL

ERL Dimensions	Operational Definitions	Indicators
Knowledge of Research Concepts	- the understanding of the nature and concepts of research process involving research questions, theoretical foundation, research design, sampling, research instrumentation, etc.	• Knowledge of key elements of research process • Knowledge of reporting research using a writing style • Knowledge of research ethics
Data Literacy	- the ability to understand and evaluate the analyses and interpretation of research data either qualitative and quantitative data	• Knowledge of data, its type and data collection process • Ability to read and interpret data • Knowledge of data analysis and ability to evaluate data analysis
Information Literacy	- familiarity and understanding of information and its type, and being able to access them and to evaluate critically its need for research	• Knowledge of relevant information and research gaps • Ability to access information and evaluate its credibility
Evidence-Based Reasoning	- the ability to evaluate research and its outputs through appropriate reasoning based on evidences	• Ability to evaluate findings and conclusions based on data evidences • Ability to evaluate the research articles based on observance of research ethics and proper review process

Figure 2

Snapshot of Sample Context Scenario and Items

Scenario # 1

In the phenomenological study entitled "A Fly in the Buttermilk": Description of University Life by Successful Black Undergraduate Students at a Predominantly White Southeaster University", Davis, et al. (2004) aimed to obtain a "first person perspective" about the lived academic experience of Black students in a large, predominantly white university. The participants of the study were 11 black undergraduate students at a large southeastern state university. The researchers primarily used interview and they demonstrated their sensitivity to researcher bias by observing a "bracketing" exercise. As a result, researchers reported five interrelated themes:

1. "It happens Everyday": Unfairness/Sabotage/Condescension
2. "You have to Initiate the Conversation": Isolation and Connection
3. "They Seem the Same; I'm The One Who's Different."
4. "I have to Prove I'm Worthy To Be Here."
5. "Sometimes I'm not Even Here/Sometimes I Have to Represent All Black Students': Invisibility and Supervisibility.

1) Do you agree with the choice of researchers to use phenomenological approach corresponding to their aim and interest in the study? KRC
2) Do you agree with the researchers to observe "bracketing" practices during the interview and analyses of transcripts? KRC

knowledge of research concepts, six (6) items for information literacy, ten (10) items for data literacy, and seven (7) items for evidence-based reasoning. The item placement is presented in Table 3. To minimize response bias, some items were framed as inversely scored items. The response format of the instrument is formatted in numerical scale where the respondent would respond by selecting an answer from choices placed along a continuum with 1 as *strongly disagree* to 5 as *strongly agree*. The instrument is so-called *Educational Research Literacy Scale (ERLS).*

Table 3

Item Placement along Four Dimensions of Educational Research Literacy

Dimensions	Total Items	Item Placement	
		Scenario	Item No.
Knowledge of Research Concepts (KRC)	13	1	1, 2, 6, 7
		2	1[a], 2, 9
		3	1[a], 2, 3
		4	1[a], 2[a], 3[a]
Information Literacy (IL)	6	1	4, 5[a]
		2	10[a], 11
		3	8, 9
Data Literacy (DL)	10	1	3
		2	3, 5, 6
		3	4, 5, 7
		4	6[a], 7, 9
Evidence-Based Reasoning (EBR)	7	2	4, 7, 8
		3	6
		4	4, 5, 8[a]
Total	**36**		

[a.] *The item is inversely scored items.*

Item and Scale Content Validity Indices

The scale was subjected to content validation process. Content experts were invited to evaluate the relevance of the items to measure the corresponding dimensions. Zamanzadeh et al. (2015) stressed that content experts are those who have content knowledge and expertise. The content experts evaluated the alignment of the items with the constructs underlying the instrument and rate relevance or essentiality of the item for the construct (McCoach et al., 2013).

For each item, the item level-content validity index (I-CVI) and for the entire scale, scale level-content validity index (S-CVI) were computed. The obtained I-CVI and the S-CVI were greater than the minimum acceptable value of .79 and .70, respectively (See Table 4).

Table 4

Content Validity Indices of Items

Scenario	Item No.	I-CVI[a]
1	1	1.0
	2	1.0
	3	1.0
	4	1.0
	5[b]	1.0
	6	1.0
	7	1.0
2	1[b]	1.0
	2	1.0
	3	1.0
	4	1.0
	5	1.0
	6	1.0
	7	1.0
	8	1.0
	9	1.0
	10	1.0
	11	1.0
3	1[b]	1.0
	2	1.0
	3	1.0
	4	1.0
	5	1.0
	6	1.0
	7	1.0
	8	1.0
	9	1.0
4	1[b]	1.0
	2[b]	1.0
	3[b]	1.0
	4	1.0
	5[b]	1.0
	6[b]	1.0
	7	1.0
	8[b]	1.0
	9	1.0
		S-CVI[c] = 1.0

[a.] *I-CVI or Item Level-Content Validity Index = Nr/N where Nr - Number of experts evaluated the item relevant (rating 3&4); N - total number of experts.*

[b.] *Inversely scored items*

[c.] *S-CVI or Scale Level-Content Validity Index is the average of I-CVIs*

Table 5

Item-Total Correlation of the Items

Item	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
KRC1	.498	.904
KRC2[a]	.345	.906
KRC3[a]	.313	.907
KRC4[a]	.345	.906
KRC5	.687	.901
KRC6[a]	.167	.908
KRC7[a]	.174	.908
KRC8	.685	.901
KRC9	.797	.898
KRC10	.673	.901
KRC11[a]	.390	.906
KRC12[a]	.275	.907
KRC13[a]	.145	.909
DL1	.550	.904
DL2	.481	.904
DL3	.549	.903
DL4	.585	.903
DL5[a]	.230	.908
DL6	.448	.905
DL7	.441	.905
DL8	.566	.903
DL9[a]	.203	.908
DL10[a]	.059	.910
IL1	.462	.905
IL2	.606	.903
IL3[a]	-.083	.911
IL4	.458	.905
IL5	.560	.903
IL6	.436	.905
EBR1	.465	.905
EBR2	.482	.904
EBR3	.641	.902
EBR4	.626	.902
EBR5	.570	.903
EBR6	.450	.905
EBR7	.427	.905

Note. KRC = Knowledge of Research Concepts; DL = Data Literacy; IL = Information Literacy; EBR = Evidence-Based Reasoning

[a] items with item total correlation below .40

Internal Consistency Reliability Evidence

The internal-consistency method is one of the methods to establish reliability evidence of the instrument (Price, 2017; Rios & Wells, 2014). Rios and Wells (2014) defined internal consistency as the proportion of true score variance to total observed score variance, and the split-half reliability and Cronbach coefficient α are commonly used. Reliability analysis using Cronbach coefficient α on the 36-item four dimension-scale was executed. Initially, the obtained Cronbach coefficient α of the entire scale was .90, which is acceptable.

Further, item-total correlation analysis was examined to determine items that might be deleted to improve Cronbach coefficient α. The item-total statistics presented in Table 5 showed that twelve (12) items obtained item-total correlation below the threshold value of 0.40. These items were discarded from the scale. Consequently, twenty-four (24) items were retained.

Reliability analysis was re-executed on the 24-item scale and the result showed an increase in Cronbach coefficient α of the scale (α=.93). The Cronbach α of the subscales: Knowledge of research concept (α=.92), data literacy (α=.90), information literacy (α=.90), and evidence-based reasoning (α=.90) obtained high coefficients. The Cronbach coefficient α showed high internal consistency reliability of the entire scale and subscales.

Construct Validity Evidence

The internal structure or construct validity of an instrument may be examined using factor analyses – exploratory factor analysis and confirmatory factor analysis (McCoach et al., 2013). The 24-item ERLS was subjected to the analyses.

Exploratory Factor Analysis. The factorability of the data from the 24-item

Table 6

Rotated Factor Loadings of the Items to Four Factors

	Factor			
	1	**2**	**3**	**4**
KRC1				.712
KRC5				.727
KRC8				.803
KRC9				.795
KRC10				.826
DL1	.593			
DL2	.848			
DL3	.894			
DL4	.846			
DL6	.640			
DL7	.537			
DL8	.741			
IL1			.730	
IL2			.935	
IL4			.714	
IL5			.749	
IL6			.734	
EBR1		.647		
EBR2		.686		
EBR3		.925		
EBR4		.580		
EBR5		.593		
EBR6		.795		
EBR7		.802		

Note. KRC = Knowledge of Research Concepts; DL = Data Literacy; IL = Information Literacy; EBR = Evidence-Based Reasoning

scale was examined. Bartlett's test of sphericity yielded a significant result ($\chi 2$ [276] = 1742.03, p < .05) indicating the factorability of the data for the 24 items of the scale. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy showed that the sample size for the data was adequate with an obtained KMO value equal to 0.83 which is considered as meritorious (Hair Jr. et al., 2014). Thus, factor analysis was considered suitable.

Factor analysis was executed with principal axis factoring method of extraction limiting four (4) factors to be extracted and using varimax rotation. The four-factor solution accounted for 36.26% of explained variance. As presented in Table 6, rotated factor loadings showed that the items were significantly and meaningfully loaded to four factors with no significant cross-loading of items. Further, the items measuring respective dimensions are grouped together that means the items are valid to measure respective dimensions. The factors were named according to the prior identified dimensions of educational research literacy. As such, factor 1 is data literacy; factor 2 is evidence-based reasoning; factor 3 is information literacy; and factor 4 is knowledge of research concepts.

Confirmatory Factor Analysis. Based on the result of EFA, confirmatory factor analysis (CFA) with maximum likelihood parameter estimation was executed to test the four-factor model (See Figure 2). The result showed that the items were loaded ideally to the corresponding dimension/factor. However, the model fitness was not really good ($\chi 2/df=1.828$, CFI=.88, TLI=.86, SRMR=.082, RMSEA=.097).

To improve model fit, some modifications (See Figure 3) were made by examining model modification indices which suggested to covariate measurement error for items *DL4* and *DL8*, and items *EBR4* and *EBR4*. Modification to the model had made significant improvement to the model fit ($\chi 2/df=1.331$, CFI=.95, TLI=.95, SRMR=.0781, RMSEA=.061). Further, the difference between the Bayesian Information Criterion (BIC) of the original model (BIC=692.011) and the modified model (BIC=576.203) was much larger than 10, which strongly support the modified model.
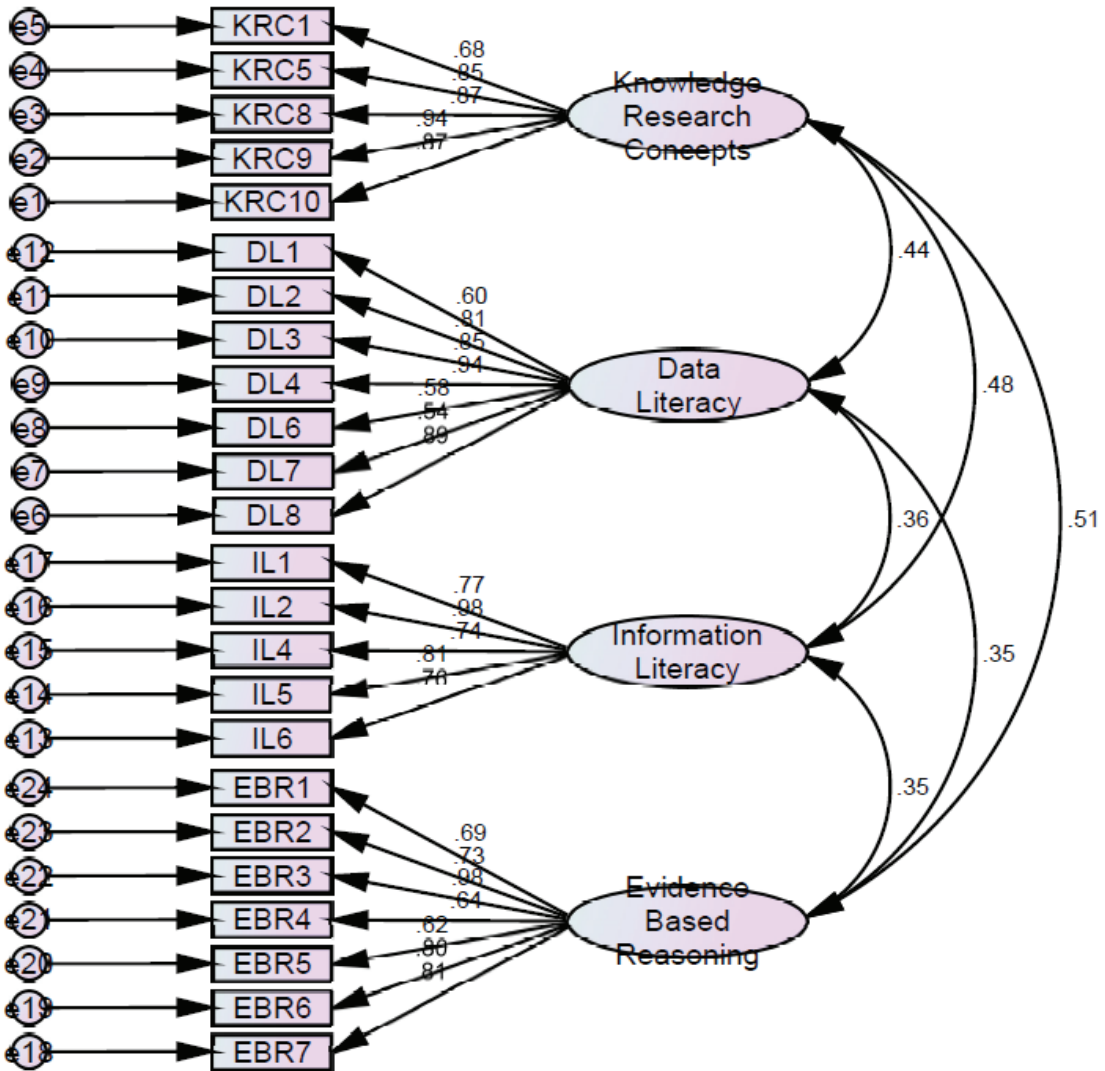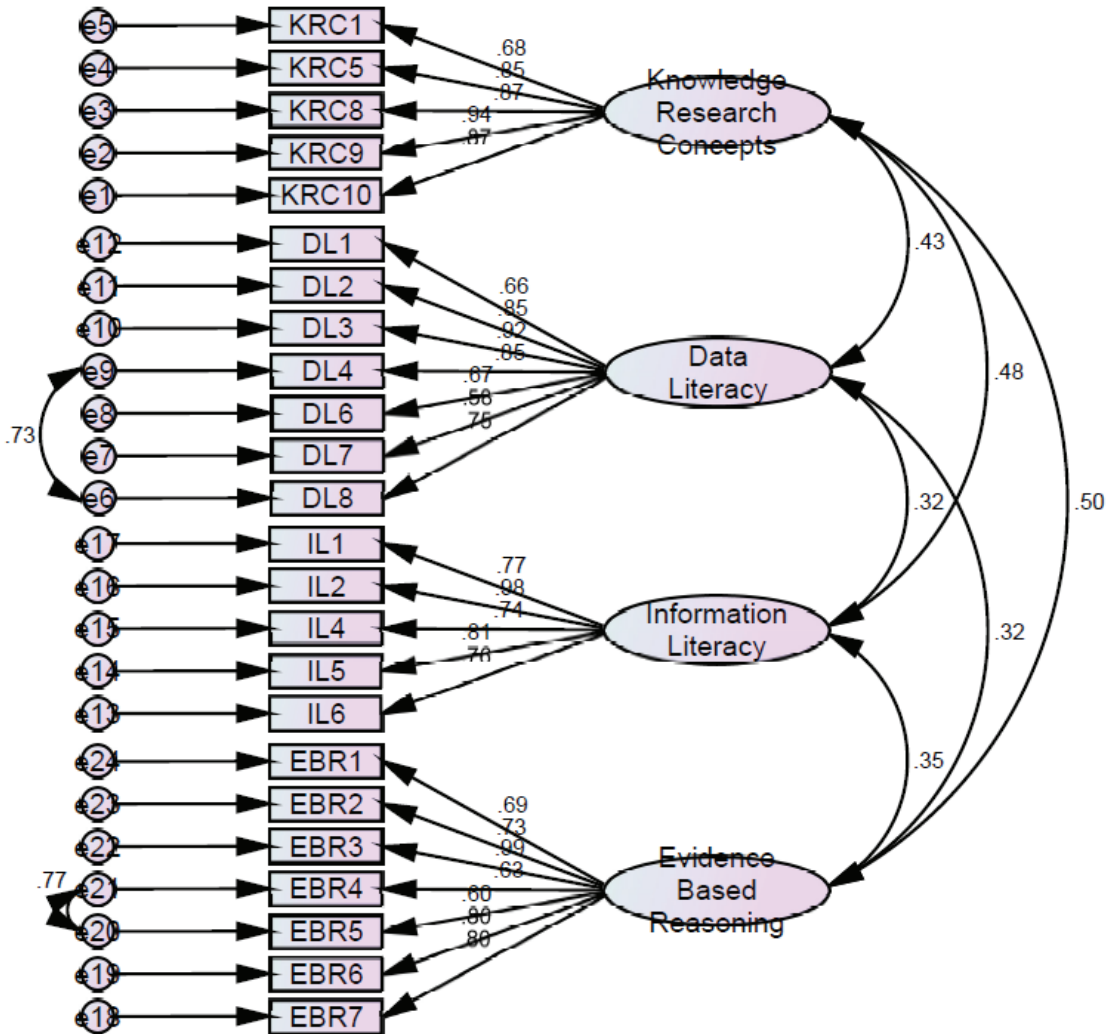
Figure 2

Four Factor Model of ERLS

Figure 3

Modified Four Factor Model of ERLS

Discussion

The development of the instrument commenced by rationalizing underlying dimensions of educational research literacy. The present study rationalized four dimensions, namely: knowledge of research concepts, data literacy, information literacy, and evidence-based reasoning (Are et al., 2017; Beaudry & Miller, 2016; Brody et al., 2012; Goad, 2002; Groß Ophoff & Rott, 2017; Groß Ophoff et al., 2017; Kurbanoglu et al., 2006; Shank & Brown, 2007; Shank et al., 2014; Tecuci et al., 2016).

"How were the dimensions conceived?" was the fundamental question in the development of items. The analysis of the qualitative data of the study illustrated the conceptions of the dimensions. These conceptions are discussed in the following paragraphs.

Firstly, knowledge of research concepts was conceived as knowledge of the elements of the research process. Bryman (2012) identified elements of research, such as: literature review, concepts and theories, research questions, sampling cases, data collection, data analysis, and writing up.

Secondly, data literacy was contextually understood as the ability to know and interpret data and to evaluate data analysis in research. Schneider (2013) viewed data literacy as ability to locate, analyze, organize, present, and evaluate research data that involves skills to identify, scope, plan, store, protect, evaluate, manage, and provide data. Likewise, ODI (2015) in Gould (2017) stated that data-literate individual can identify, collect, evaluate, analyze, interpret, present, and protect data. Gould (2017) claimed that data literacy encompasses statistical literacy that Groß Ophoff et al. (2017) considered as one of the factors involved in educational research literacy. Thus, data literacy requires one's ability to interpret and evaluate and communicate statistical information (Gonulal et al., 2017).

Thirdly, information literacy was conceived as the ability to know and access information needed and evaluate its credibility. Exner (2014) stressed that one of the competencies of an information literate student is the clear understanding of the nature and extent of the needed information. Information literacy refers to the ability to access and evaluate information (American Librarian Association (ALA), 2018). Moreover, Duncan and Varcoe (2012) considered information literate level involves basic ability to determine the need of information, to access information, to evaluate and incorporate information into knowledge base and value system.

Lastly, evidence-based reasoning was referred to as the ability to evaluate findings and conclusions based on data evidences and to evaluate the research articles based on observance of research ethics and proper review process. As Groß Ophoff et al. (2017) emphasized that evidence-based reasoning refers to the ability to substantiate reasoning or critically evaluate given conclusions with respect to scientific quality criteria. A framework for evidence-based reasoning developed by Brown et al. (2010) emphasized how the evaluate the claim by analyzing, interpreting and applying data. Tecuci et al. (2016) viewed evidence-based reasoning requires combination of imaginative reasoning, critical reasoning, and expert knowledge.

The current study provided enough evidences that the instrument – Educational Research Literacy Scale (ERLS) is considered as reliable and valid instrument to measure educational research literacy. The study confirmed 24-item ERLS as the reliable instrument to measure educational research literacy. The Cronbach's α equal to .92 is considered as high value

(Emerson, 2019). The factor loadings in the Exploratory Factor Analysis (EFA) proved the acceptability of EFA solutions (Watkins, 2018) and suggested that items were valid to measure the corresponding dimensions of educational research literacy. The result of EFA was further confirmed in the result of Confirmatory Factor Analysis. CFA tested the model fitness (Hair Jr. et al., 2014). CFA presented the good fitness of the four-factor model being tested in the study. This confirmed that educational research literacy is measured along four factors or dimensions. The four dimensions, such as knowledge of research concepts, data literacy, information literacy, and evidence-based reasoning were proven in the study to constitute the concept of educational research literacy.

Conclusion

The primary purpose of the present study was to develop and validate instrument to measure educational research literacy. Specifically, the study aimed to determine underlying dimensions of educational research literacy, to develop items for the instrument to measure the dimensions of educational research literacy, and to establish reliability and validity evidences of the instrument.

The study confirmed that educational research literacy consisted four underlying dimensions, such as knowledge of research concepts, data literacy, information literacy, and evidence-based reasoning. These dimensions are measured by the twenty-four (24) developed items that made up Educational Research Literacy Scale (ERLS). The study offered number of evidences suggesting that the 24-item ERLS were proven to be reliable and valid instrument to measure educational research literacy. It is therefore concluded that ERLS possessed sound psychometric properties.

Although the data showed evidences of the psychometric properties of the scale, some limitations need to be taken into consideration. Firstly, the scale was developed to comprise four factors or dimensions, but these factors accounted for a low percentage explained variance, which indicates the need for further theoretical investigations of the dimensions of educational research literacy. However, this study serves as the springboard for further investigations to explore other crucial dimensions of the literacy.

Secondly, the samples came from the same province in the country that may have relative nature and characteristics. Random selection of the participants was not addressed since the present study used a convenience sampling method and the sample size was small. The generalizability of findings may have not been addressed and the use of the scale in other participants and contexts may not be suitable. Hence, future studies may be conducted on the different samples and larger sample sizes to provide evidence of widespread use of the scale and to further establish other scale psychometric properties.

Despite its limitations, the present study delineated the concept of educational research literacy that provided new contributions to the effort of understanding the concept. The study would offer a theoretical foundation, as the springboard, for future studies and investigations. The instrument developed in the study would serve as a tool for higher education institutions to determine the status quo of faculty members' educational research literacy. Further, the instrument would unveil related issues and problems. This serve as baseline information for institutionalizing policies and standards for faculty research development program.

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Revised Educational Research Literacy Scale

Educational Research Literacy Scale

Direction: The following scenarios are taken from published educational research. Read each item of the scenarios carefully and rate your agreement to each of the items that follow each scenario using a scale of 1 to 5, with 1 as strongly disagree and 5 as strongly agree. Encircle the number corresponding to your rating on the answer sheet provided.

Scenario # 1

In the phenomenological study entitled "A Fly in the Buttermilk": Description of University Life by Successful Black Undergraduate Students at a Predominantly White Southeaster University", Davis, et al. (2004) aimed to obtain a "first person perspective" about the lived academic experience of Black students in a large, predominantly white university. The participants of the study were 11 black undergraduate students at a large southeastern state university. The researchers primarily used interview and they demonstrated their sensitivity to researcher bias by observing a "bracketing" exercise. As a result, researchers reported five interrelated themes:

1. "It happens Everyday": Unfairness/Sabotage/Condescension

2. "You have to Initiate the Conversation": Isolation and Connection

3. "They Seem the Same; I'm The One Who's Different."

4. "I have to Prove I'm Worthy To Be Here."

5. "Sometimes I'm not Even Here/Sometimes I Have to Represent All Black Students': Invisibility and Supervisibility.

1) Do you agree with the choice of researchers to use phenomenological approach corresponding to their aim and interest in the study? KRC1

2) Do you agree that the reported essence of participant's experiences below reflects the five themes reported in the study? DL1

   "Unfairness, sabotage, and condescension in the white world in which I live at the university. In order to connect with students, faculty, administrators, and others on and around campus I must be the one to initiate interaction, and I must also prove I am worthy as a student or friend. I am continuously made aware of how different I am, especially when I am the only black student in the class. Life is full of opposites: I feel as if I am seen as the same as other blacks by many whites, yet I often feel different from other black students. Perhaps the most common experience I have is one of extremes: Either I am invisible or I am its opposite – I am supervisible."

3) Researchers quoted reported findings of previous survey studies by Smith (1980) and Allen, Nunley, & Scott-Warner (1988) that stated, "55-78% of students, staff, and faculty described their institutions as hostile and unwelcoming to Black students." Do you agree that quoted finding could support researchers' reported theme, *"It happens Everyday": Unfairness/Sabotage/Condescension*? IL1

4) Do you agree that quoted researches in item no.4 is an up to date to support the findings of the study? * IL2

Scenario # 2

Chularut and DeBacker (2004) studied on "The Influence of Concept Mapping on Achievement, Self-regulation, and Self-efficay in Students of English as a Second Language". They investigated the effectiveness of concept mapping used as method of instruction among students in English as a second language classrooms. Seventy-nine ESL students participated in the study.

1) The researchers investigated the effectiveness of the intervention, which is using concept mapping as method of instruction, and used stratified random assignment of the participant to the two groups: concept mapping group and individual study plus discussion group. Do you agree that it was a quasi-experimental study? * KRC5

2) As shown in table below, do you agree with researchers' interpretation that using concept mapping promotes learning on both low and high English proficiency? DL2

Table 2

Means and standard deviations of pretest and posttest scores on achievement, self-monitoring, knowledge acquisition strategies, and self-efficacy by method of instruction and English proficiency level

	Achievement	Self-monitoring	Knowledge Acquisition	Self-efficacy
Pretests				
Individual study				
Low proficiency	.29 (.11)	2.31 (.25)	2.02 (.44)	2.41 (.30)
High proficiency	.60 (.08)	2.60 (.26)	2.35 (.44)	2.86 (.26)
Concept mapping				
Low proficiency	.30 (.12)	2.33 (.20)	2.10 (.42)	2.42 (.34)
High proficiency	.60 (.08)	2.44 (.19)	2.35 (.44)	2.62 (.26)
Posttests				
Individual study				
Low proficiency	.57 (.08)	3.18 (.24)	2.90 (.24)	3.51 (.21)
High proficiency	.71 (.04)	3.08 (.29)	2.98 (.38)	3.81 (.21)
Concept mapping				
Low proficiency	.69 (.10)	4.11 (.34)	4.00 (.48)	3.64 (.20)
High proficiency	.91 (.06)	4.52 (.19)	4.42 (.30)	4.11 (.25)

3) The researchers claimed that concept mapping promote the use of self-monitoring and knowledge acquisition strategies and to increase self-efficacy for learning from

English text. Considering the tabular data in item no. 3, do you agree with the claim of the researchers? EBR1

4) As gleaned from the table in item no. 3, do you agree the learning gains of concept map group is higher than the individual study group? DL3

5) Researchers reported a significant main effect of method of instruction [$F(1,75 = 20.61$, $p < .001$, Partial = .22] on the achievement variable. They interpreted, "the scores of concept mapping group were higher than those of the individual study plus discussion group." Do you agree with their interpretation? DL4

6) Based on the result reported in item 6, do you agree with the claim of the researchers that concept mapping enhances the achievement of the ESL students? EBR2

7) Researchers stated in the research procedure, "Before the intervention began, the researcher collected informed consent letters from the director of the ESL learning center and study participants". Do you agree that the researchers observed proper research ethics in conducting research? EBR3

8) Do you agree that to access easily this article from computer databases, key words like concept mapping, self-regulation, or self-efficacy to search may be used? IL4

Scenario # 3

The study on "Improving high school students' statistical reasoning skills: A case of Applying Anchored Instruction" by Prado and Gravoso (2011) described the process of designing, implementing, and evaluating a learning unit called, Mark's Eco-ecounter, on Binomial Distribution, Poisson Distribution, and Normal Distribution based on anchored instruction. The learning unit applied a low-cost media mix composed of a video presentation, a teacher's guide, and answer sheets. To investigate the effect of learning unit based on anchored instruction on the students' statistical reasoning, researchers selected the students of 2nd year classes state university's laboratory high school located in Leyte, Philippines. One class was taught using anchored instruction while the other class was using teacher-centered approach. To evaluate students' problem solving and statistical reasoning, the scoring rubric was used. After the instructional intervention, interviews with students and the teacher were conducted.

1) As describe in the scenario, do you agree that researchers randomly assigned participants to the experimental groups? * KRC8

2) Do you agree that the researchers employed mixed method design? KRC9

3) Do you agree that the main dependent variable investigated in the study was the students' statistical reasoning skills? KRC10

4) As shown in the Figures 1 and 2, do you agree that anchored instruction promotes reasonably higher performance scores in both traditional word problems and authentic promotes related to Binomial, Normal and Poisson Distributions? DL6

Figure 1

Respondents' means pre-- and post--test scores in the traditional word problems
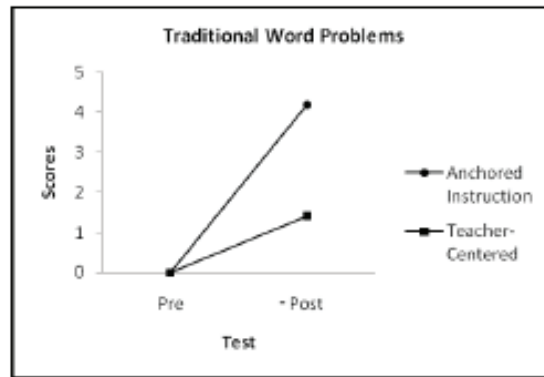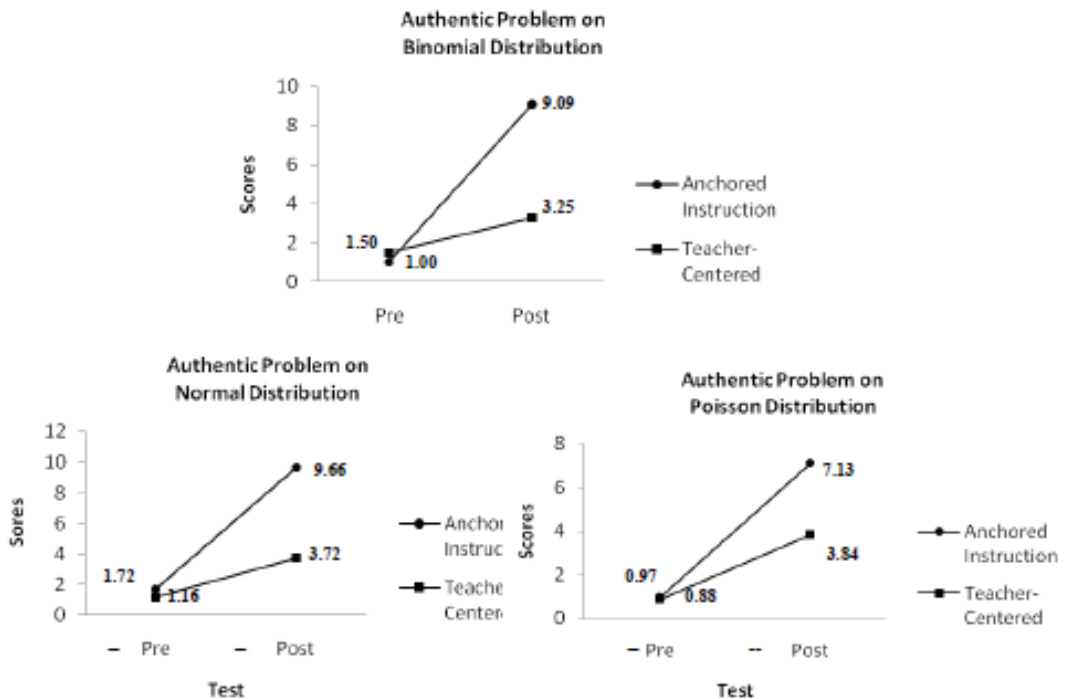

Figure 2

Respondents' means of their pre-- and post--test scores in authentic problems on Binomial Distribution, Normal Distribution, and Poisson Distribution

5) Researchers claimed that the instructional intervention (anchored instruction) was effective in improving high school students' statistical reasoning skills. Consider Figures 1 and 2 in item no. 2, do you agree on their claim? EBR4

6) Researchers reported statistical result in solving authentic problems, Binomial (t(62) =1.81, p>.05), Normal (t(62) = 1.07, p>.05), and Poisson Distribution (t(62)

= 0.30, p>.05). They interpreted, as "there was no significant difference between the experimental and control groups". Do you agree with their interpretation? DL7

7) Researchers cited, "Anchored instruction, according to Crews, Biswas, Goldman, and Bransford (1997), promotes attitudes necessary for effective problem solving, as well as the specific concepts and principles that allow learners to think effectively about a particular domain." Do you agree that the information cited is relevant and necessary to the study? IL5

8) Do you agree that Table 4 show information on the positive experiences of students? IL6

Table 4

Students' learning experiences in the intervention

Responses	Explanation
Learning was interesting	The use of Mark's Eco-encounter made the class interesting and the activities made the learning environment interactive.
Learning was situated in realistic situation	Students were posed with realistic situations in which problems on probability distribution were integrated. This helped them appreciate the problems and motivated to learn.
Students were motivated to learn on their own	Students were not dependent on the teacher's lecture anymore as they found guidance in solving their task by reading their book, thus learning on their own.
Learning allowed collaboration among students	Students were able to foster cooperation and teamwork with their classmates as they helped each other, divided their tasks, and shared knowledge, ideas, and opinions.
Learning unit allowed students to learn beyond statistics	Students learned about environment conservation and Philippines' rich biodiversity.
Learning unit provided 'episodic memory cues'	The learning unit aided students in answering their post-test as they were able to relate problems in the test to what they had during their activities.
Promoted change in students' perception of statistics	Students who studied through Mark's Eco-encounter now had positive feelings towards statistics, saying the subject (statistics) is interesting. Students in the control still say that statistics is boring.

Scenario # 4

The study on "Preservice Teachers' Educational Beliefs and Their Perceptions of Characteristics of Effective Teachers", by Minor, et al. (2002) aimed to examine preservice teachers' perceptions of characteristics of effective teachers, as well as to investigate whether these perceptions are related to educational beliefs. Data for this study were collected from 134 preservice teachers enrolled in several sections of an introductory-level education class for education majors at a large university in southern Georgia. Researchers used Preservice teachers' perceptions of characteristics of effective teachers survey (PTPCETS), an open ended survey to elicit participants' belief on the characteristics of effective teachers and the Witcher-Travers (1999) Survey on Educational Beliefs (WTSEB) to determine participants' educational belief (either transmissive, progressive or eclectic views). The constructed

themes using Phenomenological analysis of responses on PTPCETS reported by the researchers is shown in table below.

Table 1

Themes Emerging from Preservice Teachers' Perceptions of Characteristics of Effective Teachers

Theme	Endorsement Rate (%)
Student centered	55.2
Effective classroom and behavioral manager	33.6
Competent instructor	33.6
Ethical	29.9
Enthusiastic about teaching	23.9
Knowledgeable about subject	19.4
Professional	15.7

1) To address the purpose and so as not to distort the findings of the study, do you agree that researchers should have presented tables to show the findings on the relationships the different themes and the students' educational beliefs? EBR5

2) Rate your degree of agreement on the credibility of the study's reported finding "no statistically significant relationship between student level of educational beliefs and each of the seven perception categories" without statistical results on relationships reported? * EBR6

3) Factor analysis result is reported in the table below. Do you agree the three metathemes capture the student responses? * (DL)8

Table 2

Summary of Themes and Factor Loadings from Maximum Likelihood Varimax Factor Analysis: Three-Factor Solution

Theme	Factor Loading			C
	1	2	3	
Competent instructor	.75			.58
Student centered	.59			.40
Effective classroom and behavior manager	.56			.40
Ethical		.84		.72
Professional		.71		.56
Enthusiastic about teaching			.78	.67
Knowledgeable about subject			-.68	.55
Trace	1.44	1.28	1.17	3.88
% of variance explained	22.51	17.93	15.07	55.51

4) Researchers claimed, "... findings from this study suggest that teacher educators should develop and use activities that deal specifically with gender issues and multicultural education." In relation to the purpose of the study, do you agree with the claim of researchers? * EBR7