RASCH MODEL FOR MEASURING THE VALIDITY AND RELIABILITY OF THE PEERS ONLINE LEARNING INTERACTION QUESTIONNAIRE (POLI-Q) FOR HIGHER EDUCATION COURSE

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ABSTRACT

Developing a valid and reliable instrument to measure peer online learning interaction for knowledge construction is crucial for instructors, instructional designers, and researchers. The valid and reliable instrument in understanding student's perception of the course online peer interaction is for learning purposes. Thus, this study aims to test the validity and the reliability of the developed Peer Online Learning Interaction Questionnaire (POLI-Q) for higher education courses. POLI-Q consists of seven constructs which are question, answer, comment, discussion, information sharing, scaffolding, and reflection with five Likert Scales. The validity and reliability were tested using Rasch Model analysis. The findings of the Rasch Model analysis confirmed that POLI-Q is valid and reliable to measure peer online interaction that is related to learning. However, the instrument validity of the response spread across scales analysis resulted in excluding the scale number 1 (Strongly Disagree) which was not represented in the results while the other 4 scales were supported. Hence, it is recommended that the POLI-Q can be used by the instructors, instructional designers, and researchers to measure peer online learning interaction for higher education courses.

Keywords: Peer online interaction, Online learning, Knowledge construction, Higher Education, Developing POLI-Q, Rasch Model analysis

Introduction

Knowledge construction is the process of acquiring knowledge and making new meanings. Knowledge is constructed by learning participants' interaction with each other in the learning environment (Säljö, 2004). Therefore, interaction is essential for knowledge construction through which the learners make new meaning of what they learn (Damşa & Ludvigsen, 2016). Learning interaction is that of a two-way topic focusing on communication to promote learning and deeper understanding. It is the way where learners seek clarification through asking questions, explaining, and clearing points, and reflecting the level of understanding. Therefore, deeper learning is encouraging all learners to take the opportunity to collaborate and discuss with others, and to understand ideas from different sources and points of view. The interaction is an educational activity that contributes to the success of the online course and enhances students' motivation and learning process (Ossiannilsson, 2012). Moore (1989) identified three types of interaction that take place in online interaction and distance learning. The three types of interaction are learner-content interaction, learner instructor interaction, and learner-learner interaction (Peer Interaction). However, this study focuses only on peer interaction. Nonetheless, Moore (1989) considered peer interaction as the valuable and essential resource for learning. Consequently, the way that peers learning interaction takes place in online learning environment has actually been explored in previous studies such as Zhu (1996), and Pena-Shaff and Nicholls (2004). Both studies analyzed the actual process of students' knowledge construction and construction of meaning through online interaction and discussion (Zhu, 1996 and Pena-Shaff & Nicholls, 2004).

However, the researchers' focus was on analyzing the written form of students' interaction while students' attitude towards content-based online discussion is still not widely studied. The importance of investigating students' attitudes about the process of knowledge construction through content-based discussion is to help researchers draw a valid and accurate conclusion through triangulating their findings. Therefore, the use of a survey approach will help researchers acquire information about participants' behavior, attitude, belief, and reason for action in the investigated topic (Bulmer, 2004). Moreover, a survey also helps researchers extract information about the attitude that is considerably difficult to measure through observational techniques (McIntyre, 1999). Nonetheless, the intensive review of the literature showed that there is a lack of survey instruments to measure students' perceived content-based discussion for knowledge construction through online peer interaction. In this respect, this study is an effort to develop the Peer Online Learning Interaction Questionnaire (POLI-Q) which will be a significant contribution to provide a valid and reliable survey instrument for measuring peer online interaction dimension. The instrument is hoped to help the researchers to collect information that measures the attitude towards peer interaction for knowledge construction.

Therefore, this study focuses on measuring POLI-Q instrument validity and reliability. Testing the instrument validity refers to the degree to which an instrument accurately measures what it

intends to measure. However, instrument reliability refers to the degree to which an instrument yields consistent results. Therefore, POLI-Q validity and reliability will be measured using the Rasch model underscoring the POLI-Q quality through Point Measure Correlation. Moreover, POLI-Q validity is analyzed through the response spread across scales while the reliability is analyzed by person separation reliability value.

Literature Review

Online Learning

In recent years, a wide variety of online tools that support online learning are available for users. Therefore, online learning is getting more popular especially among learners (Phirangee, 2016). Online learning provides the facilities for online discussion forums where learners share a resource, discuss ideas, have access to others' ideas, and reflect on their ideas (Hewitt, 2005). The convenience of online learning has attracted the concern and attention of students and universities, as access to online courses can be done at any time from anywhere, allowing learners to study at their convenience (Bolliger & Inan, 2012). Moreover, the facilitative nature of the online learning environment helps students engage in learning and allows for repeated exposure to learning activities (Shih et al., 2013). Furthermore, interaction in online learning increases students-centered learning promoting more participation in the interactive discussion forum (Akhter & Mahmood, 2018). Therefore, there is a trend by many colleges and universities to transform the traditional classes into blended or fully online courses to allow for easier access to their courses and meet the needs of a diverse student population (Keengwe & Kidd, 2010). Additionally, the trend towards online learning is stressed by academic leaders who plan to move to offer more online courses to compensate for the decrease in traditional course offering and to reduce the educational cost yet maintaining the effectiveness of learning (Allen, Seaman, Straut, and Poulin, 2016 and Wordu & Chinda, 2019).

Online Interaction and Learning

It is argued that " interaction is education at its most fundamental form" (Shaleand Garrison, 1990). However, with the advent of internet technology, online interaction is a way of interaction that takes place in an online environment. Online interaction allows people to communicate and interact regardless of they are geographically far from each other. In education, online interaction for learning is an opportunity given to learners to communicate beyond the classroom time that allows them to gain knowledge and improve skills in a different academic setting (Espitia & Cruz, 2013) and to reflect on their thinking and experience through the discourse with other students and instructor (Balaji & Chakrabarti, 2010). Therefore, online interaction has been recognized as a vital element of a successful online and blended learning process (Moore, 1989; Su, Magjuka, and Lee, 2005; Hurst, Wallace, and Nixon, 2013). The frequency and the content of online interaction are found to be the indicators of students' success and persistence in the course (Shelton et al., 2017). Online interaction was categorized into three types and labeled as learner-content interaction, learner-instructor interaction, and learner-learner interaction (Moore,

1989). Those types of online interaction can be accomplished either asynchronous or synchronous interaction modes. In this study, the focus is on learner-learner interaction (peer interaction) as it reflects the learners' interactivity to promote learning.

Peer Interaction

Peer or learner-learner interaction is considered as one of three essential types of interaction that are necessary for creating effective instruction (Moore, 1989). Peer interaction is defined as communication between one learner and other learners, alone or in group settings, with or without the presence of an instructor (Moore & Kearsley, 2011). It can be between one-to-one students or among a group of students sharing the same course and guided by their instructor. Students are required to master peer interaction skills as it is critical for achieving collaborative and cooperative tasks where learning can occur as a result of peer interaction alone (Anderson, 2003). Hence, peer interaction was seen a long time ago as the key to the learning process due to the collaboration that is resulted from the interaction (Palloff & Pratt, 1999). Peer interaction for learning is mainly a type of collaboration where students collaborate to accomplish the shared goal through actively exchanging knowledge and ideas (Sidek et al., 2018). Therefore, students should be given the opportunity for peer interaction learning activities such as discussion and peer assessment to encourage more connection with peers and the instructor and content (Sidek et al., 2018). Hence, online interaction was found to have a positive impact on students' success and academic performance through more frequent interaction, interaction content, and better social presence (Shelton et al., 2017; Al-dheleai et al., 2020; Al-dheleai & Tasir, 2020 and Al-dheleai et al., 2020).

Researchers considered asking questions, providing answers as important components of knowledge construction and peer online discussion (Tawfik et al., 2020; Liu et al., 2013). Moreover, reflection and questioning are effective to engage online learners (Liu, 2019 & Furnari, 2014). Hancock and Rowland (2017) reported that students feel comfortable to share information and to respond to a discussion, to ask questions, to challenge, and argue other participants' statements. In an online discussion forum, active learning is promoted through involving peers in a collaborative learning and knowledge sharing process, reflections, and information exchange (Nor et al., 2010). Additionally, peer's participation in online forum discussion showed cases of peers agreement and disagreement with each other statements and arguments; explanation and negotiation of meaning, scaffolding, knowledge sharing, reflections on learning and understanding as a result of participation in online discussion (Nor et al., 2010). Peers scaffolding developed peer's assistance in online learning discussion (Hsieh, 2017). Therefore, the reported studies show the importance of Zhu model peer online interaction component for this research study.

Underpinning research model & theory

Peer interaction (Zhu, 1996)

Various studies had been carried out to develop content analysis instruments to analyze student-student interaction**.** For instance, Zhu (1996) developed the measurement tool to analyze the types of students' participation and their roles in the electronic discussion. According to Zhu (1996), students' roles in the electronic discussion were categorized to reflect the meaning of the messages such as questions, answers, information sharing, discussion, comment, reflection, and scaffolding. Furthermore, Fahy et al. (2000) made some changes to Zhu's analytic tool to come up with a new tool called Transcript Analysis Tool (TAT). TAT classified learners' online interaction into five categories, which are vertical questions, horizontal questions, statements, reflections, and scaffolding. Lastly, Pena-Shaff and Nicholls (2004) findings, students' knowledge construction through their participation in the discussion through posting statements that express clarification, interpretation, conflict, assertion, judgment, and reflection almost related to the process of knowledge construction.

Table 1: Peer Interaction Constructs Definition Based on Zhu 1996

Construct	Definition
Question	Seeking answers from more capable class members by posting information-seeking questions for more understanding
Answer	Providing specific information to answer information seekers questions
Reflection	Self-evaluation through showing the level of improvement in own understanding after going through reading/learning.
Comments	Comment with agreement/disagreement on reading tasks or on other members ideas and shared information
Discussion	Sharing personal understanding of the discussion topic
Information Sharing	Elaborating on topics/concepts under discussion through sharing more information about the topic/concept.
Scaffolding	Providing guidance and suggestions

It appears that Zhu's interaction model was the source of other lately developed models. Therefore, this study opted to develop a survey instrument that measures the peer interaction component of Zhu's model. The purpose of the developed instrument is to provide a valid survey to be used as a data collection instrument for future research when measuring the perception towards peer online interaction is concerned. POLI-Q reflects students' engagement in collaborative and reflective activities to construct knowledge through social interaction. Through social interaction, the chance is given to those who seek answers from more capable class members by posting information-seeking questions for more understanding (Question). Moreover, those who like to provide answers and exchange ideas are allowed to elaborate during the discussion through reflective thought (Reflection), comments on reading tasks or on other members ideas, and shared information (Comment), providing specific information to answer information seekers questions (Answer), sharing personal understanding during discussion

(Discussion), elaborating on topics under discussion through information sharing (Information Sharing) and providing guidance and suggestions (Scaffolding) (Zhu, 1996).

The survey instrument will be an additional validation of the existing peer online interaction content analysis instruments based on Zhu's peer interaction component of the meaning negotiation for knowledge construction model. The survey can be used as an instrument to measure the perception towards peer online interaction in higher education courses.

Item response theory and Rasch model

Item response theory (IRT) accurately improves test scoring and test items development (An & Yung, 2014). Therefore, IRT models are widely used in large-scale assessment programs (Carlson & Davier, 2013). One of the most used IRT models in IRT applications is the Rasch model (RM) (An & Yung, 2014). RM is generally the same as the measurement of a parameter in IRT or which is also shown as Latin Trait Theory (LTT) (Dawis, 1987; Bond & Fox, 2007). RM is a mathematical formula that specifies the form of the relationship between items that operationalize one construct. This model is not primarily concerned about total scores and not all items are treated as equal contributions to the total score. That is, difficult items are weighted more highly than easier items when estimating the level of knowledge ability. The RM assumption is that respondents with high ability have the probability to answer more questions correctly than respondents with a lower ability (Bond & Fox, 2007). The RM model is used to analyze the data from instruments to measure the variables that cannot be measured directly, such as the characteristics of ability, attitude, and personality. This measurement model is used primarily in areas related to psychometric theory and techniques of measurement in psychology. This model shows the probability of people's ability to measure item difficulty (Wright & Masters, 1982). RM can convert the qualitative data to linear measurement. Moreover, it converts raw data into ration scale on a common interval scale (Linacre, 2002).

Objectives

The objectives of this study are:

1. To analyze POLI-Q instrument quality through correlation, fit, and dimensionality analysis.
2. To analyze POLI-Q instrument validity of the response spread across scales.
3. To analyze POLI-Q instrument person separation reliability value.

Methodology

For the instrument to be valid and reliable, empirical evidence of its validity and reliability is required to be used to measure the construct that is intended to measure. Fowler (1995) asserted that "a good question produces answers that are reliable and valid measures of something we

want to describe". Therefore, this study was intended to test POLI-Q validity and reliability through applying the Rasch Analysis approach using Winsteps software.

Peer Online Learning Interaction (POLI-Q) was developed by the researchers to reflect Zhu's (1996)'s peer interaction knowledge construction categories in online learning to be used in quantitative and survey research that measure student's perception and attitude of peer online learning interaction. POLI-Q contains seven constructs which are question, answer, comment, discussion, information sharing, scaffolding, and reflection. Refer to the Appendix for complete POLI-Q questionnaire constructs and items.

Research Design

The Master of education students were exposed to one semester of online interaction via the university learning management system discussion forums and the use of social networking tools. Several discussion topics were posted by the instructors for discussion by students. The student-centered learning and the student's participation in the discussion were given the emphasis and encouraged by the instructors to give students more control of their learning. At the end of the semester, the students were asked to voluntarily respond to the POLI-Q questionnaire.

Sample and Data Collection

This study data was collected from 49 postgraduate students from the school of education in one of the Malaysian public universities. The respondents were 35 female and 14 male students where 45 respondents' ages ranged between 25 and 35 years old while only 4 respondents reported their age more than 35 years old. Moreover, 26 respondents were full-time students while the other 24 were part-time students. This study sample was purposively selected from postgraduate students who attended ICT in an education course and were exposed to online discussions as part of the learning process and activities before responding to this survey.

The study sample of 49 respondents is considered adequate for validity and reliability test using the Rasch model. Previous researchers argued that Rasch analysis can be conducted and be useful even with a small sample size (Linacre, 1994). Linacre (1994) argued that one of the fundamental Rasch analysis books was based on analyzing 18 items with a sample of 35 respondents (Linacre, 1994); Linacre, (1994) mentioned "Best Test Design" book written by (Wright & Stone, 1979).

Research Ethics

In respect to the research ethics standards, the respondents were given the option either to participate in the study or to withdraw at any time. Moreover, the participants were assured that the data will be used only for the research purpose and the participants are anonymous with no personal information that reveal their identity was required.

Data Analysis

Rasch Analysis approach is used to evaluate the strength and the quality of the instrument (Boone, 2016). Interestingly, the Rasch Analysis approach evaluates instrument quality through item-fit (Boone et al., 2013) and the person-fit statistics where researchers can omit the weak items or the respondents who provide unusual answering patterns (Dawis, 1987 and Boone, 2016). Therefore, the POLI-Q instrument was developed using five Likert scales. The validity and reliability test were tested via the Rasch Model analysis approach using Winsteps software. The data analysis was done using item correlation and fit, dimensionality; response spread validity across scales, and the person separation reliability. The findings of the validity and reliability of POLI-Q instrument analysis are reported in the following sections.

Findings

POLI-Q Correlation and fit findings

POLI-Q validity was measured based on Point Measure Correlation (PTMEA Corr.). PTMEA Corr. is one of the early detections of construct validity (Bond and Fox, 2007). The good correlation values of the items should be ≥ .20. For the analysis of these constructs items, the result expected mean square (MNSQ) infit analysis value should be 0.4 <x <1.5, and the PTMEA value should be + 0.2 <x<1 (Bond & Fox, 2007).

As shown in Table 1, all POLI-Q items were correlated positively with a correlation value of > .20. These findings confirm that all items are at a very good fit which indicates that their suitability to be used for statistical analysis. Items' suitability under schedule also shows the information for mean square (MNSQ) to make it easier for outlier detection or misfit. Table 1 also shows the item fit analysis of POLI-Q and suggests that all items are positive and fit. Therefore, the data showed an acceptable correlation for this POLI-Q.

As shown in Table 1, the lowest correlation values were 0.56, 0.61, and 0. 62 for items SSI.IS2, SSI.R1, SSI.C2 respectively, and the highest values of item correlation were 0.78, 0.79, 0.80 for items SSI.D1, SSI.S1, SSI.A3, SSI.S3, SSI.D2 and SSI.A1 respectively. Therefore, correlation analysis indicated that all POLI-Q items were correlated positively with a correlation value of > .20 which indicating an acceptable correlation for this POLI-Q as early evidence of construct validity.

Items' suitability under schedule also shows the information for mean square (MNSQ) to make it easier for outlier detection or misfit. The item fit analysis was determined by MNSQ to determine which items could be considered as the most difficult items. Items SSI.C2, SSI.C4, and SSI. IS2 with outfit values (1.56, 1.54, 1.46) respectively were the most difficult items. However, considering the acceptable expected mean square (MNSQ) infit analysis value as 0.4 <x <1.5, the item fit analysis of POLI-Q and suggest that all items are positive and fit including the three items SSI.C2, SSI.C4, and SSI.IS2. The findings of both analyses of correlation and

item fit to confirm that all items are at a very good fit which indicates that their suitability to be used for statistical analysis.

Table 1: Item Correlation and Fit Analysis of POLI-Q

MEASURE	MODEL S. E.	INFIT		OUTFIT		PT-MEASURE		EXACT MATCH		ITEM
		MNSQ	ZSTD	MNSQ	ZSTD	CORR.	EXP.	OBS%	EXP%	
-1.11	0.27	1.35	1.1	1.56	1.7	A .62	.68	68.1	73.0	**SSLC2**
-0.58	0.31	1.19	.8	1.54	1.8	B .64	.71	70.2	73.1	**SSLC4**
-0.59	0.33	1.33	1.6	1.46	1.2	C .56	.66	66.0	72.4	**SSLIS2**
0.01	0.35	1.21	1.0	1.30	1.0	D .61	.69	76.6	77.3	**SSLR1**
-0.71	0.3	1.25	1.1	1.29	1.0	E .65	.71	68.1	72.1	**SSLQ2**
-0.61	0.28	1.12	.6	1.28	1.0	F .65	.71	57.4	68.6	**SSLQ1**
-0.52	0.33	1.07	.4	1.23	.7	G .63	.67	68.1	72.7	**SSLIS3**
0.91	0.33	1.16	.8	1.17	.7	H .68	.73	70.2	73.8	**SSLR3**
0.73	0.32	1.17	.8	1.16	.7	I .68	.72	70.2	72.8	**SSLR2**
-0.36	0.3	1.04	.2	1.00	.1	L .73	.74	66.0	71.9	**SSLD4**
0.18	0.29	1.02	.2	.99	.1	M .73	.73	72.3	71.4	**SSLQ3**
-0.46	0.31	.99	.0	.94	-.1	N .73	.72	72.3	72.7	**SSLS4**
0.07	0.29	.98	.0	.99	.0	n .76	.75	74.5	69.6	**SSLA4**
1.21	0.36	.88	-.5	.98	.0	m .72	.71	85.1	77.3	**SSLS2**
0.84	0.36	.98	.0	.91	-.2	l .72	.71	74.5	77.0	**SSLC3**
-0.56	0.35	.97	.0	.87	-.3	k .69	.67	72.3	76.0	**SSLIS1**
-0.63	0.32	.91	-.3	.76	-.8	j .75	.70	78.7	74.6	**SSLD3**
-0.65	0.31	.87	-.5	.82	-.6	i .74	.71	80.9	72.6	**SSLA2**
-0.65	0.39	.84	-.6	.83	-.4	h .72	.67	85.1	81.4	**SSLC1**
1.14	0.32	.81	-.9	.80	-.8	g .79	.74	74.5	73.0	**SSLA3**
1.44	0.32	.79	-1.0	.79	-.9	f .79	.74	85.1	73.3	**SSLS3**
-0.13	0.34	.78	-1.1	.68	-1.0	e .75	.68	78.7	74.0	**SSLIS4**
0.47	0.35	.75	-1.2	.65	-1.3	d .78	.70	85.1	77.2	**SSLD1**
0.74	0.35	.74	-1.3	.59	-1.7	c .80	.71	80.9	76.2	**SSLD2**
0.79	0.37	.71	-1.3	.60	-1.3	b .78	.69	87.2	79.3	**SSLS1**
-0.71	0.3	.69	-1.4	.59	-1.7	a .80	.71	87.2	72.1	**SSLA1**

POLI-Q dimensionality findings

POLI-Q instrument direction that measured using Rasch analysis is found to be satisfactory. In RM analysis, a satisfactory dimensionality, which is determined by raw variance explained by measures should be more than 40%, and unexplained variance in 1st contrast which should be ≤ 15. Table 2 shows the raw variance explained by measures was 45.5%, which was more than 40%, and the unexplained variance in 1st contrast was 6.6%, which is less than 15 as an expected value determined by unexplained variance in 1st contrast.

Table 2: Dimensionality Analysis

	-- Empirical --		Modelled
Total raw variance in observations	= 61.5 100.0%		100.0%
Raw variance explained by measures	= 33.5 54.5%		53.9%
Raw variance explained by persons	= 23.4 38.1%		37.7%
Raw Variance explained by items	= 10.1 16.4%		16.2%
Raw unexplained variance (total)	= 28.0 45.5%	100.0%	46.1%
Unexplained variance in 1st contrast	= 4.1 6.6%	14.6%	
Unexplained variance in 2nd contrast	= 3.2 5.2%	11.5%	
Unexplained variance in 3rd contrast	= 3.0 4.8%	10.5%	
Unexplained variance in 4th contrast	= 2.6 4.3%	9.4%	
Unexplained variance in 5th contrast	= 2.2 3.6%	7.9%	

POLI-Q response spread validity across scales findings

Rasch analysis determines the validity of the response probabilities being spread fairly across scales. Both table 3 and figure 1 show the summary of the category structure on a scale gradation and size structure of the intersection. The column arrangement observation (observed count) shows the respondents' answers given to the ranking scale.

As shown in Table 3, the most frequent answer is the scale of respondents ranking 4 which is 24 (51 %). The next grading scale that respondents selected was scale 5 of 17 (36%). The scale 3 had 4 (9%) respondents. While the least grading scale of least was scale 2 with 2 (4%) respondents. However, Rasch analysis deleted the scale number 1 which was not presented in the results of Calibration scaling analysis. Generally, Table 3 shows that the responses patterns obtained started from -1.82 logit and moved up monotonously towards +2.76 logit signifying that the patterns of respondents' answers are normal.

Table 3: Calibration Scaling Analysis

CATEGORY LABEL	OBSERVED SCORE	COUNT%		OBSVD SAMPLE AVRGE	EXPECT	INFIT MNSQ	OUTFIT MNSQ	STRUCTURE CALIBRATN	CATEGORY MEASURE
2	2	2	4	-1.82	-1.90	1.09	1.01	NONE	(-3.67)
3	3	4	9	-1.92*	-1.03	.14	.06	-1.62	-2.09
4	4	24	51	1.35	.84	1.19	1.66	-1.32	.28
5	5	17	36	2.76	3.28	1.66	1.47	2.94	(3.44)

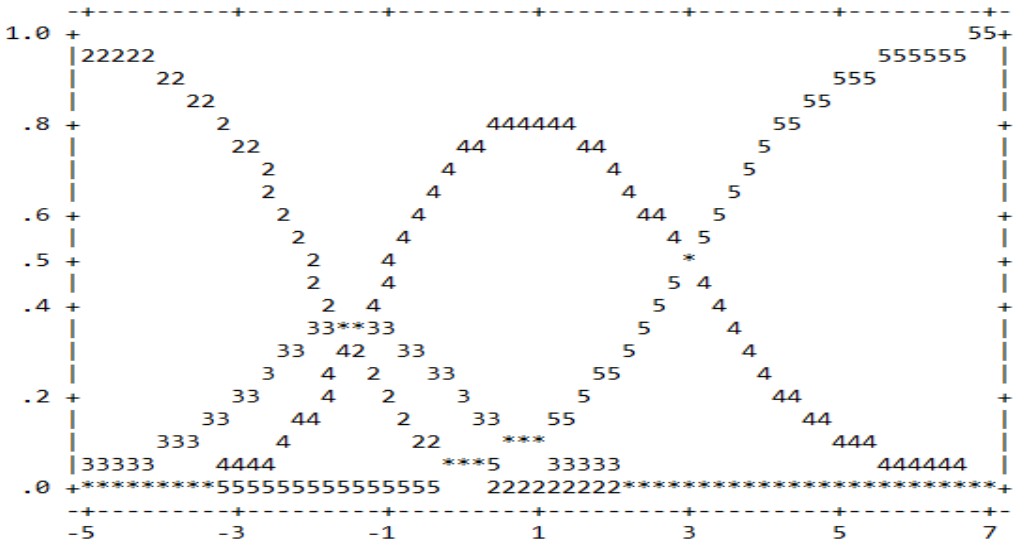

Figure 1: Category Structure of POLI-Q

POLI-Q person separation reliability findings

For accepting reliability in Rasch analysis, the reliability value should exceed 0.50 (Linacre, 2007; Bond and Fox, 2007), and acceptable separation should be more than 2 (Fisher, 2007). Consequently, RM analysis is to measure POLI-Q reliability. Therefore, person separation and reliability along with item separation and reliability were conducted and the findings are shown in Tables 4 and 5. The person separation value was 4.62 with high person reliability with a value of .95. Similarly, item reliability was high with a value of 0.80 whereas item separation was 1.99, Hence, the item and person reliability findings tell that the number of respondents 49 with the number of items 28 are reliable to measure POLI-Q instrument where both showed strong reliability level.

Table 3: Person Separation and Reliability

	Raw Score	Count	Measure	Infit		Outfit	
				IMSQ	ZSTD	OMSQ	ZSTS
Mean	117.1	28	1.70	.99	-.4	1.00	-.4
S.D	13.2	0.0	2.43	.74	2.1	.75	2.1
Real RMSE	.49						
ADJ.SD	2.07						
Separation	4.26						
Person reliability	.95						

Table 4: Item Separation and Reliability

	Raw Score	Count	Measure	Infit		Outfit	
				IMSQ	ZSTD	OMSQ	ZSTS
Mean	205.0	49	.00	.99	.0	1.00	.0
S.D	5.8	0.0	.75	.19	.8	.28	.9
Real RMSE	.34						
ADJ.SD	.67						
Separation	1.99						
Item reliability	.80						

Discussion

The purpose of this study was to develop a Peer Online Learning Interaction Questionnaire POLI-Q. The content and the structure of the survey questionnaire were based on the previous studies related to learning interaction among students in an online environment. Hence, assessing the psychometric properties is vital for any instrument to be used as a reliable and valid measurement tool (Mofreh et al., 2020). Thus, the quality of the developed instrument was tested using several analyses of RM analysis including Point Measure Correlation, fit, and dimensionality analysis.

Point Measure Correlation (PTMEA) was conducted to achieve the first research objective by analyzing the POLI-Q instrument validity. Consequently, the findings indicated that POLI-Q instrument items and constructs are valid and reliable. Therefore, POLI-Q constructs good validity was confirmed since there were no negative PTMEA values. The PTMEA values of items were more than 0.20 and had good dimensionality as evidence of good construct validity.

The second objective of this study was to check how the responses spread across the scales to determine the used scale's validity. Therefore, POLI-Q rating scales showed that only 4 scales were valid where RM analysis deleted the scale number 1 which was not presented in the results of Calibration scaling analysis.

The RM analysis measured reliability with person separation reliability of POLI-Q was conducted to achieve the third research objective. The statistical findings showed the ability of the items to separate persons with different levels of the concept measured. The POLI-Q items reliability items showed that each item could be described by the level of its difficulty. Thus, the findings of this study indicated that the developed instrument can be used as a measurable predicator for POLI-Q.

The findings of this study were supported by many studies which used Rasch Model analysis for testing the construct validity (Wolfe et al., 2004; Fox & Jones, 2009; Forkmann et al., 2009; Aziz et al., 2008; Mofreh et al., 2014; Mofreh et al, 2018).

In general, the POLI-Q obvious validity and reliability show that Zhu's (1996) peer interaction is still perceived as valid for peer online discussion and knowledge construction. Moreover, Zhu's (1996) peer online interaction appeared to be accepted by learners in the current time and can be achieved using the new online interaction tools such as social media tools. Posting discussion messages with different types of meanings reflected in Zhu (1996) peer interaction was perceived as essential in the online learning process as learners can achieve the shared goals through student-centered discussion and collaboration with other participants to complete learning tasks (Anderson, 2003; Palloff & Pratt, 1999; Sidek et al., 2018 and Iv et al., 2020). Peer online interaction can take place when students post statements that express questions, answer, information sharing, discussion, comment, reflection, and scaffolding during the process of knowledge construction. Therefore, the developed POLI-Q instrument can be used as a measurement instrument to measure learners' attitudes towards peer online interaction specifically when the interaction is for meaning and knowledge construction. Furthermore, the POLI-Q instrument can be employed to measure peer online interaction using computer supported interaction besides newly appearing online interaction mediums including social media tools (Al-dheleai & Tasir, 2017).

Implications

Developing a valid and reliable instrument to measure peer online learning interaction for knowledge construction is crucial for instructors, instructional designers, and researchers, as it enables them to understand peer interaction's impact on learning. Therefore, this study was an effort to develop a reliable and valid instrument to measure peer online learning interaction POLI-Q using Rasch Model analysis. Accordingly, POLI-Q can be used by the instructors, instructional designers, and researchers to measure peer (student-student) online learning interaction and knowledge construction. University instructors and researchers can use POLI-Q to understand how learners perceive the meaning construction patterns that take place during

peer online learning interaction as part of the process of their learning and knowledge construction. Instructors and instructional designers must design online learning activities and discussion forums based on learners' feedback to meet learners learning behavior and needs. Developing learning activities and discussion patterns based on learners' preferred learning behavior and need will highly contribute to the better quality of students learning and performance.

POLI-Q can be used by higher education lecturers and researchers to measure learners' course online interaction. POLI-Q provides a reliable finding on attitude towards peer online interaction which allows the universities lecturers to facilitate and improve a collaborative learning process through peer online interaction for better learning and understanding. The data collected using the POLI-Q survey can guide higher education instructional designers to design collaborative online learning interaction topics and activities that trigger peer discussion and meaning negotiation that facilitates learner's knowledge construction.

Limitations and recommendations for future research

Although data analysis showed POLI-Q as a valid and reliable instrument to measure peer online learning interaction for knowledge construction, there are however some limitations that might need to be considered in the future use of the instrument. That is because the sample of this study was limited to postgraduate students in the school of education. Therefore, it is recommended that future research need to target students from both undergraduate as well as postgraduate students. Moreover, future researchers might need to extend the sample of their studies to include students from different faculties and fields to test the instrument validity and reliability. The wider sample from different programs will ensure higher reliability and enable researchers to judge POLI-Q validity to measure peer online interaction for knowledge construction across higher education programs and fields.

Conclusion

To conclude, the finding of Rasch Model analysis showed that POLI-Q is a valid and reliable instrument to measure peer online interaction for knowledge construction. The students support the idea that their online interaction for knowledge construction is supposed to focus on the measured patterns in the developed instrument. The reliability and validity of the instrument are fundamental features in the evaluation of any measurement instrument for more accurate and reliable research (Mohajan, 2017). Therefore, POLI-Q provides a reliable instrument to measure university students' attitudes towards online interaction activities during their learning and knowledge construction. The instrument shows the types of discussion patterns that are more important to boost students' collaborative involvement in the online discussion during the process of learning and knowledge construction at the higher education level.

Appendix

POLI-Q Questionnaire

CODE	Statement
	Question
SSI-Q1	I could post my questions to other course participants.
SSI-Q2	Students' questions were related to the course content.
SSI-Q3	Posting questions helped me to find an appropriate answer from other course participants.
	Answer
SSI-A1	I actively posted my answers to other course participants' questions.
SSI-A2	I could post my answers to other course participants' questions.
SSI-A3	I received answers to my questions from other course participants.
SSI-A4	Students' answers helped me to understand the course content.
	Comments
SSI-C1	I actively commented on other students' posts.
SSI-C2	I could comment on other students' course-related posts.
SSI-C3	Other students commented on my course-related posts.
SSI-C4	Comments from peers on course-related posts helped me to understand the course content.
	Discussion
SSI-D1	I could participate in the course-related peer discussion.
SSI-D2	Other students participated in the course-related discussion.
SSI-D3	Students' discussion was related to the course content.
SSI-D4	The course-related discussion helped me to understand the course content.
	Information sharing
SSI-IS1	I could participate in sharing information with other students (ex: website link, video, document)
SSI-IS2	Other students shared information (ex: website link, video, document).

SSI-IS3	Information sharing by students was related to the course content.
SSI-IS4	Information sharing by peers helped me to understand the course content.
	Scaffolding
SSI-S1	I could provide information to support peer students' understanding of the course content.
SSI-S2	Other students provided information to support my understanding of the course content**.**
SSI-S3	Students' support helped me to understand the course content.
SSI-S4	I actively provided information that supports students understanding of the course content.
	Reflection
SSI-R1	I could post statements that reflect my level of course content understanding.
SSI-R2	Other students posted statements that reflect their level of the course content understanding.
SSI-R3	My posts, comments, and discussion reflected a good level of the course content understanding.

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References

Akhter, H., & Mahmood, M. (2018). Study of the Impact of Online Education on Student's learning at University Level in Pakistan. *International Journal of Distance Education and E-Learning*, *3*(2).

Al-dheleai, Yahya M; Tasir, Z. (2020). Online Social Presence " OSP " Patterns Correlation with Students ' Academic Performance among Master of Education Program Students. *International Journal of Instruction*, *13*(2), 493–506.

Al-dheleai, Yahya M., Tasir, Zaidatun; Al-rahmi, Waleed Mugahed., Al-Sharafi, Mohammed A., Mydin, A. (2020). Modeling of Students Online Social Presence on Social Networking Sites with Academic Performance. *International Journal of Emerging Technologies in Learning (IJET)*, *15*(12), 56–71.

Al-dheleai, Y. M., & Tasir, Z. (2017). Using Facebook for Students' Interaction and its Correlation with Students ' Academic Performance. *The Turkish Online Journal of Educational Technology*, *16*(4), 170–178. http://www.tojet.net/articles/v16i4/16416.pdf

Al-Dheleai, Y. M., Tasir, Z., & Jumaat, N. F. (2020). Depicting Students' Social Presence on Social Networking Site in Course-Related Interaction. *SAGE Open*, *10*(1), 0–7. https://doi.org/10.1177/2158244019899094

Allen, I. E., Seaman, J., Straut, T. T., & Poulin, R. (2016). Online report card: Tracking online education in the United States. *Babson Survey Research Group and Quahog Research Group, LLC.*

An, X., & Yung, Y. (2014). Item Response Theory : What It Is and How You Can Use the IRT Procedure to Apply It. *SAS Institute Inc.*, *10*(4), 1–14.

Anderson, T. (2003). Getting the Mix Right Again : An updated and theoretical rationale for interaction. *The International Review of Research in Open and Distributed Learning*, *4*(2).

Aziz, A. A. B. D., Mohamed, A., Zaharim, A., Zakaria, S., Ghulman, H. A., & Masodi, M. S. (2008). Evaluation of Information Professionals Competency Face Validity Test Using Rasch Model. *Proceedings of the 5th WSEAS/IASME International Conference on Engineering Education*, 396–403.

Balaji, M. S., & Chakrabarti, D. (2010). Student interactions in the online discussion forum: Empirical research from 'media richness theory perspective. *Journal of Interactive Online Learning*, *9*(1), 1–22.

Bolliger, D. U., & Inan, F. A. (2012). Development and Validation of the Online Student Connectedness Survey (OSCS). *The International Review of Research in Open and Distributed*

Learning, *13*(3), 41–65.

Bond, T. G., & Fox, C. M. (2007). *Applying the Rasch model: Fundamental measurement in the human sciences* (2nd Editio). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

Boone, W. J. (2016). Rasch Analysis for Instrument Development : Why, When, and How ? *CBE—Life Sciences Education*, *15*(4). https://doi.org/10.1187/cbe.16-04-0148

Boone, W. J., Staver, J. R., & Yale, M. S. (2013). *Rasch analysis in the human sciences*. Springer Science & Business Media.

Bulmer, M. (2004). Questionnaires, 1st edition, Sage Benchmarks in Social Science Research Methods, edited by: Bulmer, M., *Sage Publications, London*, 354 pp.

Carlson, J. E., & Davier, M. Von. (2013). Item Response Theory. *ETS Research Report Series*, *2013*(2), i–69.

Damşa, C. I., & Ludvigsen, S. (2016). Learning through interaction and co-construction of knowledge objects in teacher education. *Learning, Culture, and Social Interaction*, *11*, 1–18. https://doi.org/10.1016/j.lcsi.2016.03.001

Dawis, R. V. (1987). Scale construction. *Journal of Counseling Psychology*, *34*(4), 481.

Espitia, M., & Cruz, C. (2013). Peer-feedback and online interaction: a case study. *Revista de Lenguaje y Cultura*, *18*(2), 131–151.

Fahy, P. J., Crawford, G., Ally, M., Cookson, P., Keller, V., & Prosser, F. (2000). The development and testing of a tool for analysis of computer-mediated conferencing transcripts. *Alberta Journal of Educational Research*, *46*(1).

Forkmann, T., Boecker, M., Wirtz, M., Eberle, N., Westhofen, M., Schauerte, P., Mischke, K., Kircher, T., Gauggel, S., & Norra, C. (2009). Journal of Behavior Therapy Development and validation of the Rasch-based depression screening (DESC) using Rasch analysis and structural equation modeling. *Journal of Behavior Therapy and Experimental Psychiatry*, *40*(3), 468–478. https://doi.org/10.1016/j.jbtep.2009.06.003

Fowler, F. J. (1995). *Improving survey questions: Design and evaluation* (Vol. 38). Sage.

Fox, C. M., & Jones, J. A. (2009). Uses of Rasch Modeling in Counseling Psychology Research. *Journal of Counseling Psychology*, *45*(1), 30–45. https://doi.org/10.1037/0022-0167.45.1.30

Furnari, M. (2014). Medical students' reflections in online discussions—does teacher facilitation matter. *Rhetoric and Reality: Critical Perspectives on Educational Technology, Proceedings Ascilite Dunedin*, 574–578.

Hancock, C., & Rowland, B. (2017). Online and out of synch: Using discussion roles in online asynchronous discussions. *Cogent Education*, *4*(1), 1368613.

Hewitt, J. (2005). *Toward an Understanding of How Threads Die in Asynchronous Computer Conferences*. *14*(4), 567–589.

Hsieh, Y. C. (2017). A case study of the dynamics of scaffolding among ESL learners and online resources in collaborative learning. *Computer Assisted Language Learning*, *30*(1–2), 115–132.

Hurst, B., Wallace, R., & Nixon, S. B. (2013). *The Impact of Social Interaction on Student Learning*. *52*(4).

Iv, D. H. S., Hao, Q., Dennen, V., Tsikerdekis, M., Barnes, B., Martin, L., & Tresham, N. (2020). *Towards Understanding Online Question & Answer Interactions and their effects on student performance in large-scale STEM classes*.

Keengwe, J., & Kidd, T. T. (2010). *Towards Best Practices in Online Learning and Teaching in Higher Education*. *6*(2), 533–541.

Linacre, J. M. (1994). *(1994). Sample size and item calibration stability. Rasch Measurement Transactions*. *7*, 328.

Linacre, John M. (2002). Optimizing Rating Scale Category Effectiveness. *Journal of Applied Measurement*, *3*(1), 85–106.

Liu, E. Z.-F., Cheng, S.-S., & Lin, C. H. (2013). The Effects of Using Online Q&A Discussion Forums with Different Characteristics as a Learning Resource. *The Asia-Pacific Education Researcher*, *22*(4), 667–675. https://doi.org/10.1007/s40299-013-0072-2

Liu, Y. (2019). Using reflections and questioning to engage and challenge online graduate learners in education. *Research and Practice in Technology Enhanced Learning*, *14*(1), 1–10.

McIntyre, L. (1999). The Practical Skeptic, Core Concepts in Sociology. *Mt. View, CA: Mayfield Press*.

Mofreh, S. A. M., Ghafar, M. N., & Omar, A. H. H. (2018). Developing Lecturers' Teaching Practices Instrument. *Journal of Institutional Research South East Asia*, *16*(1), 165–180.

Mofreh, S. A. M., Ghafar, M. N. A., Omar, A. H. H., Mosaku, M., & Ma'ruf, A. (2014).

Psychometric Properties on Lecturers ' Beliefs on Teaching Function : Rasch Model Analysis. *7*(11), 47–55. https://doi.org/10.5539/ies.v7n11p47

Mofreh, S. A. M., Ghafar, M. N., Hamid, D. H. T. A. H., & Mydin, Y. O. (2020). Assessing Model of Teaching Beliefs and Practices: Using Structural Equation Modeling. *Journal of Institutional Research South East Asia*, *18*(1).

Mohajan, H. K. (2017). Two Criteria for Good Measurements in Research : Validity and Reliability. *Annals of Spiru Haret University. Economic Series*, *17*(4), 59–82. https://doi.org/10.26458/1746

Moore, M. G. (1989). Three Types of Interaction. *Taylor & Francis, January 1989*. https://doi.org/10.1080/08923648909526659

Moore, M. G., & Kearsley, G. (2011). *Distance education: A systems view of online learning*. Cengage Learning.

Nor, N. F. M., Razak, N. A., & Aziz, J. (2010). E-learning: Analysis of online discussion forums in promoting knowledge construction through collaborative learning. *WSEAS Transactions on Communications*, *9*(1), 53–62.

Ossiannilsson, E. (2012). *Benchmarking e-learning in higher education : Lessons learned from international projects*. Juvenes Print.

Palloff, R. M., & Pratt, K. (1999). Building Learning Communities in Cyberspace: Effective Strategies for Online Classroom. *Sanfrancisco, CA: Jossey-Bass*.

Pena-Shaff, J. B., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education*, *42*(3), 243–265.

Phirangee, K. (2016). Students ' Perceptions of Learner-Learner Interactions that Weaken a Sense of Community in an Online Learning Environment. *Online Learning*, *20*(4), 13–33.

Säljö, R. (2004). Learning and technologies, people and tools in coordinated activities. *International Journal of Educational Research*, *41*(6), 489–494. https://doi.org/https://doi.org/10.1016/j.ijer.2005.08.013

Shale, D., & Garrison, D. R. (1990). Education at a distance: from Issues to Practice. *Malabar, FL: Robert E. Kriger.*

Shelton, B. E., Hung, J., & Lowenthal, P. R. (2017). Predicting student success by modeling student interaction in asynchronous online courses. *Distance Education*, *7919*, 1–11. https://doi.org/10.1080/01587919.2017.1299562

Shih, H., Chen, S. E., Chen, S., & Wey, S. (2013). The Relationship Among Tertiary Level EFL Students ' Personality, Online Learning Motivation, And Online Learning Satisfaction. *Procedia - Social and Behavioral Sciences*, *103*, 1152–1160. https://doi.org/10.1016/j.sbspro.2013.10.442

Sidek, S., Tasir, Z., & Jumaat, N. F. (2018). Interacting Through Disclosing: Peer Interaction Patterns Based on Self-Disclosure Levels Via Facebook. *Journal of Theoretical and Applied Information Technology*, *96*(11), 3127–3141.

Su, B., Magjuka, R. J., & Lee, S. (2005). The Importance of Interaction in Web-Based Education : A Program-level Case Study of Online MBA Courses. *Journal of Interactive Online Learning*, *4*(1), 1–19.

Tawfik, A. A., Graesser, A., Gatewood, J., & Gishbaugher, J. (2020). Role of questions in inquiry-based instruction: towards a design taxonomy for question-asking and implications for design. *Educational Technology Research and Development*, *68*(2), 653–678. https://doi.org/10.1007/s11423-020-09738-9

Wolfe, E. W., Ray, L. M., & Harris, D. C. (2004). A Rasch Analysis of Three Measures of Teacher Perception Generated From The School and Staffing Survey. *Educational and Psychological Measurements*, *64*(5), 842–860. https://doi.org/10.1177/0013164404263882

Wordu, H., & Chinda, K. (2019). *E-Learning Systems For Remedying Deficiencies In Teaching and Learning In Tertiary Institutions In West Africa*. *7*(2), 1–7.

Wright, B. & Stone, M. (1979). Best test design. *MESA Press: Chicago, IL*.

Wright, B. D., & Masters, G. N. (1982). *Rating scale analysis*. MESA press.

Zhu, E. (1996). Meaning Negotiation, Knowledge Construction, and Mentoring in a Distance Learning Course. *Proceedings of Selected Research and Development Presentations, National Convention of the Association for Educational Communications and Technology, (18th, Indianapolis, 1996)*.