International Journal of Instruction
e-ISSN: 1308-1470 ● www.e-iji.net

October 2023 ● Vol.16, No.4
p-ISSN: 1694-609X
pp. 921-938

Article submission code: 20221119091108

Received: 19/11/2022
Revision: 13/05/2023

Accepted: 03/06/2023
OnlineFirst: 01/09/2023

Conceptions of Learning Physics among University of Mindanao Students: A Validation Study

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The students' conception in learning physics profoundly influences learners' characteristics vis-à-vis learning outcomes. This study examined the validity of the models of conceptions in learning physics based on Tsai's original framework (2004) among randomly selected University of Mindanao students (n=321). Confirmatory factor analysis revealed that the second-order factor structure (Model C) showed an acceptable fit (RMSEA=0.068, CFI=0.93, TLI=0.92) which demonstrated lower information criteria such as AIC, and BIC against other models given with the valid constructs (Raykov rho>0.7). It revealed the composition, and factor correlation (0.72) of 2 domains of conception such as quantitative and qualitative learning aspect with acceptable factor loadings (λ=0.5 to λ=0.98) of its constructs and items. The analysis via generalized partial-credit model through item response theory (IRT) analysis showed that the items could distinguish students' conceptions via item difficulty and discrimination thresholds. Given the valid domains and constructs, this study could provide meaningful insights to improve physics instruction, inform learner characteristics and learning outcomes. It should be noted that teachers should design problem tasks that evoke students' qualitative-quantitative reasoning to produce meaningful attention to learning. Investigation of interplay between students' conceptions, problem-solving ability, motivation, and self-regulation situated in varied environments requires further study.

Keywords: conceptions in learning, physics, university of mindanao, confirmatory factor analysis, item response theory, learning

INTRODUCTION

Delivering scientific literacy in the classroom plays a key role in increasing awareness to technological advancements that led new ways in acquiring knowledge. However, challenges occur when teachers deliver instruction because students consider physics a difficult subject (Fidan & Tuncel, 2019). Educators and researchers investigate learners' prior knowledge and experience, self-efficacy (Bandura, 1997), and learning conceptions (Entwistle and Peterson 2004; Marton et. al., 1993) to determine learner characteristics, and shape teacher instruction to shape student learning. Among the

Citation: Pelobillo, G. (2023). Conceptions of learning physics among university of Mindanao students: A validation study. *International Journal of Instruction*, *16*(4), 921-938. https://doi.org/10.29333/iji.2023.16451a

issues in understanding student performance, the conceptions of learning gained much attention to science education researchers in the elementary to university level. It is noted that conceptions in learning have significant influence, and made a profound contribution to academic self-efficacy. Reason being, students with fully-developed conception could be attributed to learning awareness, and students' adaptation process to different learning tasks. Säljö (1979) pioneered the study on the students' conception of learning (Eklund-Myrskog, 1998; Lee et al., 2008; Tsai et al., 2011) through the analysis of interviews with adults about their actual experience in learning. Hence, the following themes emerged: interpretative process in understanding reality, meaning abstraction, acquisition of facts, memorization, and increase of knowledge. Generally, these five conceptions were the basis as a groundwork to investigate the conceptions in learning as shown in table 1.

Table 1
Conceptions in learning proposed by educators

Säljö (1979)	Marton et al. (1993)	Eklund-Myrskog (1998)	Marshall et al. (1999)
An interpretative process aimed at the understanding of reality	Changing as a person	Forming a conception of one's own	A change as a person
Abstraction of meaning	Seeing something in a different way	Getting a new perspective	Seeing in a new way
Acquisitions of facts, procedures that can be retained and/or utilized in practice	Understanding	Applying knowledge	Making sense of physical concepts and procedures
Memorizing	Applying	Understanding	Applying equations and procedures
Increase of knowledge	Memorizing	Remembering	Memorizing
	Increasing one's knowledge		

The table shows a brief categorization and review which was revealed by notable educators, and could be viewed as the revised versions of Säljö's (1979) conceptions in learning. Several studies have investigated the domains and attributes of conceptions in learning. For example, Asikainen et al. (2013) explained that memorization, applying knowledge, and increase in knowledge constituted the lower level, and understanding, and conceptual change were categorized to higher level. In the context of science, Tsai (2004) employed phenomenography which led to the identification of seven conceptions namely calculating and practicing tutorial problems, memorizing, preparing for tests, increase of knowledge, seeing in a new way, applying, and understanding. With this, researchers conducted validation studies inspired by the findings abovementioned to quantify and examine the conceptions of learning.

The constructs of conceptions in learning have also been classified which indicates a second-order conception. As noted by Tsai (2004), reproductive learning refers to learning conception with memorizing knowledge, and constructive learning refers to connecting learning and seeking comprehensive understanding. Cano (2005) mentioned that the reproductive profile refers to memorization and increasing knowledge, and the constructive profile refers to the other constructs such as understanding, and seeing things in a new way. There are also studies (e.g., Brownlee et al., 2009; Entwistle & Peterson, 2004; Kember, 1997; Samueeowicz & Bain, 2001) that elaborated the transitional aspect as a bridge between the quantitative, and qualitative orientations. For example, Brownlee et al. (2009) mentioned that the transitional aspect refers to students' practical understanding, and making sense and processing information. Entwistle & Peterson (2004) explained that the transition is equated with understanding which involves relating previous experience, and make sense of ideas that can be transformed into personal meaning. Further, Lin et al. (2012) investigated Tsai's (2004) work which showed that the three orientations such as testing, memorizing, and practice and calculating are classified as reproductive or quantitative, and the remaining constructs are classified as constructive or qualitative. Suprapto et al. (2017) explained that there are three conceptions in learning physics that is in line with the findings and framework of Lin et al. (2015). Suprapto et al. (2017) stated that the first conception refers to the promotion of active learning and quality of outcomes that related to understanding and improving physics learning. The second conception refers to calculating and practicing that encompass equations, test patterns, and calculations in solving problems, and lastly, the third conception refers to testing.

Given that several authors presented the constructs in various setting and domains vis-à-vis subject disciplines, it is worth studying to examine the order of categories of the conceptions in learning physics. Moreover, this study is driven by the idea that there are little or no explained validation studies about learning conceptions and its domains in physics at the STEM and university level in the Philippines, most specifically in University of Mindanao (UM). As the institution increasingly provides teacher support, and deliver assessment tools to improve learning and instruction, this validation study adds contribution to the institution to inform learner characteristics, refine authentic assessment tasks, and provide meaningful insights for physics learning outcomes. This study utilized conservative analysis through item-response theory (IRT), and confirmatory factor analysis (CFA). It determined the appropriate and contextualized model of conceptions in learning physics which is guided by the following objectives:

1. Determine the factor correlations in each construct for the conceptions in learning physics
2. Determine the contextualized model that could represent conceptions in learning physics in University of Mindanao using goodness of fit indices, and AIC and BIC values.
3. Illustrate the appropriate model with factor loadings, error variance, and correlation between constructs.
4. Determine the item discrimination, item difficulty, and the item fit in each item

METHOD

This quantitative and survey research utilized multi-dimensional item response theory (MIRT) analysis through generalized partial-credit model (GPCM), and confirmatory factor analysis (CFA) to describe the learners' conceptions in learning physics. It provided explanation of the valid scale of each factor, and determination of appropriate CFA model that could represent students' conceptions in learning physics in University of Mindanao's context.

The participants included a total of 321 students with physics subjects from four departments at the University of Mindanao. Overall, majority of the students (99%) participated in the study. The students' participation was voluntary as specified by the ethics review board. This study was administered to students enrolled in physics-related subjects. Regarding the departments, 71 students come from computing education (22.1%), 105 from science teacher education (32.8%), 83 from engineering education (26%), 58 from STEM senior high school (18%), and 4 from architecture education (1.1%). All participants had voluntarily participated via cluster sampling. To reach the sample participants, the researcher created an online survey via google from which also specified the consent and voluntary participation. Moreover, the researcher consolidated physics-related courses and class list as a way a acquire their email. Also, the survey form was sent in the participants learning management system (LMS). The researcher then started the data collection right after the approval of the research and publication center (RPC), college dean, and vice president for academic affairs. The researcher assured the confidentiality of personal identity as per ethics review board of the University of Mindanao.

The conceptions in science learning were originally developed by Tsai (2004). Its seven categories elicit a hierarchical system (lower to higher level conception) which was described in detail using phenomenographic method by Marton (1993). The components and items are the following: memorizing (items 1, 2, 3, and 4), testing (items 5, 6, 7, and 8), practicing and calculating (items 9, 10, 11, and 12), increase of knowledge (items 13, 14, 15, 16, 17, and 18), applying (items 19, 20, and 21), understanding (items 22, 23, and 24), and seeing in a new way (items 25, 26, 27, and 28). Each items have five-point Likert-scale that ranged from 1 (totally disagree), to 5 (totally agree). All items and constructs have acceptable internal consistency reliability of 0.94 which makes it adequate for this study (Henson, 2001).

There are four hypothesized models in this study as shown in figure 1. These are theoretically built upon on the framework of students' approaches to learning (Marton & Säljö, 1976) wherein the students have deep, and surface approaches to particular tasks. It also relates to the proposed the range of conceptions from reproductive to constructive by Marton et. al. (1993) which then studied and expanded by contemporary researchers. The first model (Figure 1a) refers to the first order CFA structure based on Tsai's (2004) seven constructs on conceptions in learning physics. It served as a basis for the constructive validity, and comparison with the proposed models. Figure 1b shows the second-order model-1 to investigate the latent variables having qualitative and quantitative aspect. With this, the quantitative or reproductive aspect constitutes calculating and practicing tutorial problems, testing, memorizing, increase of knowledge, and the qualitative or constructive aspect constitutes applying, seeing in a new way, and understanding. Figure 1c was based on the findings of Lin et al. (2012) which showed the second hypothesized model (second-order model 2) to examine whether the increase of knowledge, seeing in a new way, application, and understanding constitutes the qualitative or reproductive conception. The testing, memorizing, and practice and calculating were labeled as reproductive or quantitative conception. Figure 1d (second-order model 3) shows the transitional aspect that refers to testing, and practice and calculating. Figure 1d also examines the second-order qualitative (seeing in a new way, application, and understanding), and quantitative (memorizing, and increase of knowledge) aspects.

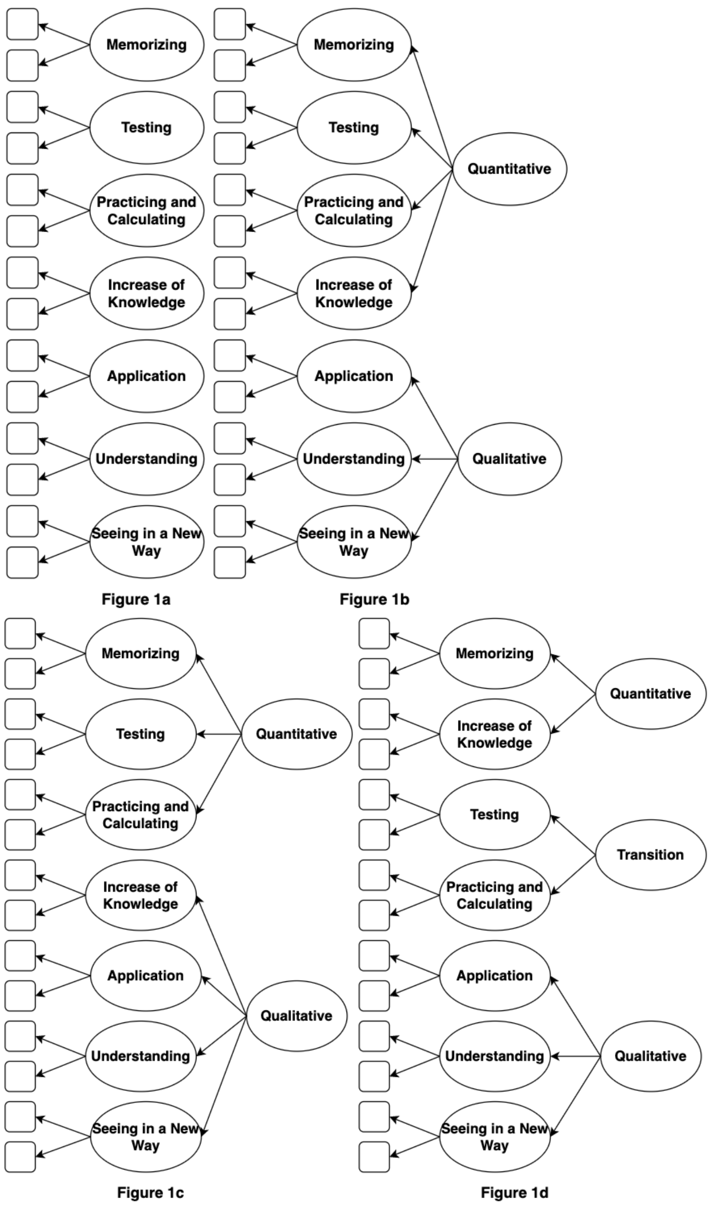

Figure 1
Conceptions in learning physics' hypothesized models

In this research, the application of confirmatory factor analysis (CFA) was used to provide validation and testing of four hypothesized models and its factor structures (Harrell-Williams & Wolfe, 2013). Further, it is also used to investigate the model that could best represent the conceptions in physics learning in UM context.This study used multidimensional item response theory (MIRT) as a response to the limitations of CFA especially in educational assessments. Further, this analysis was used to examine each item in the measurement instrument (Chalmers, 2012; Edwards, 2009). Particularly, this study used graded response model which belongs to the category of polytomous item response theory.

The generalized partial-credit model (Muraki, 1992) was utilized to produce S-X^2 (Pearson X^2 statistic) p-values, root mean square error of approximation (RMSEA) as item fit statistics to investigate the model based on the guidelines of Orlando & Thissen (2003), and Browne and Cudeck (1992). The generalized partial-credit model (GPCM), generated threshold parameters or item difficulty which indicates that the students' conceptions in learning physics in this study represent a latent trait where the average score is zero, denoting greater values mean greater item difficulty. Further, this analysis involved slope parameters or discrimination in each item to measure differential capability (Watanabe et al., 2017).

This analysis made a comparison of CFA parameter estimates to check the if there are offending estimates such as Heywood cases (factor loadings ≤ 0.5), and multicollinearity problem (factor correlations or $\lambda > 0.85$). The construct reliability of the scale was also assessed by calculating the Raykov's rho that determines the distinction of constructs with values 0.7 and above as acceptable. Further, Cronbach's alpha was utilized to examine the scale items' internal consistency. This study used fit indices to check and compare the quality of model assessment such as root mean square residual (SRMR), root mean square error (RMSEA), comparative fit index (CFA), Tucker-Lewis's index (TLI). The recommended acceptable quality of thresholds such as, TLI/CFI ≥ 0.90 (Shi et al., 2019), RMSEA ≤ 0.08, and SRMR $\leq$ 0. 08 (Balog, 2015).

FINDINGS AND DISCUSSION

Factor Correlations

Table 2 shows the significant correlation ($p<0.05$) between the seven constructs of learning conceptions in physics. Correlation analysis showed that memorizing and testing are highly correlated (r=0.92). The three constructs such as seeing in a new way, application, increase of knowledge, and understanding are highly correlated to each other (from r=0.83 to 0.98). It shows that practice and calculating are correlated to other factors ranging from r=0.49 to r=0.82. This analysis provided a basis for initial support for categorizing seven conceptions.

Table 2
Correlation between constructs

Latent Variables	1	2	3	4	5	6
1. Memorize						
2. Testing	0.92					
3. Practice and Calculating	0.66	0.49				
4. Increases of Knowledge	0.65	0.55	0.82			
5. Applying	0.64	0.48	0.78	0.96		
6. Understanding	0.61	0.40	0.75	0.97	0.98	
7. Seeing in a New Way	0.49	0.36	0.63	0.87	0.91	0.83

It shows that testing and memorizing demonstrated high correlation value indicating that students rely on surface approach to learning. It means they tend to concentrate on assessment requirements that focus on comprehension and learning facts to reinforce understanding (Momsen et al., 2010; Hall et al., 2011). Although students engage in higher order thinking skills, learning expectations caused them to rely searching equations to solve the problem task in physics. It should be noted that surface approaches relies on reproducing parts of the content knowledge. With this, the students should highly use deep learning strategies to guarantee engagements with peers and reduce student stress and attrition rate (Momsen et al., 2013). Practice and calculating and increases of knowledge gained high correlation. It highlights the use of calculations and mathematical procedures to increase accuracy in understanding physics concept (Kuo et al., 2020). Reason being, giving problem-solving activities with mathematical calculations may depend on conceptual understanding as a primary warrant for quantitative answer. As a result, practice and calculating gained high correlation with applying and understanding physics concepts. It means that doing calculations may lead to generating concepts for qualitative understanding to the problem solution and increase academic success. This implies that physics teachers should give contextualized questions or exercises to students to increase knowledge and provoke reasoning. High correlation results between understanding, applying, and seeing in a new way shows a qualitative distinction wherein students use multiple strategies to reflect on their learning progress in applying physics problems to real-life context. With its theoretical alignment to students' approaches to learning (Marton & Säljö, 1976), its association represents the students' intention to understand critically the content through integrating concepts or seeing patterns to generate ideas.

Fit Indices

This study utilized lavaan (Rosseel, 2012) package in R for performing confirmatory factor analysis (CFA) having Satorra & Bentler (2001) scaled test statistic, and robust standard errors via maximum likelihood estimation. The quality of the models was screened using fit indices, and AIC and BIC for model comparison. Table 3 shows the summary of the goodness of fit (GOF) for the four hypothesized models such as the original first-order, and three second-order models. The RMSEA values for models A (0.074), B (0.074), and C (0.68) showed an acceptable fit except for model D (0.082). Based on the CFI and TLI values, it shows that model A (CFI=0.88, TLI=0.87) showed a good fit, and model C (CFI=0.93, TLI=0.92) showed a better fit while models B (CFI=0.86, TLI=0.84), and D (CFI=0.85, TLI=0.84) showed underfit values. The Bayesian information criteria (BIC), and Akiake's information criteria (AIC) for Model C showed small values (AIC/BIC=0.982) given the positive variance when compared to other models.

Table 3
Fit Indices and AIC and BIC values

Models	RMSEA	CFI	TLI	AIC	BIC
A-Original 1st order	0.074	0.88	0.87	16087.82	16338.16
B-2nd-order 1	0.074	0.86	0.83	16117.15	16358.52
C-2nd-order 2	0.068	0.93	0.92	15984.66	16275.06
D-2nd-order 3	0.082	0.85	0.84	16102.49	16351.40

It shows that Model A showed a multicollinearity problem given that the factors such as application when correlated with factors seeing in a new way (r=0.9) and understanding (r=0.98), and the correlation between memorizing and testing (r=0.921). It also showed 2 items with Heywood case (factor loadings or $\lambda > 1$) such as item 6 (I learn physics so that I can do well on science-related tests) under testing factor. There is also a multicollinearity problem given the highly correlated factors (r=0.94) between qualitative and quantitative classification for Model B. Further, there were Heywood cases or offending estimates such as the applying (λ=1.011), and understanding (λ=1.0) construct under the qualitative classification. Results revealed that Model D the 2nd order factors such as transition, and qualitative aspect demonstrated high correlations (r=0.95) with quantitative aspect. It has also offended estimates based on the factor loadings (λ) such as application (λ=1.00), under the qualitative aspect. It shows that Model C gained acceptable factor loadings (from λ=0.5 to λ=0.98) for each item and latent variables, acceptable factor correlation value between quantitative and qualitative aspect at 0.72, and acceptable construct reliability (ranging from 0.703 to 0.893) using Raykov's rho (Hair et al., 2010).

Structural Equation Model

The figure 2 shows Lin's et. al. (2012) depiction of the conceptions in learning physics. There is a positive factor correlation (r=0.72) between the qualitative, and quantitative aspect or classification of the conceptions in learning physics. It also showed the sufficient factor loadings of the constructs and items with positive error variance. As a result, both the qualitative and quantitative aspect have extracted sufficient variance from their variables. By inspecting the fit indices, parameter estimates, and model comparison from previous to present study, figure 2 shows satisfactory reliability and validity based from the results.

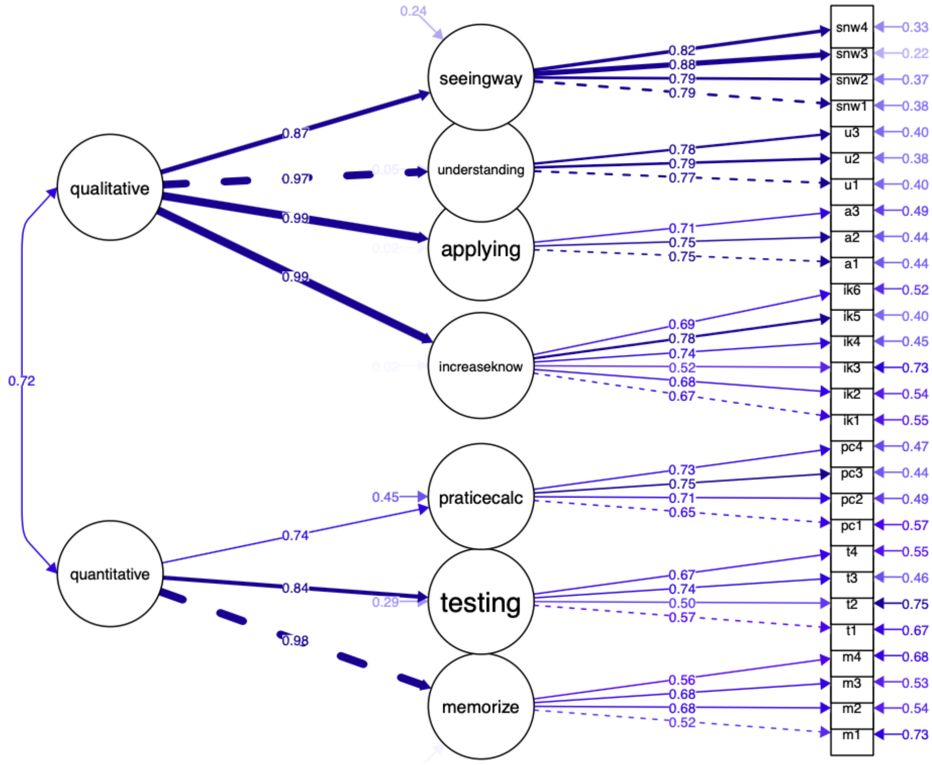

Figure 2
Model C-second order CFA structure

The quantitative or reproductive conceptions in learning includes memorizing, testing, and practice and calculating. It means learning through rote memorization or rehearsal (Tsai, 2004; Lee, 2008), and familiarization of scientific concepts and symbols, doing well on physics tests, and knowing formulae in problem-solving (Lee, 2008). It is found to be present among students especially to those who regard learning as reproductive, and remembering (Dart et al., 2000) and possess surface learning strategies (Ferla et al., 2008). In context, this could be attributed to the parent's influence (Li et al., 2018), examination that is oriented to school culture (Hong & Peng, 2008; Tsai & Kuo, 2008) through the use of multiple-choice, and module-oriented activities which then reflects to school's physics assessment. It also means that the students value school, and high-stakes examinations that give important roles in performance evaluation. Hence, students with high scores on testing tend to use more surface motive and strategy (Lee, 2008) as a means to learn science in general. However, it relates to the traditional assessment thereby giving them limited opportunities to novel assessment tasks, and limiting their opportunities to develop their learning conceptions. Lee (2008), and Tsai (2004) mentioned that practice and calculating also demonstrated deep learning which makes a mixed patterns of quantitative and qualitative to achieve success. In this study, it was found that the students gained much attention to practice and calculating under the quantitative aspect of conceptions in learning. It shows that students learn physics through the process of familiarizing with algorithmic procedures with the fear of failure in physics exams.

The constructs of conceptions in learning physics such understanding, increase of knowledge, applying, and seeing in a new way refer to the qualitative or constructive and high-level aspect. It means learning acquisition of knowledge about a natural phenomenon to a newly acquired contextualized knowledge (Lee et al., 2008) wherein learners with higher level conceptions further develop their reasoning, and epistemological beliefs. Further, they are capable of using self-regulated learning, metacognitive, and deep learning strategies (Zheng, 2018) as they hold constructivist conceptions in learning in the facilitative constructive environment (Tynjala, 1997). It shows that the UM students viewed physics learning as a careful collection on scientific ideas to generate emphasis on correct knowledge that is new to their experience. This means that the increase of knowledge was found in the constructive classification (Cano and Cardelle-Elawar 2004; Cano 2005; Marton et. al., 1993). Consequently, the students have shown the ability to explore scientific questions to practical situations as they use deep motives in learning. It should be noted that applying knowledge could also indicate extrinsic aims for qualifying science-related careers or as a means to utilize learning to get higher scores. Students have also highlighted their ability to understand and construct knowledge to make sense of the natural phenomena. Meaning, physics students who view learning as a means to understand the concepts could further achieve constructive forms of learning, self-efficacy (Suprapto, 2017), and reflective thinking.

Item Discrimination, Difficulty, and Fit

This model underwent MIRT analysis. Reason being, the analysis assumes that persons may have behavior differences in selecting a response based on the Likert-scale that can provide item difficulty measures, discrimination parameters and item-fit. The survey items correspond to the students' learning conceptions in physics wherein its optimized scale could be uniformly ordered. The context of this IRT analysis is based on generalized partial-credit model (GPCM),. With this, items could differ in discrimination to show the fixed category boundaries over time, and changes in the item location (Ostini & Nering, 2006). The student's response to the conceptions in learning physics relies on their response expectation. In table 4, GPCM shows the estimation parameters such as the slope (item difficulty), and threshold (item discrimination), and item fit, and RMSEA in each item.

Table 4
Item difficulty, discrimination, and fit

Latent Constructs and Items	Slope	Threshold				Item-fit		
		b1	b2	b3	b4	S-X^2	p-val.	RMSEA
Memorizing								
Item 1	1.21	5.10	3.25	0.80	-1.87	70.139	0.002	0.045
Item 2	1.96	6.04	4.28	1.11	-1.77	61.576	0.012	0.032
Item 2	1.96	6.04	4.28	1.11	-1.77	61.576	0.012	0.032
Item 3	1.95	4.75	1.69	-1.39		86.110	0.000	0.052
Item 4	1.54	4.32	2.64	0.16	-2.25	124.642	0.000	0.052
Testing								
Item 5	1.62	3.89	1.78	-0.64	-3.09	144.393	0.000	0.060
Item 6	1.00	6.25	4.12	1.20	-1.17	71.303	0.000	0.046
Item 7	2.43	5.99	3.58	0.53	-2.73	89.966	0.000	0.032
Item 8	2.00	7.61	4.20	0.90	-2.69	77.908	0.000	0.052
Practice and Calculating								
Item 9	1.61	6.42	5.40	2.24	-0.61	59.986	0.007	0.061
Item 10	2.51	7.53	3.47	-0.62		67.535	0.000	0.059
Item 11	2.27	6.05	2.84	-0.64		60.684	0.006	0.048
Item 12	2.29	6.77	3.44	-0.23		59.514	0.000	0.057
Increases of Knowledge								
Item 13	2.12	7.00	2.84	-0.93		56.080	0.000	0.067
Item 14	2.22	7.75	7.04	3.41	-0.42	44.246	0.005	0.067
Item 15	1.27	5.42	4.41	1.68	-0.78	61.427	0.002	0.047
Item 16	2.37	5.89	2.55	-0.88		88.674	0.000	0.076
Item 17	2.90	7.44	3.19	-1.05		60.698	0.000	0.065
Item 18	2.32	6.80	3.72	0.62		73.781	0.000	0.071
Application								
Item 19	2.74	6.86	2.94	-1.26		97.861	0.000	0.069
Item 20	2.79	8.94	7.68	3.89	-0.77	74.546	0.000	0.074
Item 21	2.35	5.54	2.77	-0.31		73.293	0.001	0.068
Understan-ding								
Item 22	3.10	9.59	7.88	3.64	-1.03	97.606	0.000	0.076
Item 23	3.72	9.46	5.10	0.00		80.368	0.000	0.072
Item 24	2.78	7.27	3.64	-0.38		57.402	0.000	0.062
Seeing in a New Way								
Item 25	3.26	7.88	3.64	-0.77		57.656	0.001	0.056
Item 26	2.80	8.71	6.36	3.21	-0.88	69.112	0.000	0.060
Item 27	4.90	11.96	4.80	-0.50		73.400	0.000	0.065
Item 28	3.68	8.02	3.97	-0.18		141.601	0.000	0.078

The discrimination estimates ranged from 1.0 to 4.90 which indicates that the items have distinguished between students with high or low conceptions in learning physics because of their positive values. The item difficulty ranged from -1.93 to 11.96 which accounts for four estimated thresholds. For example, in item 20 (Learning physics means learning how to apply knowledge and skills I know to unknown problems), its first threshold ($b1=8.94$) corresponds to the probability of affirming the first response category in a Likert scale. The higher value ($b2=7.68$) corresponds to the probability of endorsing the 2nd, and 3rd response category in the scale. It predicted the person ability and established a relationship between the performance and person trait in every item. The results have

It is shown that all items have higher S-X^2 (Pearson X^2 statistic), and lower RMSEA. Moreover, the factors such as memorizing ($r=0.78$), testing ($r=0.81$), practicing and calculating ($r=0.74$), increases of knowledge ($r=0.8$), applying ($r=0.70$), understanding ($r=0.7$), and seeing in a new way ($r=0.8$) have a strong reliability value. The measurement system of conceptions in learning physics is acceptable and able to identify between students with low and high conceptions in learning physics.

Based from the overall results, the use of conceptions in learning vis-à-vis the students' physics performance to varied contextualized problems could give light in refining teacher instruction as a way to balance their reproductive and constructive learning. It serves as a meaningful information to teachers when it comes to student assessment, and improving their instructional practices in laboratory activities, and for students to gain awareness when it comes to learning physics. With this, teachers should design problem tasks that evoke the students' conceptual argument (qualitative reasoning) vis-à-vis calculations (quantitative reasoning) as it offers precision in generating solutions to physics problems (Kuo et al., 2020), and engage students with problem-based instruction to produce meaningful evidence to students' conception and attention to learning.

CONCLUSION

This study is aligned to Lin's et. al. (2012) 2-order factor model on conception of learning physics, and the theoretical framework of students' approaches to learning (Marton & Säljö, 1976). It provided correlations between factors which served as the basis for confirmatory factor analysis. The appropriate second-order model with fit indices in context showed two dimensions that represents their learning which could also depend with teacher's instruction and assessment culture in University of Mindanao. Further, this study proceeded to generation of item-fit parameters under item-response theory (IRT) which revealed the model could identify between students with high and low conceptions in learning. The use of IRT ensures item-level performance based on discrimination and difficulty values to provide teachers with valuable insights to student's conceptions vis-à-vis improvement of instruction (Pelobillo, 2022) to balance between reproductive and constructive learning.

This study is limited to the conceptions in learning physics among UM students with physics courses. With this, there is a need for group comparison of learning conceptions relating to physics classroom culture to provide more insightful findings. As such, it could give department-specific actions in improving physics instruction and assessment of student outcomes. Moreover, the investigation on the interplay between students' conceptions, problem-solving ability, motivation, and self-regulation situated in varied environments requires further study.

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