Why do pre-clinical medical students learn ultrasound? Exploring learning motivation through ERG theory

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Abstract

Background

Point-of-care ultrasound (POCUS) has become a hot issue and trend in medical education in recent years. Ultrasound is an indispensable skill for clinical physicians. Previous studies have already discussed the importance of and advancements in ultrasound education. However, learning motivations with regard to ultrasound education have seldom been discussed in the literature. For medical students, learning ultrasound could have a strong connection with their future career. ERG theory extended Maslow's hierarchy of needs through the concepts of existence, relatedness, and growth. The theory has been widely used in the workplace to analyze employee job performance but has not been applied in medical education. As mentioned above, we seek to analyze pre-clinical medical students' learning motivation toward ultrasound education with regard to their future careers by applying ERG theory.

Method

This mixed method design used questionnaires for data collection. We also produced further qualitative and quantitative results. The research team asked learners neutral and open-ended questions. After data collection, three steps for analysis were followed based on grounded theory. Finally, the results of the thematic coding were used to complete the quantitative analysis.

Results

Our study involved 140 pre-clinical medical students, and their responses fell into 13 categories. Our test showed that students' motivations toward ultrasound learning were unbalanced across the three ERG domains ($F = 41.257$, $p < .001$). Pairwise comparisons showed that students mentioned existence motivation (MD = 39.3%; $p < .001$) and growth motivation (MD = 40.7%; $p < .001$) more than relatedness motivation. However, there was no significant difference between existence motivation and growth motivation (MD = -1.4%; $p = .830$).

Conclusion

Based on our survey, first, we found that students placed a high value on existence and growth needs rather than relatedness. In addition, we recommend that ERG theory be applied in medical education motivation analysis.

Background

Point-of-care ultrasound (POCUS) has become a hot issue in recent years. Its use has become widespread in clinical practice. Ultrasound is non-ionizing and requires inexpensive equipment. As technology has

advanced, it has become more compact and its quality has improved. Compared to traditional ultrasound, POCUS emphasizes portability. POCUS helps clinicians to make a correct diagnosis and interpret imaging findings immediately at any time and any place. For this reason, it has been called the visual stethoscope of the 21st century.[1] Because POCUS has become a trend of the future, it is an indispensable skill for clinical physicians. Previous literature has already discussed the importance of and advancements in ultrasound education for medical students.[2] However, previous studies mainly focus on the learning results obtained through the design of different learning courses.[3] There are many other factors that also affect learning results, including learning motivation, but this factor is rarely addressed in the literature.

Motivation is defined as the organized pattern of the goals, beliefs, and emotions that a person is striving for[4]. In general, discussions of motivation rely on needs-hierarchy theory or the Motivated Strategies for Learning Questionnaire (MSLQ). [5, 6] In the medical education domain, Lars Knudsen analyzed medical students' learning motivation toward learning ultrasound imaging using the Situational Motivation Scale (SMS)[7]. All of the learning motivation analysis approaches mentioned above are applicable to the general population. However, ultrasound is a tool and skill that is closely connected to medical students' future careers. Medical students are very likely to have a specific purpose for learning ultrasound due to considerations related to their future work. Hence, we sought to use a learning motivation theory targeting the career and job domains. ERG theory is a motivation analysis theory commonly applied to the study of human motivation in the workplace.[8]

ERG theory was first proposed by Clayton P. Alderfer in 1969.[9] This theory revised Maslow's hierarchy of needs into 3 categories: existence, relatedness, and growth. Existence refers to concerns about the basics of life. Relatedness is connected to interpersonal needs for mutual trust and respect. Growth is related to achieving self-value through creativity, productivity, or one's contributions to the world. ERG theory is mainly applied to career motivation. Although ERG theory has seldom been used in the medical education domain, it has already been widely used in the workplace to analyze employee job performance.[8, 10, 11] As mentioned above, we seek to analyze pre-clinical medical students' learning motivation toward ultrasound education using ERG theory, which is a specific analysis tool for career-related learning motivation.

Method

This mixed method study used questionnaires for data collection b and the initial qualitative analysis before pre-clinical medical students started the voluntary sonoanatomy course in Taipei Medical University. After data analysis, we also made produced quantitative results. We do not expect a certain framework to emerge from the responses to the questions about learning motivations, thus avoiding the bias that may arise from the subjective tendency and opinion of the researchers. Therefore, the research team asked learners neutral and open-ended questions. Two primary questions were used: "Why do you want to learn ultrasound?" and "What do you expect from the ultrasound course?" In addition, our questionnaires were administered online to prevent face-to-face pressure between teachers and pre-

clinical medical students who learned basic medical knowledge such as anatomy and pathology in class. We distributed 140 questionnaires and received 140 valid questionnaires back. Thirty-eight questionnaires with incomplete responses (for example: “interesting” and “want to learn”) were identified. After data collection, three steps for analysis were followed based on grounded theory.

The first step: the researchers performed an initial simple classification of learning motivations and judged them without a framework.

The second step: the researchers held a consensus meeting for thematic coding based on ERG theory and the analysis performed in the first step.

The third step: The evaluators finished the thematic coding of learning motivations.

Finally, the results of the thematic coding were used to complete the quantitative analysis. The three analyzers were a clinical teacher (emergency physician for 10 years subspecializing in emergency ultrasound and medication education), a medical educator (educational faculty member for 7 years subspecializing in evidence-based medicine and medical education), and a senior learner (third-year emergency medicine resident).

Data Analysis

The inter-rater reliability was .910, and agreement among pairs ranged from .879 to .958. After we completed the thematic coding, we applied quantitative analysis by calculating the descriptive statistics and using the chi-square test, t-test, and multivariate analysis. Descriptive statistics included counts of background information and motivation categories. Chi-square tests were used to analyze differences in ultrasound learning experience (yes / no) and sex in each motivation domain (yes / no). The t-test was used to explore the differences in ultrasound learning experience (yes / no) and sex in the sum of the motivation categories in each domain. Multivariate analysis was used to compare the sum of the motivation domains and the sum of the motivation categories in each domain. For these continuous analyses, we calculated the mean difference (MD). These analyses were completed in Statistical Product and Service Solutions version 19 for Microsoft Windows. We used eta-square to show the effect size of the multivariate analysis and set a common threshold, p-value < 0.05, to judge the statistical significance level. We also reported the 95% confidence interval [12] to indicate the estimated range.

Results

Our study involved 140 pre-clinical medical students, of whom 78 were male and 62 were female. A total of 19 students had participated in ultrasound learning before our survey. All of them completed the open-ended online survey. Based on their responses, our qualitative analysis identified 13 categories within three motivational domains (Table 1). The existence domain encompassed four categories: (E1) Future work requirement; (E2) Want to pass the current course (non-specific); (E3) Want to pass the current course (knowledge); and (E4) Want to pass the current course (skill). The category “future work

requirement” was the most frequently mentioned motivation for learning ultrasound in the existence domain. The relatedness domain encompassed only two categories: (R1) Teacher-student relationship and (R2) Not teacher-student relationship. Regarding the growth domain, students’ responses reflected seven categories: (G1) To be a good doctor in the future; (G2) Just want to learn (non-specific); (G3) Just want to learn (interesting); (G4) Just want to learn (diverse); (G5) Just want to learn (improve my current clinical learning); (G6) Just want to learn (improve my own diagnostic knowledge); and (G7) Just want to learn (improve my own diagnostic skills). We did not find any sex difference or ultrasound learning experience difference in the three domains or in the 13 categories (Table 2 and Table 3).

Table 1
Characteristics and learning experience on learning motivation domain

	Ultrasound learning experience	
Item	No [a]	Yes [b]
Sex		
Male	69	9
Female	52	10
Existence		
E1. Future work requirement	68	14
E2. Want to pass current course (non-specific)	2	1
E3. Want to pass current course (knowledge)	13	3
E4. Want to pass current course (skill)	1	0
Number of students mentioning any motivation about existence	76	15
Relatedness		
R1. Teacher-student	27	5
R2. Not teacher-student	3	1
Number of students mentioning any motivation about relatedness	30	6
Growth		
G1. To be a good doctor in future	10	1
G2. Just want to learn (non-specific)	21	1
G3. Just want to learn (interesting)	17	1
G4. Just want to learn (diverse)	2	2
G5. Just want to learn (improve my current clinical learning)	9	0
G6. Just want to learn (improve my own diagnostic knowledge)	21	3
G7. Just want to learn (improve my own diagnostic skill)	28	5
Number of students mentioning any motivation about growth	84	9

a. n = 121; b. n = 19.

Table 2
Sex and learning experience on learning motivation domain

	Sex		**Chi-**		**Ultrasound learning experience**		**Chi-**	
Item	Male [a]	Female [b]	square	*p*	No [c]	Yes [d]	square	*p*
Sex							0.621	.431
Male	-	-	-	-	69	9		
Female	-	-			52	10		
Existence			1.742	.187			1.88	.170
No mentioned	31	18			45	4		
Mentioned	47	44			76	15		
Relatedness			0.135	.714			0.396	.529
No mentioned	57	47			91	13		
Mentioned	21	15			30	6		
Growth			0.004	.947			3.581	.058
No mentioned	26	21			37	10		
Mentioned	52	41			84	9		

a. n = 78; b. n = 62; c. n = 121; d. n = 19.

Table 3
Sex and learning experience difference in number of components within students' description

Domain and					***95%***	***CI***
population	M	*SD*	*MD*	*t*	*lower*	*upper*
Existence by sex			-0.198	-1.924	-0.401	0.006
Male [a]	.6410	.58051				
Female [b]	.8387	.63229				
Existence by learning experience			0.253	1.694	-0.424	0.549
Novice [c]	.6942	.60337				
Experienced [d]	.9474	.62126				
Relatedness by sex			0.027	0.365	-0.121	0.175
Male [a]	.2692	.44643				
Female [b]	.2419	.43175				
Relatedness by learning experience			0.068	0.626	-0.147	0.282
Novice [c]	.2479	.43361				
Experienced [d]	.3158	.47757				
Growth by sex			-0.099	-0.727	-0.368	0.170
Male [a]	.8205	.67888				
Female [b]	.9194	.92857				
Growth by learning experience			-0.208	-1.059	-0.597	0.181
Novice [c]	.8926	.79374				
Experienced [d]	.6842	.82007				
Overall by sex			-0.269	-1.778	-0.569	0.030
Male [a]	1.7308	.83235				
Female [b]	2.0000	.95814				
Overall by learning experience			0.113	0.508	-0.326	0.551

a. n = 78; b. n = 62; c. n = 121; d. n = 19. M, mean; MD, mean difference; SD, standard deviation.

Domain and				95%	CI
Novice [c]	1.8347	.90689			
Experienced [d]	1.9474	.84811			
a. n = 78; b. n = 62; c. n = 121; d. n = 19. M, mean; MD, mean difference; SD, standard deviation.					

Comparison of the three domains

Overall, 91 (65%), 36 (25.71%), and 93 (66.43%) students mentioned existence motivation, relatedness motivation, and growth motivation for learning ultrasound (Table 4). Our test showed that students' motivations for ultrasound learning were unbalanced ($F = 41.257$, $p < .001$). Pairwise comparisons showed that they mentioned existence motivation (MD = 39.3%; 95% CI, 29.5–49.0%; $p < .001$) and growth motivation (MD = 40.7%; 95% CI, 28.5–52.9%; $p < .001$) more than relatedness motivation. However, there was no significant difference between existence motivation and growth motivation (MD = -1.4%; 95% CI, -14.6–11.7%; $p = .830$).

Table 4
Pairwise comparison of motivations

		95% CI				**Eta-**
Comparisons	MD	*Lower*	*Upper*	*F*	*p*	square
Multivariate tests (overall)				41.257	< .001	.374 [a]
Existence vs Relatedness	0.393***	0.295	0.490			
Existence vs Growth	-0.014	-0.146	0.117			
Relatedness vs Growth	-0.407***	-0.529	-0.285			
Multivariate tests (existence)				69.996	< .001	.605 [a]
E1 vs E2	.471***	.372	.571			
E1 vs E3	.564***	.476	.652			
E1 vs E4	.579***	.496	.661			
E2 vs E3	.093**	.033	.153			
E2 vs E4	.107***	.055	.159			
E3 vs E4	.014	− .014	.043			
Multivariate tests (relatedness)				25.605	< .001	.156
R1 vs R2	.200***	.122	.278			
Multivariate tests (growth)				9.540	< .001	.299
G1 vs G2	− .079	− .154	− .003			
G1 vs G3	− .050	− .126	.026			
G1 vs G4	.050	− .004	.104			
G1 vs G5	.014	− .046	.074			
G1 vs G6	− .093	− .170	− .015			
G1 vs G7	− .157	− .238	− .076			
G2 vs G3	.029	− .056	.113			
G2 vs G4	.129	.066	.191			
G2 vs G5	.093	.018	.168			
G2 vs G6	− .014	− .108	.080			

[+] $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$; CI, confidence interval; MD, mean difference.

		95% CI		Eta-
G2 vs G7	− .079	− .181	.024	
G3 vs G4	.100	.039	.161	
G3 vs G5	.064	− .009	.137	
G3 vs G6	− .043	− .130	.044	
G3 vs G7	− .107	− .207	− .008	
G4 vs G5	− .036	− .086	.015	
G4 vs G6	− .143	− .214	− .072	
G4 vs G7	− .207	− .286	− .128	
G5 vs G6	− .107	− .176	− .039	
G5 vs G7	− .171	− .254	− .089	
G6 vs G7	− .064	− .147	.019	

[+] $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$; CI, confidence interval; MD, mean difference.

Further comparison of the categories in each motivation domain

In addition, we analyzed the submotivations in each domain (Table 4). Regarding the existence domain, (E1) Future work requirement as a motivation for ultrasound learning was mentioned more frequently than (E2) Want to pass the current course (non-specific) (MD = 47.1%; 95% CI, 37.2–57.1%; $p < .001$), (E3) Want to pass the current course (knowledge) (MD = 56.4%; 95% CI, 47.6–65.2%; $p < .001$), and (E4) Want to pass the current course (skill) (MD = 57.9%; 95% CI, 49.6–66.1%; $p < .001$). Moreover, (E4) Want to pass the current course (skill) was mentioned less than (E2) Want to pass the current course (non-specific) (MD = -10.7%; 95% CI, -15.9% to -5.5%; $p < .001$) and (E3) Want to pass the current course (knowledge) (MD = -1.4%; 95% CI, -4.3–1.4%; $p = .319$). Regarding the relatedness domain, (R1) Teacher-student relationship was mentioned more frequently than (R2) Not teacher-student relationship (MD = 20.0%; 95% CI, 12.2–27.8%; $p < .001$).

In the growth domain, we compared the seven submotivations, and (G7) Just want to learn (improve my own diagnostic skills) was more frequently mentioned than (G1) To be a good doctor in the future (MD = 15.7%; 95% CI, 7.6–23.8%; $p < .001$), (G2) Just want to learn (non-specific) (MD = 7.9%; 95% CI, -2.4–18.1%; $p = .131$), (G3) Just want to learn (interesting) (MD = 10.7%; 95% CI, 0.8–20.7%; $p = .035$), (G4) Just want to learn (diverse) (MD = 20.7%; 95% CI, 12.8–28.6%; $p < .001$), (G5) Just want to learn (improve my current clinical learning) (MD = 17.1%; 95% CI, 8.9–25.4%; $p < .001$), and (G6) Just want to learn (improve my own diagnostic knowledge) (MD = 6.4%; 95% CI, -1.9–14.7%; $p = .129$).

Discussion

Most previous studies focused only on the students' feedback after curriculum implementation to understand the effects of different curriculum designs. Most of the studies indicated that motivation increased after curriculum implementation but seldom mentioned students' motivation before participating in the curriculum.[13–15] This is the first article providing a detailed exploration of students' motivation before engaging with the curriculum to understand why students want to learn ultrasound. In our study, we found that existence needs and growth needs were more significant than relatedness needs with respect to students' motivation to learn ultrasound. It makes sense that students learned this technique not for others but for themselves because ultrasound knowledge is closely connected to their future careers as doctors. In the existence needs subgroup analysis, we found that most students mentioned the words "future" and "clinical". In particular, the categories (E1) Future work requirement and (G7) Just want to learn (improve diagnostic skills) dominated, even though ultrasound training is not required for medical undergraduates today.

None of the students in our study had started their clerkship or internship, and they had little previous experience with ultrasound. However, they showed great interest in learning because they anticipated future applications of ultrasound. This interest suggests that students are already aware of the increasing importance of ultrasound applications, which has become a hot issue in recent years. With respect to growth needs, learning ultrasound performance skills has great importance for students. Unlike X-ray and computed tomography (CT) examinations, ultrasound is an operator-dependent examination. The operator's experience and execution technique determine the quality of an ultrasound examination. Ultrasound performance skills have great importance in ultrasound education and are also affected by learning motivation, which is why previous studies on ultrasound education mainly focus on performance.[3, 13–15] Unfortunately, the learning motivations for learning ultrasound were not well established.

In performing further motivation analysis, we found some results that we did not expect. The first finding was that relatedness needs were less salient than existence needs and growth needs. We expected that relatedness needs would be as important as the other types of needs. Confucianism has a far-reaching influence on Chinese culture. Interpersonal relationships are very important and affect learning motivation in Chinese people[16]. To our surprise, the research did not reflect this, possibly because of students' awareness that ultrasound skills would be essential in the future. In other words, it is not that relatedness needs in Chinese culture have decreased but that the widespread nature of ultrasound clinical applications has increased existence and growth needs. Students' learning motivation is thus less affected by interpersonal factors. This explains why more medical students were motivated by existence needs and self-growth needs to attend sonoanatomy courses rather than by relatedness needs.

When pre-clinical medical students realize that ultrasound skills are an important competency for becoming a well-prepared physician in the future, they establish concrete learning objectives and plans to motivate their self-directed learning of ultrasound skills. [17].

The second finding was that relatedness needs did not differ between the genders. We initially assumed that gender would be one of the factors affecting the motivation of medical students to learn ultrasound, as traditional gender role stereotypes dictate that males are interested in mathematics, science and rationality, whereas girls have more interest in language arts and writing[18]. Thus, gender may also affect learning motivation. However, our research revealed that there were no gender differences with respect to the relatedness motivation to learn sonoanatomy. This result may be explained by Bandura's Triadic Theory of Learning. Human learning is affected by environmental factors, personal factors, and behavioral factors rather than by a single intrinsic tendency and is influenced by a person's surroundings[19]. Therefore, natural gender orientation is not sufficient to influence the motivation of medical students to learn ultrasound. It seems that the results strengthen the environmental explanation (the increasing trend in ultrasound applications in clinical practice) mentioned above. Ultrasound is an indispensable skill in students' future careers. Therefore, pre-clinical medical students attended the sonoanatomy course to fulfil existence needs and growth needs rather than relatedness needs.

There are several learning theories related to adult learning.[20] Focusing on learning motivation, these contemporary theories in medical education include the expectancy-value[21], attribution[22], social-cognitive[23], goal orientation[4, 24], and self-determination[25] theories. These are not suitable for the analysis of qualitative data from learners. Compared to traditional theories, ERG theory can be applied to extract more qualitative data from learners' responses.

Because of the use of different training models and differences in the needs and perspectives of medical undergraduates, we introduce ERG theory to explore pre-clinical medical students' motivation to learn clinical skills. Our analysis revealed that pre-clinical medical students are focused on existence and growth needs. Thus, we should emphasize meeting students' needs when developing a new course or curriculum. In addition, it is not only necessary to motivate students but also to offer future-oriented teaching that is effective and efficient. This qualitative analytic study without a framework confirms that ERG theory can be applied to explore learning motivation for professional development. The ERG theory may also be adapted to analyze learners' motivation in other healthcare professions.

Our research had some limitations. First, it was an open-ended online questionnaire; thus, some replies were ambiguous and we could not ascertain their true meaning. Thus, we had to interpret some responses, and our interpretation may not have necessarily represented the respondents' actual thoughts. Second, our study was conducted in single school and in a single culture. The diversity of our sample was insufficient. Medical students' motivation to learn sonoanatomy may differ by school, region or culture. Third, this research cannot expand on the background differences of individual medical students. These differences may have affected learning motivation.

Conclusion

We suggested that ERG could be applied in medical education motivation analysis, which had not been attempted in any previous study. ERG theory can also be applied to explore the meaning behind students'

motivation. Our analysis revealed several meaningful findings. In the framework, first, we found that students placed a very high value on existence needs and growth needs but not on relatedness needs. Second, in our subgroup analysis, no gender difference was noted with respect to relatedness.

Based on our survey, we have two recommendations. First, we suggest applying ERG theory in the context of medical student and medical personnel education to analyze students' skill-learning motivation in the future. Second, ultrasound is an operator-dependent skill. The operator's experience and technique determine the quality of an ultrasound examination. We suggest that future curriculum designs incorporate increased hands-on operation time or self-directed learning time to improve students' learning outcomes.

Abbreviations

POCUS: Point of Care Ultrasound; ERG: Existence, Relatedness, Growth; MSLQ: Motivated Strategies for Learning Questionnaire; SMS: Situational Motivation Scale; MD: Mean Difference; CT: Computed Tomography.

Declarations

Ethics approval and consent to participate: The study was approved by Taipei Medical University Institutional Review Board for Human Experimentation.

The number of IRB was TMU-JIRB N201909012

The need for verbal informed consent was mentioned by the IRB.

Before the start of the course, the course outline and content were explained to the participants. These courses were voluntary and in order to understand the effect of the course, the questionnaire and results of the course will be analyzed. Therefore, the informed consent will be obtained verbally. Besides, the purpose of this research is to study learning motivation and effectiveness and will not harm the participants or affect their scores of the participants.

Consent for publication: Not applicable.

Availability of data and materials: All data generated or analyzed during this study are included in this article.

Competing Interest: The authors declare no competing financial interest.

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Author contributions: TCW, WTC, YNK, WCH contributed to the design of the study, collection and analysis of data and drafting the manuscript. CWL, FMS, CYC, HYC, THF participated in the critical review of the manuscript, and contributed analysis tools, and made substantial contributions to interpretation of data. All authors read and approved the final manuscript.

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