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COMPARING THE EFFECT OF SIMULATION BASED LEARNING VERSUS ON - SCENE LEARNING IN SELF-EFFICACY ON MARINE CADETS

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ABSTRACT

Training cadets on maritime colleges is different from one college to another. This research aims to explore the relationship between Self Efficacy and performance of cadets using R.A.D.A.R upon different types of learning of On-Scene, Simulator and both of them. The study had been conducted using a quasi-experimental design. Results show that there is a significant effect of Self Efficacy on performance of cadets using R.A.D.A.R in the presence of the three modules mentioned. Also, it was found that the effect of Self efficacy is the highest in case of receiving both courses of On-scene and simulator. In addition, it was found that GPA shows an insignificant effect on R.A.D.A.R scores in the presence of Self Efficacy. Besides, R^2 was found to be relatively small, which means that there may be other dimensions that may significantly impact R.A.D.A.R scores and explains the percentage of unexplained variation found.

KEYWORDS: Simulation Based Learning, on - Scene Learning, Self-Efficacy, International Convention on Standers of Training, Certification and Watch Keeping for Seafarers

INTRODUCTION

Shipping is perhaps the most international of the entire world’s great industries and some of the most dangerous. Safety of life at sea and the marine environment as well as over 80% of the world’s trade depends on the professionalism and competence of seafarers. It has been reported that the over 80% of accident and incidents are due to human error IMO (Ziarati, 2006).

Demand for efficient and high quality training of maritime personnel will continue to increase over the next decade. Key applications for simulation, such as training, decision support, procedure and mission planning will continue to be paramount for industry and will increase competency of seafarers. Real life training using real equipment presents a number of challenges. Increased risk to personnel and equipment combined with limited access to required marine assets and related escalating costs is creating increased demand for simulation technology.

Simulation under highly realistic circumstances presents a safer and more cost-efficient training alternative. Simulation has already proven its effectiveness and is, without doubt, the future of maritime training. Due to the almost unlimited possibilities provided by simulation, better results can be achieved in a safer, more efficient manner, which in turn produces higher quality personnel.

Maritime education is a cornerstone in the development of future maritime cadets. The ultimate goal of maritime education is to educate cadets to think and act like professional maritime officers (O’Connor, 2006). This goal can be achieved through enabling the cadet to apply theoretical learning to real situation, through the use of critical thinking skills, to recognize and resolve problems. The use of the maritime process is to design maritime interventions and evaluate their effectiveness, as well as demonstrating skills in the safe use of maritime interventions in using R.A.D.A.R. and Advanced Research Projects Agency ARPA (Wolf, 2009).

International Conventions on *Standards of Training* (STCW) discusses the simulators under the three important headings;

- Training and assessment.
- Use of simulator.
- Minimum standards of competencies.

As STCW95 mentions possibility of using simulators as a tool during the discussion on Training and Assessment of seafarers, this regulation demands all parties to ensure that it is in accordance with STCW Code A and all instructors and assessors are appropriately qualified and competent to carry out their task. On the other hand, Regulation-I/12-Use of simulators implies that legality should cover the performance standards of marine simulators being used for the training and assessment of seafarers and their certification in compliance with STCW. In addition, Section B-I/12-Guidance regarding use of simulators claims that STCW has made only the R.A.D.A.R./ARPA simulator training mandatory for the seafarers.

This balance between real ship and simulator itself puts heavy responsibilities on the simulator instructor to ensure that simulator based training is designed and conducted in such a manner that it gives real time experiences to the trainees. Simulator training is required to put the trainee in almost the same working environment, mental scenarios and physical stress as onboard the real ship. Self-efficacy can be described as a persons' belief in their ability to perform in a specific manner under certain circumstances. It is influenced by factors such as previous successes and failures and can be contextual in nature. Self-efficacy can be influenced both positively and negatively by environmental (classroom) factors and teaching style.

BACKGROUND

Rapid changes in the maritime industry have inevitably increased the need for qualified human resources. On the other hand, educational paradigms are rapidly changing and it is therefore critical for the success and development of maritime education and training that these changes are fully understood so that the decisions on how best to meet these changes are made in an informed way (Lewarn, 2002). Considering this fact, School of Maritime Business and Management (SMBM) has decided to transform its conventional curriculum to the problem based learning (PBL) curriculum in order to meet the expectations of rapidly changing maritime industry in terms of both “maritime business managers” and “deck officers” (Lewarn, 2002). Accordingly, Simulation based Learning is considered as a major power of problem based learning.

Demand for efficient and high quality training of maritime personnel will continue to increase over the next decade. Real life training using real equipment presents a number of alleges. Increased risk to personnel and equipment combined with limited access to required marine assets and related escalating costs is creating increased demand for simulation technology. Simulation under highly realistic circumstances presents a safer and more cost-efficient training alternative. Simulation has already proven its effectiveness and is, without doubt, the future of maritime training. Due to almost unlimited possibilities provided by simulation, better results can be achieved in a safer and more efficient manner, which in turn produces higher quality personnel.

Education occurs in three main settings: classroom, skill laboratories, and practical areas (Kelly, 2007). Classroom instruction is used to prepare cadets for their practical activities. Cadets learn prerequisite knowledge in the classroom that they later apply and test in practical fields (Gambeson, 2007).

The maritime skill simulator provides an enriched teaching and learning atmosphere that encourages active participation, involves exploration and mastery of new knowledge and skills to develop competent graduate maritime cadets. In the protected environment of the skill lab, cadets learn, make mistakes, question conceptual ideas, practice psychomotor skills, and expand knowledge to a new level of understanding. The extensive amendments to the STCW Convention agreed in 1995 only came into effect in 2002 with some additional changes in January 2003. The provisions concerning the need for governments to submit quality standard reports to the IMO, concerning their national training and certification systems, were only required to be met as recently as 2004.

RESEARCH IMPORTANCE

General self-efficacy assesses a broad and stable sense of personal competence to deal effectively with a variety of stressful situations. This approach is not in opposition to Bandura's (1997). Perceived self-efficacy is concerned with people's beliefs in their capabilities to produce given attainments (Bandura, 1997). There is no all-purpose measure of perceived self-efficacy. The *"one measure fits all"* approach usually has limited explanatory and predictive value because most of the items in an all-purpose test may have little or no relevance to the domain of functioning. Moreover, in an effort to serve all purposes, items in such a measure are usually cast in general terms divorced from the situational demands and circumstances. This leaves much ambiguity about exactly what is being measured or the level of task and situational demands that must be managed.

LITERATURE REVIEW

Perceived self-efficacy is concerned with people's beliefs in their capabilities to produce given attainments (Bandura, 1997). One cannot be all things, which would require mastery of every realm of human life. People differ in the areas in which they cultivate their efficacy and in the levels to which they develop it even within their given pursuits. For example, a business executive may have a high sense of organizational efficacy but low parenting efficacy. Thus, the efficacy belief system is not a global trait but a differentiated set of self-beliefs linked to distinct realms of functioning. Multi domain measures reveal the patterning and degree of generality of people's sense of personal efficacy.

There is no all-purpose measure of perceived self-efficacy. The *"one measure fits all"* approach usually has limited explanatory and predictive value because most of the items in an all-purpose test may have little or no relevance to the domain of functioning. Moreover, in an effort to serve all purposes, items in such a measure are usually cast in general terms divorced from the situational demands and circumstances. This leaves much ambiguity about exactly what is being measured or the level of task and situational demands that must be managed. Scales of perceived self-efficacy must be tailored to the particular domain of functioning that is the object of interest. Although efficacy beliefs are multifaceted, social cognitive theory identifies several conditions under which they may co-vary even across distinct domains of functioning (Bandura, 1997).

Co-development is still another correlative process. Even if different activity domains are not sub-served by common sub-skills, the same perceived efficacy can occur if development of competencies is socially structured so that skills in dissimilar domains are developed together. For example, students are likely to develop similarly high perceived self-efficacy in dissimilar academic subjects, such as language and mathematics in superior schools, but similarly low perceived efficacy in ineffective schools, which do not promote much academic learning in any subject matter. Finally, powerful mastery experiences that provide striking testimony to one’s capacity to effect personal changes can produce a transformational restructuring of efficacy beliefs that is manifested across diverserealms of functioning. Extraordinary personal feats serve as transforming experiences.

Many of the mathematical models, techniques and underlying data used in the ship dynamic models (SDM) are based on the validated ship simulation research performed by the Society of Naval Architects and Marine Engineers (SNAME), U.S. Coast Guard, International Towing Tank Committee (ITTC) and U.S. Maritime Administration at the Computer Aided Operations Research Facility (CAORF) in addition to the practical skills and knowledge of experienced ship masters and pilots.

Physical modeling of ships was first applied to training of mariners in 1966 with the building of the world's first manned model training facility in France, in the maneuvering capabilities and ship handling procedures for very large crude carriers. Physical models, in contrast to ship–bridge and radar simulators always simulate ship motions and ship handling in fast time because of scaling factors (Ship Analytic, 1995).

The Integrated Simulators Complex (ISC) was established at the Arab Academy for Science and Technology and Maritime Transport (AASTMT) as an advanced training unit which is considered – by all means - one of the most sophisticated simulation centers in the world. The simulator was designed and installed by “Ship Analytics".

The radar equipment should assist in safe navigation and in avoiding collision by providing an indication, in relation to own ship, of the position of other surface craft, obstructions and hazards, navigation objects and shorelines. For this purpose, radar should provide the integration and display of radar video, target tracking information, positional data derived from own ship’s position (EPFS) and geo referenced data.

Recalling resolution A.886 (21) by which the Assembly resolved that the functions of adopting performance standards and technical specifications, as well as amendments there to, shall be performed by the Maritime Safety Committee on behalf of the Organization.

Noting resolutions A.222(VII), A.278(VIII), A.477(XII), MSC.64(67), annex 4,A.820(19) and A.823(19) containing performance standards applicable to marine radars being produced and installed at different time periods in the past,

Noting also that marine radars are used in connection/integration with other navigational equipment required to carry on board ships such as, an automatic target tracking aid, ARPA, AIS, ECDIS and others,

Recognized the need for unification of maritime radar standards in general, and, inparticular, for display and presentation of navigation-related information,

Having considered the recommendation on the revised performance standards forradar equipment made by the Sub-Committee on Safety of Navigation at its fiftieth session.

RESEARCH METHODOLOGY AND HYPOTHESES OF STUDY

This research aimed to test the framework shown in the figure below:

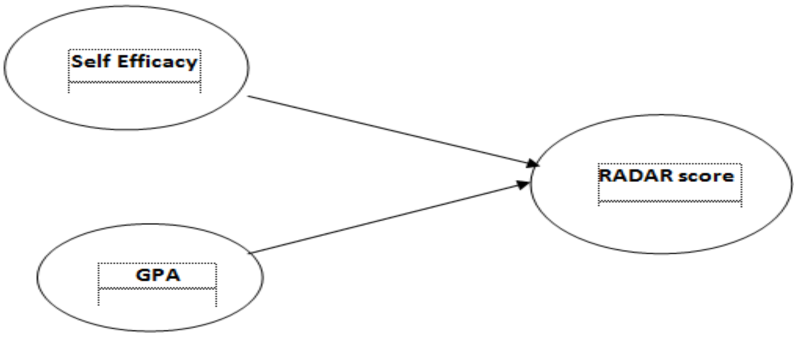

Figure 1

Accordingly, the research Hypothesis was constructed as follows:

H_1: There is significant effect of self efficacy and GPA on RADAR scores in On-Scene Learning.

H_2: There is significant effect of self efficacy and GPA on RADAR scores in Simulator Learning.

H_3: There is significant effect of self efficacy and GPA on RADAR scores in both types of Learning.

MATERIALS AND METHODS

Research Design

The study had been conducted using a quasi-experimental design.

Setting

The study had been conducted at naval college of EGYPT, the Integrated Simulators Complex (ISC) in Arab Academy for science and technology and maritime transport, Alexandria and Aida (IV) training ship.

Sample

The subjects of the study included all maritime students enrolled in using R.A.D.A.R. & A.R.P.A.(fourth semester). Approximately60 students will represent the target population of the study. The students will be randomly assigned to their control or study group about 20 for each group.

- **Study Group (I):** will receive their training about RADAR in ISC in Arab Academy for science and technology and maritime transport, Alexandria, (fourth semester). This group includes 125 students and training received in case of simulator only.
- **Control Group (II):** will receive their training about RADAR at Naval college of EGYPT (fourth semester). This group includes 117 students and training received on on-scene learning only.
- **Control Group (III):** will receive their training about RADAR. at Aida (IV) training ship for both on-scene and simulator learning. The group includes 120 students.

Finally, the researcher randomly chooses 117 students from each group to have equal groups.

Tools

Two tools will be used by the researcher for the purpose of data

Tool I: Student performance observational check list

This part will be used to assess the maritime students' skills in using of ARPA-RADAR assessment. It will include items related to technique of using of ARPA-RADAR. The total percent score performance will be calculated for identifying the maximum possible score.

Tool II: Ship handling assessment students' Self-efficacy questionnaire.

This tool was developed by (Rambo, 1997), and will be modified by the researcher to be applicable for measuring maritime students self-efficacy in performing ship handling assessment from students' perspectives. It consists of 16 statements related to maritime students' self-efficacy.

TESTING AND ANALYSIS

In this section, data is tested if reliable and valid or not. If both conditions are satisfied, data is considered as available in responding to the hypothesis already set above.

Validity Testing

Validity means the extent to which an instrument measures what it supposes to measure correctly (Hair, Anderson, Tatham, and Black, 1998; Sekaran and Bougie, 2005). One of the validity testing is convergent validity, which tests the data using factor analysis (multivariate technique) that confirms whether or not the theorized dimensions are applicable (Sekaran and Bougie, 2005). Convergent validity was essential to ensure that the items measuring the same construct are highly correlated (Hair et al., 1998). In order to test the convergent validity, the average value extracted for each of the scales was calculated. The average variance extracted (AVE) represents the average variance for each latent factor, and in an adequate model it should be greater than 0.5, which means that the factors should explain at least half the variance of their respective indicators (Garson, 2011; Hair et al., 1998). The results of the factor analysis conducted on the current research constructs of Self Efficacy indicate that AVE values for all scales under study were found to be greater than 0.5 or 50%, as represented in Table 1, which means that Self Efficacy satisfies validity testing, after deleting 3 statements out of 16 ones for self-efficacy.

Also, item loading can be evaluated by the size of the loadings of the measures on their corresponding constructs. The loadings should be at least 0.60 or above (Chin, 1998) indicating each measure is accounting for 60 percent or more of the variance of the underlying latent variable (Fornell and Larcker, 1981).Table 1 shows that all loadings of items for each of the variables under study exceed 0.60. This indicates adequate convergent validity for the variables under study.

Table 1: Validity Testing for Variables under Study

Variable	AVE in %	Items	Factor Loading of Items
Self-Efficacy	81.769	Item 1	0.718
		Item 3	0.832
		Item 5	0.734
		Item 6	0.751
		Item 7	0.863

		Item 8	0.778
		Item 9	0.762
		Item 10	0.888
		Item 11	0.812
		Item 13	0.891
		Item 14	0.719
		Item 15	0.847
		Item 16	0.877

Reliability Testing

Cronbach's Alpha, as the most commonly used test of reliability, was applied, where Alpha coefficient ranges in value from 0 to 1. The higher the score, the more reliable the generated scale is. It was indicated that 0.7 is an acceptable reliability coefficient but lower thresholds are sometimes used in the literature. (Nunnaly, 1978)

The results are shown in Table 2 below, where alpha values revealed the reliability and the internal consistency between the selected items of the studied variables. It can be shown that the values of cronbach's alpha for Self-Efficacy exceeds 0.7, which is an acceptable level for the reliability of the variables.

Table 2: Reliability Test for Variables under Study

Variables	Number of Items	Reliability Indicator
Self-Efficacy	13	0.773

Testing Regression Assumptions

Testing Normality

A data set should be normal or well-modeled by a normal distribution. A normality test is used to determine if a data set is normal and to compute how likely it is for a random variable underlying the data set to be normally distributed. An assessment of the normality of data is a prerequisite for many statistical tests because normal data is an underlying assumption in parametric testing and it had been proved by Normality Test of Kolmogrov, as p-values > 0.05

Table 3: Normality Test for Variables under Study

Variables	P-value
Self Efficacy	.200
GPA	.052
R.A.D.A.R Scores	.070

Testing Autocorrelation

Another important assumption of parametric testing is that residuals should be independent. This is one of the important assumptions of ordinary least squares method used in regression analysis. To check residuals independence, the researcher conducted the Durbin Watson test for the models fit the researcher wants to apply (Box, 1994).

The results are shown in the following table, where it was found that the Durbin Watson computed values are all greater than 2, implying that residuals are independent from each other.

Table 4: Durbin-Watson Test for Models under Study

Models	Description	D-W Test
Model I	On-scene	2.213
Model II	Simulator	2.158
Model III	Both	2.061

Multicollinearity

Multicollinearity occurs when two or more predictors in a model are highly correlated so as they provide redundant information about the response.

With respect to the assumption of multicollinearity in the current study, variance inflation factor (VIF) was conducted for the 3 models under study. The VIF value for all models under was shown to be less than 5. This result indicates that the independent variables are not inter-correlated among themselves implying that the problem of multicollinearity does not exist.

Table 5: Multicollineraity Testing

Variables	VIF Indicator
Self Efficacy	1.160
GPA	1.160

Data Analysis

In this section, the researcher attempts to find a link between the studied independent variables and the dependent variable. One of the methods that will be used is correlation matrix is a matrix giving the correlations between all pairs of data sets. It provides the Pearson's Correlation Coefficient between variables under study and each other, to be able to evaluate the relationship between those two variables. Pearson's correlation is used to find a correlation between at least two variables. The value for a Pearson's correlation can fall between 0.00 (no correlation) and ±1.00 (perfect correlation). Pearson correlation analysis is conducted to analyze the constructs and test direct relationship between pair of variables (Foster et al., 2001). A correlation matrix between the variables under study is constructed, where the value of Pearson's correlation is calculated between each pair of variables under study to investigate the relationships between the variables. Also, a multiple linear model is fitted between R.A.D.A.R Score as a dependent variable, and the variables Self Efficacy, and GPA in each case of learning.

Also, regression analysis as another method will be used. Regression analysis is widely used for prediction and forecasting. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. By using regression analysis, one may assess the direct relationship between variables as well as show the causal relationship and the nature of relationship between variables (Aiken et al., 1991; Foster et al., 2004). Through this section, a regression analysis will be presented for the relationships among variables under study according to the predefined model relations.

Model I: On-Scene Learning

Results shown in the table below identify that the correlations between Self Efficacy, GPA, and R.A.D.A.R Scores are 0.234, 0.033 respectively, in case of On-Scene Learning. It was found that there is a significant but weak positive relationship between Self Efficacy and R.A.D.A.R Scores. On the other hand, it was found that there is an insignificant relation between GPA and R.A.D.A.R Scores.

Table 6: Correlation Matrix for Model I

		GPA1	EFFICACY1	RADAR1
GPA1	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	116		

EFFICACY1	Pearson Correlation	.176	1	
	Sig. (2-tailed)	.059		
	N	116	116	
RADAR1	Pearson Correlation	.234*	.033	1
	Sig. (2-tailed)	.012	.721	
	N	116	116	116

The results of regression analysis were shown for On-Scene Learning model, as it was found that the model coefficient of determination (R Square) equals 5.5%. This means that the model explains 5.5% of the variance in R.A.D.A.R Score. This means that there may be other variables affecting R.A.D.A.R Score other than the ones in the current study and which can explain the remaining percentage of unexplained variation in R.A.D.A.R Score. In addition, observing significance, it is found that the model as a whole is significant (P-value = 0.042).Result shows that the variable; Self Efficacy is having a positive significant impact on the dependent variable “R.A.D.A.R Scores” at 0.01 significance level (Coefficient = 0.825, P-value = 0.013), while GPA shows an insignificant effect on R.A.D.A.R Scores.

Table 7: Regression Analysis for Model I

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	10.982	1.128		9.735	.000
	EFFICACY1	.825	.326	.235	2.531	.013
	GPA1	-.001	.016	-.008	-.085	.932

Overall: R^2 = 0.055, F-test = 3.270, P-Value = 0.042

Model II: Simulation Learning

In case of Simulation Learning, results shown in the table below identify that the correlations between Self Efficacy, GPA, and R.A.D.A.R Scores are 0.386 and 0.035 respectively, in case of Simulator Learning. It was found that there is a significant but weak positive relationship between Self Efficacy and R.A.D.A.R Scores. On the other hand, it was found that there is an insignificant relation between GPA and R.A.D.A.R Scores.

Table 8: Correlation Matrix for Model II

		GPA2	EFFICACY2	RADAR2
GPA2	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	116		
EFFICACY2	Pearson Correlation	.085	1	
	Sig. (2-tailed)	.363		
	N	116	116	
RADAR2	Pearson Correlation	.386**	.035	1
	Sig. (2-tailed)	.000	.713	
	N	116	116	116

Checking the model for Simulator Learning, the results showed that the model coefficient of determination (R Square) equals 14.9%. This means that the model explains 14.9% of the variance in R.A.D.A.R Score. This means that there may be other variables affecting R.A.D.A.R Score other than the ones in the current study and which can explain the remaining percentage of unexplained variation in R.A.D.A.R Score. In addition, observing significance, it is found that the model as a whole is significant (P-value = 0.000). Result shows that the variable; Self Efficacy is having a positive significant impact on the dependent variable “R.A.D.A.R Scores” at 0.01 significance level (Coefficient = 0.960, P-value = 0.000), while GPA shows an insignificant effect on R.A.D.A.R Scores.

Table 9: Regression Analysis for Model II

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	11.769	1.643		7.163	.000
	EFFICACY1	.960	.217	.386	4.427	.000
	GPA1	.000	.023	.002	.020	.984

Overall: R^2 = 0.149, F-test = 9.880, P-Value = 0.000

Model III: On-Scene & Simulation Learning

Finally, in case of both types of Learning, results shown in the table below identify that the correlations between Self Efficacy, GPA, and R.A.D.A.R Scores are 0.226 and 0.021 respectively, in case of On-Scene Learning. It was found that there is a significant but weak positive relationship between Self Efficacy and R.A.D.A.R Scores. On the other hand, it was found that there is an insignificant relation between GPA and R.A.D.A.R Scores.

Table 10: Correlation Matrix for Model III

		GPA3	EFFICACY3	RADAR3
GPA3	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	116		
EFFICACY3	Pearson Correlation	.115	1	
	Sig. (2-tailed)	.220		
	N	116	116	
RADAR3	Pearson Correlation	.226*	.021	1
	Sig. (2-tailed)	.015	.823	
	N	116	116	116

Checking the model for having both types of Learning, it was found that the model coefficient of determination (R Square) equals 15.1%. This means that the model explains 15.1% of the variance in R.A.D.A.R Score. This means that there may be other variables affecting R.A.D.A.R Score other than the ones in the current study and which can explain the remaining percentage of unexplained variation in R.A.D.A.R Score. In addition, observing significance, it is found that the model as a whole is significant (P-value = 0.000). Result shows that the variable; Self Efficacy is having a positive significant impact on the dependent variable "R.A.D.A.R Scores" at 0.01 significance level (Coefficient = 1.121, P-value = 0.000), while GPA shows an insignificant effect on R.A.D.A.R Scores.

Table 11: Regression Analysis for Model III

Model		Unstandardized Coefficients		Standardized Coefficients	T	P-value
		B	Std. Error	Beta		
1	(Constant)	11.769	1.643		7.163	.000
	EFFICACY1	1.121	.207	.226	2.452	.000
	GPA1	-.002	.041	-.005	-.054	.957

Overall: R^2 = 0.151, F-test = 11.392, P-Value = 0.000

CONCLUSIONS AND RECOMMENDATION

Based on the study findings, it can be concluded that higher self-efficacy and higher GPA was significantly correlated with higher performance of cadets using R.A.D.A.R.

Furthermore, the combination of on-scene and simulation training provides the highest R.A.D.A. Rperformance as compared to on-scene or simulation training alone, as R-squared was shown to be the greatest for model III.

In addition, it was found that the percentage of explained variation in the three models under study was relatively low, which means that there are other variables that could significantly affect RADAR scores.

It is recommended that this research be advised to Maritime Training Colleges to unify the type of training needed for cadets to start using R.A.D.A.R efficiently.

Further study should be implemented to include the analysis of other factors affecting the quality of learning such as knowledge retention, self-confidence, anxiety level, and satisfaction in order to better understand their effect on using R.A.D.A.R.

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