Available online at www.elixirpublishers.com (Elixir International Journal)

Mechanical Engineering

Elixir Mech. Engg. 43 (2012) 6680-6683

ISSN: 2229-712X

Gender difference of learning scores in theoretical mechanics

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ARTICLE INFO

Article history:

Received: 14 November 2011;

Received in revised form:

19 January 2012;

Accepted: 3 February 2012;

Keywords

Gender differences,

Theoretical mechanics,

Test,

T-test.

ABSTRACT

Gender differences played an important role in theoretical mechanics to influence students' learning interests, academic interests and achievements. In order to improve teaching quality and assist students' learning, we used SPSS to analyze the data of theoretical mechanics test, gained a comprehensive understanding of gender differences on the theoretical mechanics teaching. The findings of the study indicated that the gap of gender difference exists in theoretical mechanics learning. The test showed female students get higher points in theoretical mechanics test. The result of t-test for two groups of male and female students showed that they had significant difference in terms of mean scores obtained in choice questions, calculating questions, particle mechanics and rotating reference frame tests.

Introduction

Theoretical mechanics, quantum mechanics, electrodynamics, thermodynamics and statistical physics are the main courses of physics majors. Theoretical mechanics is the first course that students learned. The objective of theoretical mechanics teaching is to help students master knowledge, learn how to solve practical engineering problems, and develop logical thinking ability. In the long term teaching practices, we found that there are significant differences in the ways male students and female students learn theoretical mechanics, differences which are more substantial than age differences in many ways.

Gender differences played a great role in theoretical mechanics to influence students' learning interests, academic interests and achievements. According to gender role theory, prevalent gender stereotypes are culturally shared expectations for gender appropriate behaviors. Females and males learn the appropriate behaviors and attitudes from the family and overall culture they grow up with, and so non-physical gender differences are a product of socialization (Cheng-Chieh Lai, Ming-Mu Kuo, 2007) .

This study attempted to gain a comprehensive understanding of gender differences on the theoretical mechanics teaching and assist students' learning in the future.

Method

Tests can provide useful information about the success and failure of teachers' teaching and students' learning. By test, we can measure undergraduates' progress and achievements in theoretical mechanics learning.

SPSS (Statistics Package for Social Science) for Windows can carry out almost all statistical analyses. We can use SPSS for Windows statistics module to analyze the data of theoretical mechanics test. The results were analyzed using SPSS version 13.0 software.

Findings

44 students who come from the Institute of Physics and Electronics of Taishan University in China took part in the final examination of theoretical mechanics at the end of the first semester of the academic year 2010-2011. The test paper consisted of four types, such as blank-filling questions, choice questions, short-answer questions and calculating questions, we marked them using T1, T2, T3 and T4, see Table 1. The test consisted of 28 questions which marked using Q1, Q2, Q3,..., and so on. 44 valid testes were collected 31 (70.5%) male and 13 (29.5%) female students. The mean of the test is 70.18.

Gender difference of the mean score

Table 2 gives the descriptive statistics for the two groups. The last column gives the standard error of the mean for each of the two groups. The findings indicate that the mean scores of the female students are much better than male.

In Table 3, the columns labeled "Levene's Test for Equality of Variances" tell us whether an assumption of the t-test has been met. The t-test assumes that the variability of each group is approximately equal. If that assumption isn't met, then a special form of the t-test should be used. The column labeled "Sig." under the heading "Levene's Test for Equality of Variances". In this example, the significance (p value) of Levene's test is 4.544, the value is larger than 0.05 level, so we use the middle row of the output (the row labeled "Equal variances assumed"). The column labeled "t" gives the calculate t value. In the test, assuming equal variances, the t value is -3.006; the column labeled "df" gives the degrees of freedom associated with the t-test. The column labeled "Sig. (2-tailed)" gives the two-tailed p value associated with the test. In the t-test, the p value 0.004 is smaller than 0.05. That implies there are statistically reliable differences between male and female students at the 95% level.

Gender difference of each type

Theoretical mechanics requires that students have good logical thinking ability. Logical thinking ability is always combined with conception, theorem and problems solving. The t-test findings demonstrate that male and female students have significant differences in choice questions and calculating questions at the 95% level. The equal variances t-test failed to reveal a statistically reliable difference between males and females in blank-filling questions and short-answer questions, see Table 4 and 5.

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The choice questions and calculating questions are involved in problem solving process. For solving theoretical mechanics problems, students should be familiar with the knowledge concepts, theorems and physics picture, analyze the problems with great effort, and reflect on their thinking activity. On the ways of problem solving, female students are more flexible than male students. Female students are more clearer with which kind of basic issue to start with, then consider use which theorems or methods to solve the problem than males.

The blank-filling questions and short-answer questions mainly test students' basic knowledge on theoretical mechanics. The mastery of knowledge need students has good memory ability. The findings demonstrate that male and female students have mastered the knowledge in a same degree.

Gender difference of each chapter

As far as the distribution of knowledge, theoretical mechanics can be divided into five chapters, such as particle mechanics, particle system mechanics, rigid body mechanics, rotating reference frame and analytical mechanics. We analyzed the gender difference of each chapter, see Table 6 and 7.

The t-test findings demonstrate that male and female students have significant differences in particle mechanics and rotating reference frame. The particle mechanics includes more knowledge points than other chapters. Female students are more adept at learning and applying complicated knowledge than males. The rotating reference frame mainly study the laws of motion of mechanical systems in different rotating reference frames. Generally, rotational problems are concerned with space coordinate system. The solutions of rotational problems need students have good space thinking ability. Generally spatial abilities entail visual problems or tasks that require individuals to estimate, predict, or judge the relationships among figures or objects in different contexts (Abbas Amani, Hassan Alamolhodaei, Farzad Radmehr, 2011)[1]. Female students have higher space thinking ability, they tended to solve problems by using more spatial processes, while male students tried to solve problem in a mc

Conclusion

The findings of the study indicated that the gap of gender difference exists in theoretical mechanics learning. The test showed female students get higher points in theoretical mechanics test. The result of t-test for two groups of male and female students showed that they had significant difference in terms of mean scores obtained in choice questions, calculating questions, particle mechanics and rotating reference frame tests with these p-values 0.035, 0.011, 0.001 and 0.044 respectively.

The result of t-test for two groups of male and female students showed that they hadn't significant difference in terms of mean scores obtained in blank-filling questions, short-answer questions, particle system mechanics, rigid body mechanics, and analytical mechanics tests with these p-values 0.136, 0.121, 0.365, 0.222 and 0.227 respectively.

As theoretical mechanics educators, we should minimize gender difference in theoretical mechanics performance and making necessary opportunity for male students to perform as the same as females in theoretical mechanics courses in university. To overcome this gap, teachers should create more training opportunities to increase male students' knowledge problem solving ability and space thinking ability.

References

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Table 1 Structure of theoretical mechanics test paper

	T1:blank filling	T2:choice	T3:shortanswer questions	T4:Calculating questions	
Score values	16	16	18	50	100

Table 2 Mean score of the test

	gender	N	Mean	Std. Deviation	Std. Error Mean
SUM	male	31	67.2258	8.92827	1.60356
	female	13	77.2308	12.48435	3.46254

Table3 Independent samples test of means

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
SUM	Equal variances assumed	4.544	.039	-3.006	42	.004	-10.00496	3.32845	-16.72205	-3.28788
	Equal variances not assumed			-2.622	17.380	.018	-10.00496	3.81583	-18.04229	-1.96764

Table 4 Statistics of each type of the test

	gender	N	Mean	Std. Deviation	Std. Error Mean
T1	male	31	9.3871	2.23125	.40075
	female	13	10.5385	2.43637	.67573
T2	male	31	8.7742	3.78338	.67952
	female	13	11.3846	3.20256	.88823
T3	male	31	13.2581	3.21422	.57729
	female	13	15.0769	4.07148	1.12922
T4	male	31	35.8065	4.58563	.82360
	female	13	40.2308	5.97430	1.65697

Table 5 Independent samples test of each type

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
T1	Equal variances assumed	.003	.956	-1.520	42	.136	-1.15136	.75725	-2.67955	.37682
	Equal variances not assumed			-1.466	20.892	.158	-1.15136	.78562	-2.78567	.48294
T2	Equal variances assumed	1.030	.316	-2.178	42	.035	-2.61042	1.19843	-5.02896	-.19189
	Equal variances not assumed			-2.334	26.523	.027	-2.61042	1.11835	-4.90701	-.31383
T3	Equal variances assumed	1.030	.316	-1.581	42	.121	-1.81886	1.15013	-4.13992	.50220
	Equal variances not assumed			-1.434	18.584	.168	-1.81886	1.26823	-4.47732	.83960
T4	Equal variances assumed	2.936	.094	-2.666	42	.011	-4.42432	1.65931	-7.77294	-1.07570
	Equal variances not assumed			-2.391	18.217	.028	-4.42432	1.85037	-8.30849	-.54015

Table 6 Group statistics of each chapter

	gender	N	Mean	Std. Deviation	Std. Error Mean
Particle mechanics	male	31	9.9677	2.76265	.49619
	female	13	13.2308	2.68185	.74381
Particle system mechanics	male	31	8.2581	2.35185	.42240
	female	13	8.9231	1.75412	.48650
Rigid body mechanics	male	31	20.0000	3.19374	.57361
	female	13	22.0000	5.27573	1.46322
Rotating reference frame	male	31	14.5161	4.28852	.77024
	female	13	17.5385	4.68358	1.29899
Analytical mechanics	male	31	14.4839	2.44773	.43963
	female	13	15.5385	2.96129	.82131

Table 7 Independent samples test of each chapter

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Particle mechanics	Equal variances assumed	.001	.972	-3.604	42	.001	-3.26303	.90530	-5.09000	-1.43605
	Equal variances not assumed			-3.649	23.217	.001	-3.26303	.89412	-5.11170	-1.41435
Particle system mechanics	Equal variances assumed	1.077	.305	-.916	42	.365	-.66501	.72618	-2.13051	.80048
	Equal variances not assumed			-1.032	30.075	.310	-.66501	.64429	-1.98069	.65067
Rigid body mechanics	Equal variances assumed	5.192	.028	-1.551	42	.129	-2.00000	1.28985	-4.60302	.60302
	Equal variances not assumed			-1.273	15.822	.222	-2.00000	1.57164	-5.33478	1.33478
Rotating reference frame	Equal variances assumed	.925	.342	-2.076	42	.044	-3.02233	1.45553	-5.95971	-.08496
	Equal variances not assumed			-2.001	20.889	.059	-3.02233	1.51018	-6.16395	.11928
Analytical mechanics	Equal variances assumed	.040	.842	-1.225	42	.227	-1.05459	.86070	-2.79155	.68237
	Equal variances not assumed			-1.132	19.230	.272	-1.05459	.93157	-3.00282	.89364