THE MISCONCEPTIONS IN MECHANICS AMONG STUDENTS AFTER COMPLETING THEIR SECONDARY LEVEL EDUCATION IN MALTA

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- Introduction
- Research questions
- Methodology
- Results
- Conclusions

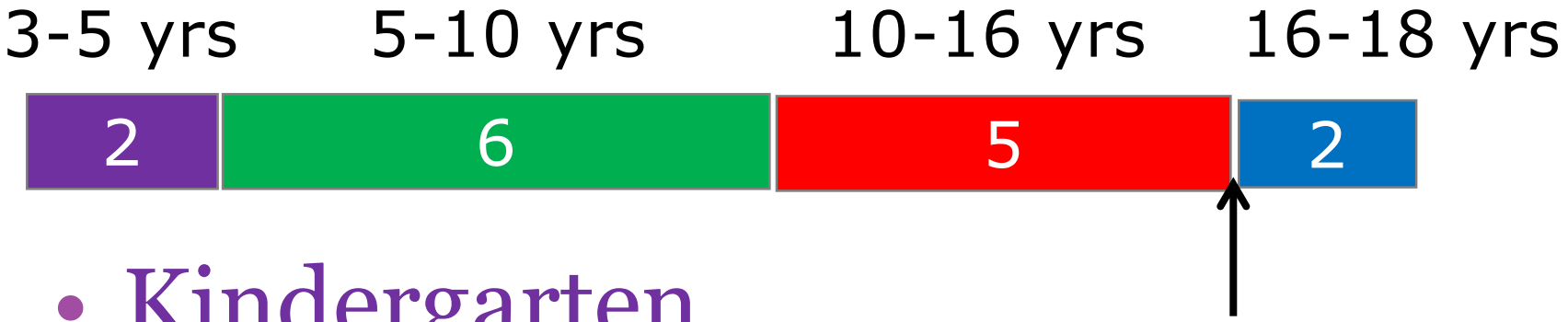
Introduction

- 1976 – David Hestenes about his children.
- Richard Stoner – quantitative problem-solving techniques versus qualitative arguments.
- Robert Karplus – ‘exploration, invention and discovery’.
- David Hestenes – sensory input, short-term and long-term memories.
- Ibrahim Halloun – preconceptions and the development of the force concept inventory.
- Students form opinions to explain everyday phenomena based on learning and experience.

Research questions

- Are misconceptions in mechanics related to the gender of the participants?
- Do repeaters have fewer misconceptions in mechanics than newly-admitted participants?
- Do high grades in SEC (ordinary level) Physics, Maths and English play a role in misconceptions in mechanics?

Education system in Malta

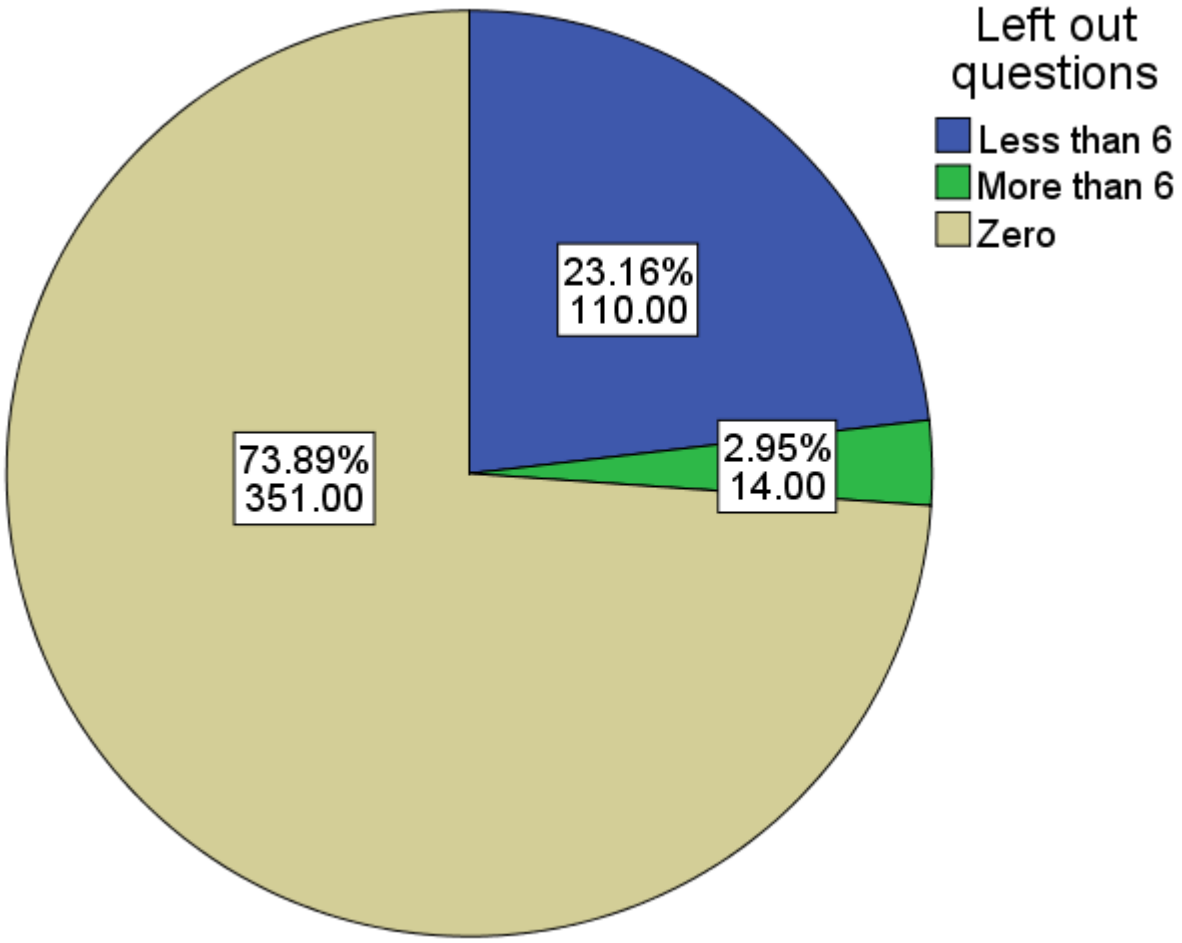


- Kindergarten
- Primary education
- Secondary education
- Post-secondary education

Methodology

- The force concept inventory (named as mechanics survey) originally published in 1992 by David Hestenes, Malcolm Wells, & Gregg Swackhamer and then revised in 1995 by Ibrahim Halloun, Richard Hake and Eugene Mosca.
- Mechanics survey consisted of 30 questions (FCI) and 2 other questions about motion graphs.
- The survey was given to all students in the physics department taking physics at advanced or intermediate level.
- Administered by colleagues teaching mechanics on the second week of commencing courses. This happened between 6th and 9th October 2015.
- SPSS 2.1 was used for the analysis.

Response


Left out questions
Less than 6
More than 6
Zero
23.16%
110.00
2.95%
14.00
73.89%
351.00

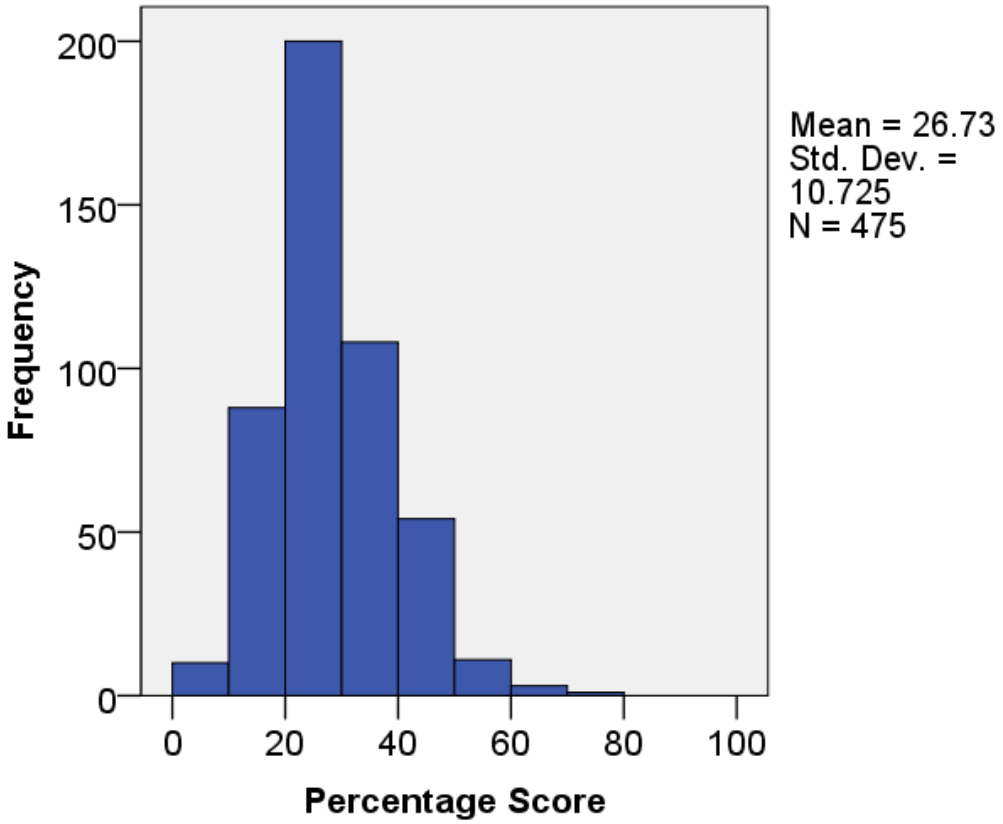
Results – Test of Normality at the 0.05 level

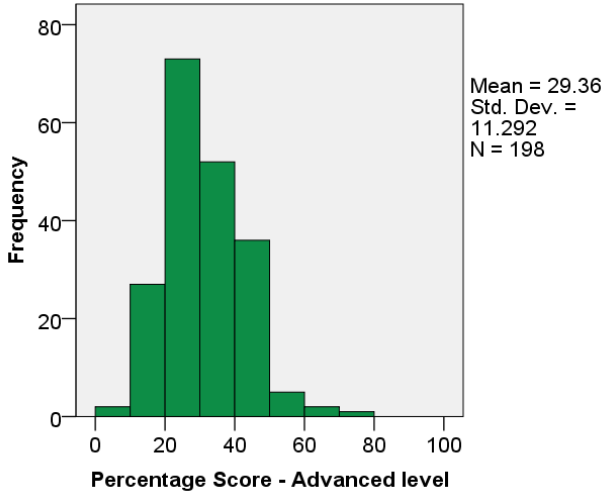
Tests of Normality (1-30)						
	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
All data	.130	475	.000	.964	475	.000
Intermediate level	.135	277	.000	.970	277	.000
Advanced level	.122	198	.000	.956	198	.000
Tests of Normality (31 and 32)						
	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
All data	.410	475	.000	.650	475	.000
Intermediate level	.395	277	.000	.669	277	.000
Advanced level	.431	198	.000	.616	198	.000

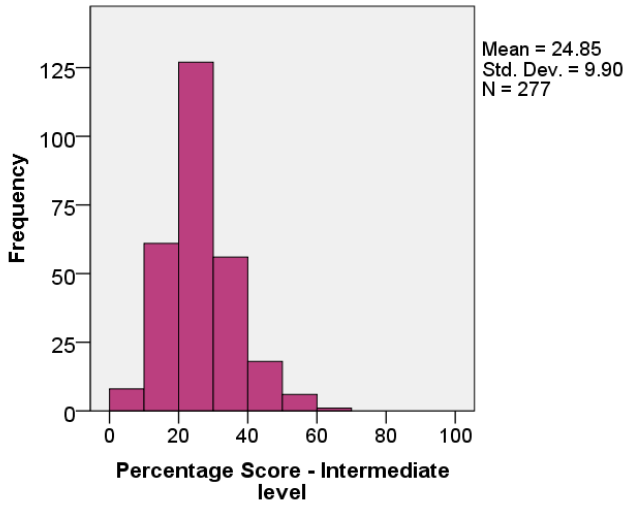
Results

- Distribution of percentage scores is not normal in all cases.
- Non-parametric tests.
- Kruskall-Wallis for k-independent samples to compare means.
- One-way ANOVA for statistics information.

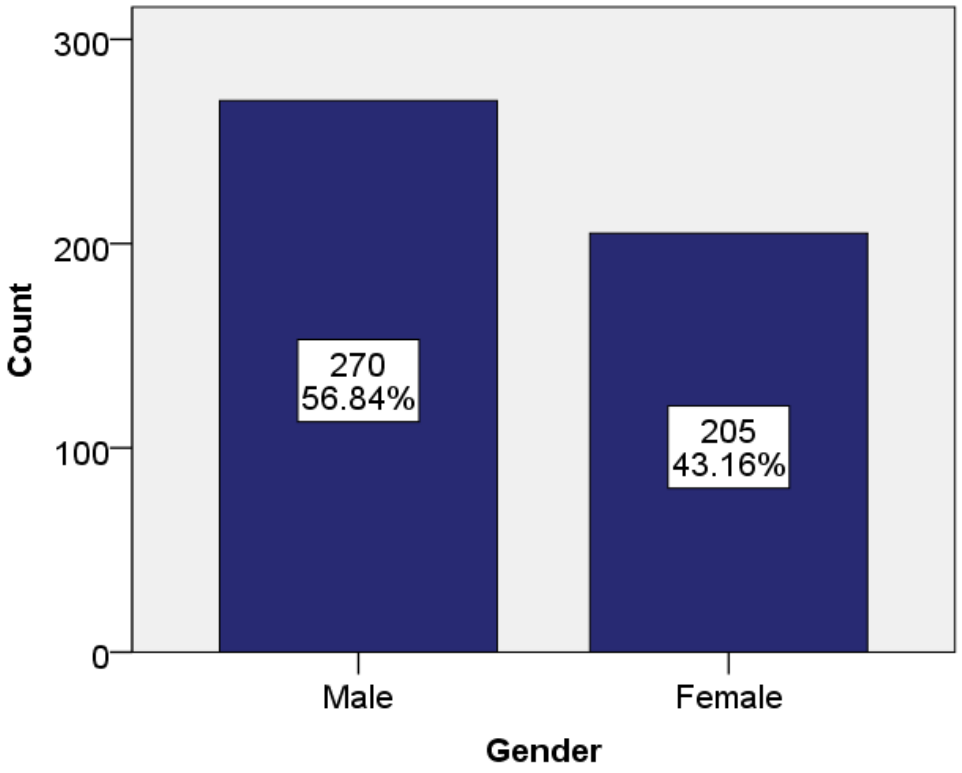
The first 30 questions (FCI)

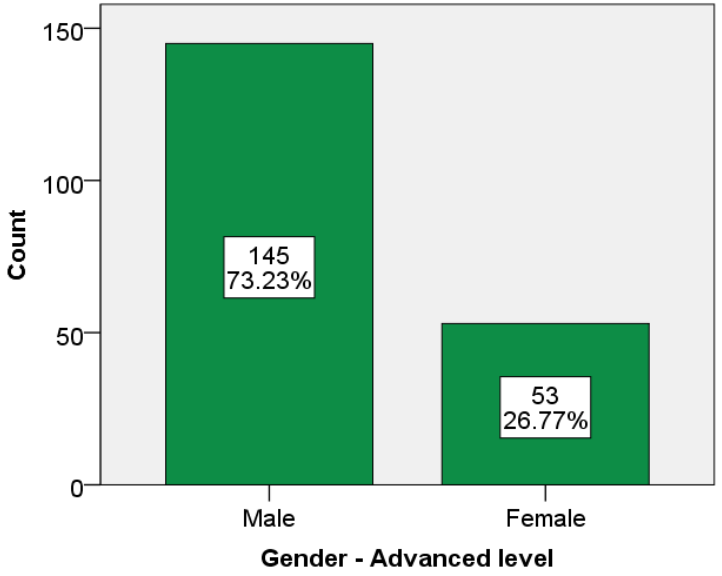


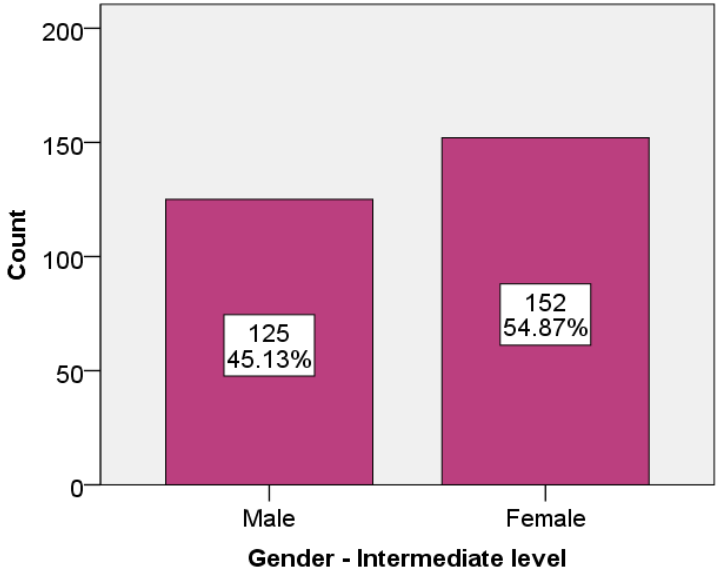




Gender


300
200
100
0
Count
270
56.84%
205
43.16%
Male
Female
Gender

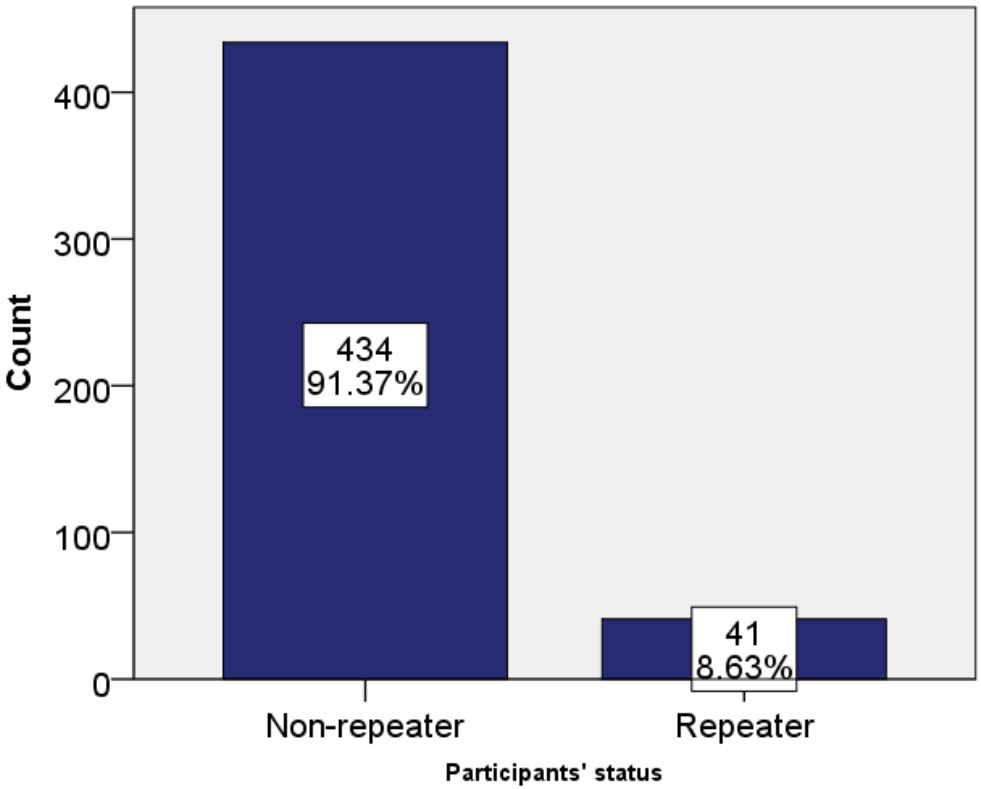

150
100
50
0
Count
145
73.23%
53
26.77%
Male
Female
Gender - Advanced level

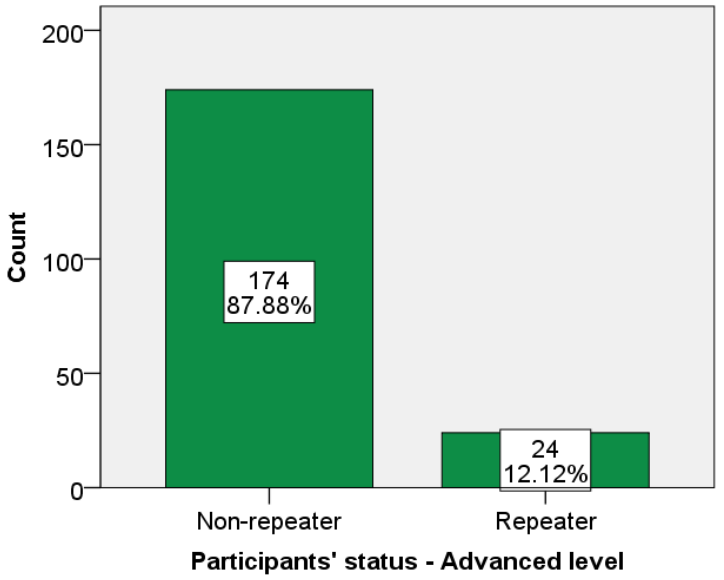

200
150
100
50
0
Count
125
45.13%
152
54.87%
Male
Female
Gender - Intermediate level

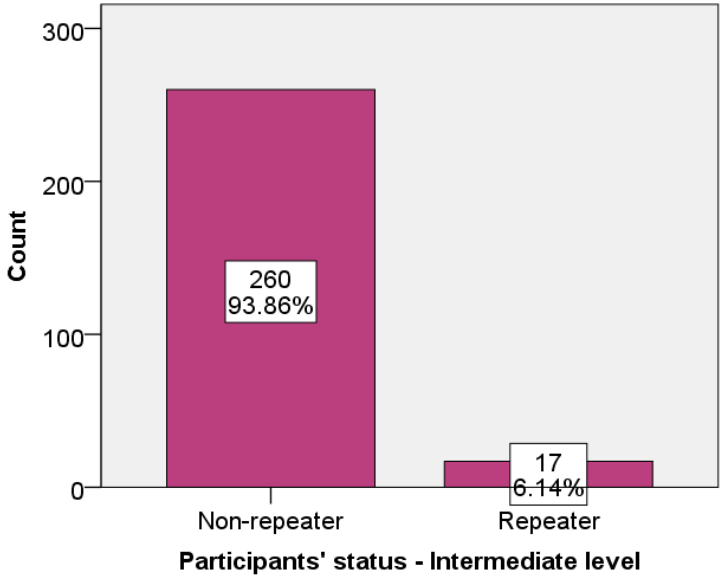
Results - Gender

Q1 – 30							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	29.75	Male	22.75	Female	7.00	YES	0.000
Intermediate	27.73	Male	22.48	Female	5.25	YES	0.000
Advanced	31.49	Male	23.52	Female	7.97	YES	0.000
Q31 – 32							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	80.56	Male	80.24	Female	0.32	NO	0.573
Intermediate	80.40	Male	78.29	Female	2.11	NO	0.356
Advanced	85.85	Female	80.69	Male	5.16	NO	0.331

Repeating


Count
400
300
200
100
0
434
91.37%
41
8.63%
Non-repeater
Repeater
Participants' status

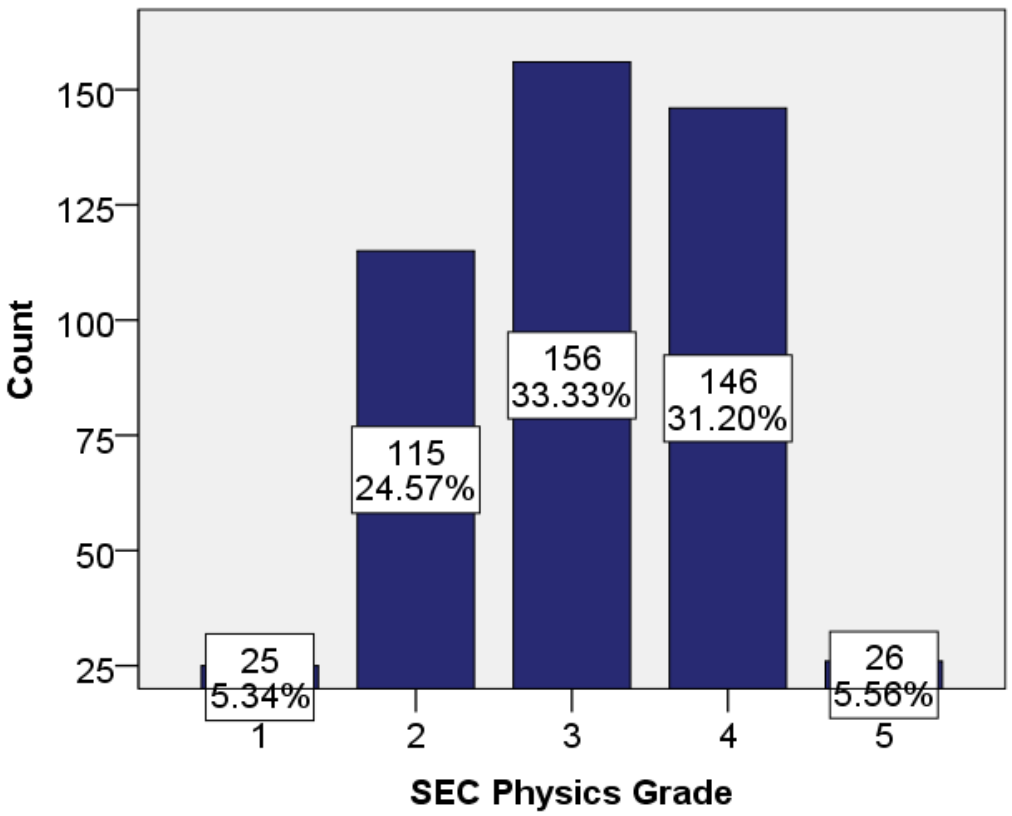

Count
200
150
100
50
0
174
87.88%
24
12.12%
Non-repeater
Repeater
Participants' status - Advanced level

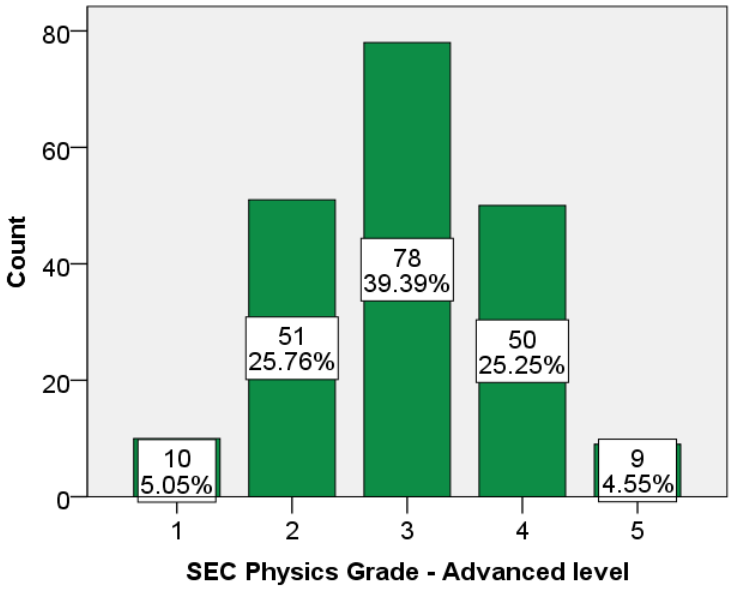

Count
300
200
100
0
260
93.86%
17
6.14%
Non-repeater
Repeater
Participants' status - Intermediate level

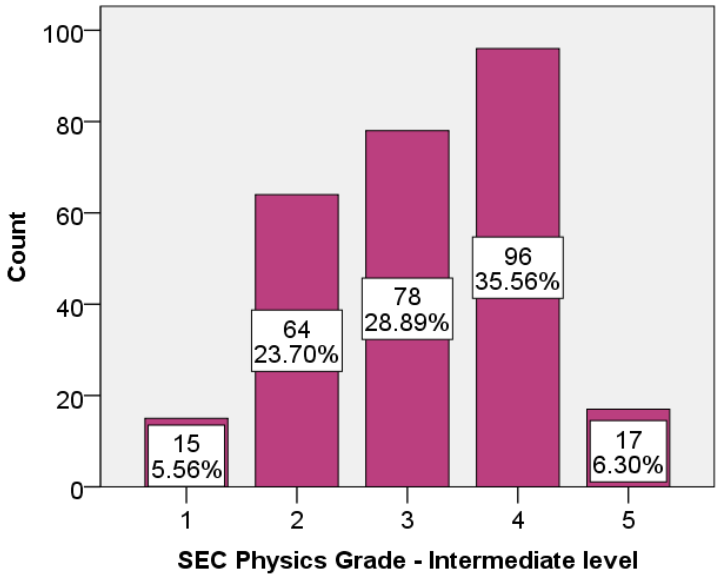
Results - Repeating

Q1 – 30							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	32.43	R	26.19	NR	6.24	YES	0.001
Intermediate	29.22	R	24.56	NR	4.66	NO	0.307
Advanced	34.72	R	28.62	NR	6.09	YES	0.004
Q31 – 32							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	84.14	R	80.07	NR	4.07	NO	0.261
Intermediate	79.62	NR	73.53	R	6.09	NO	0.546
Advanced	91.67	R	80.75	NR	10.92	NO	0.063

SEC level physics



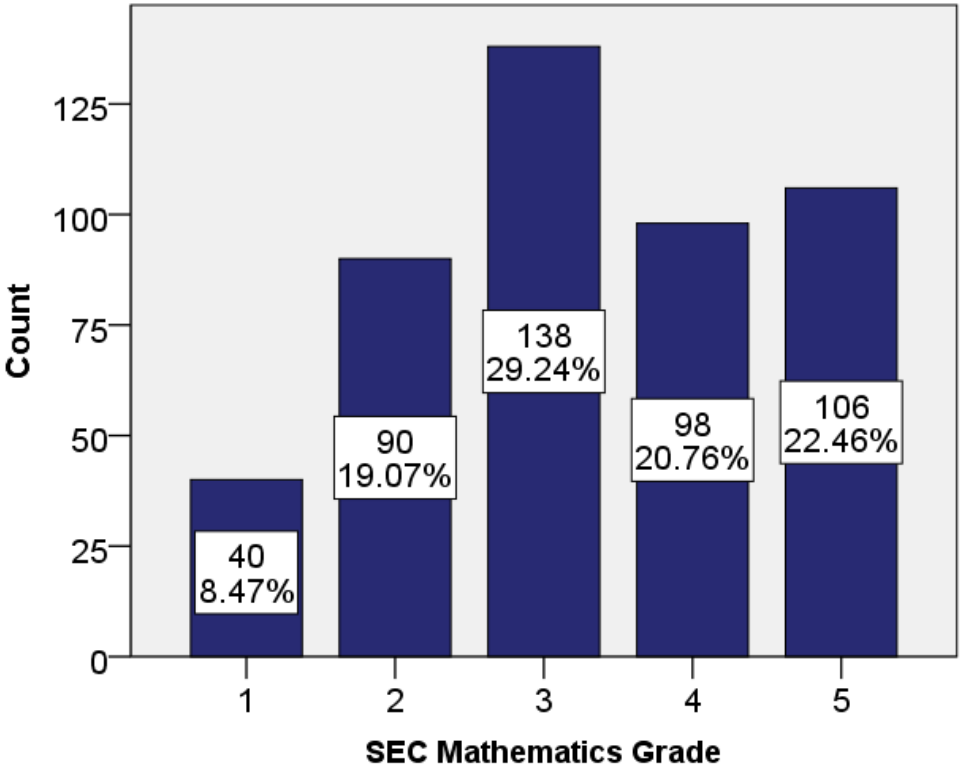


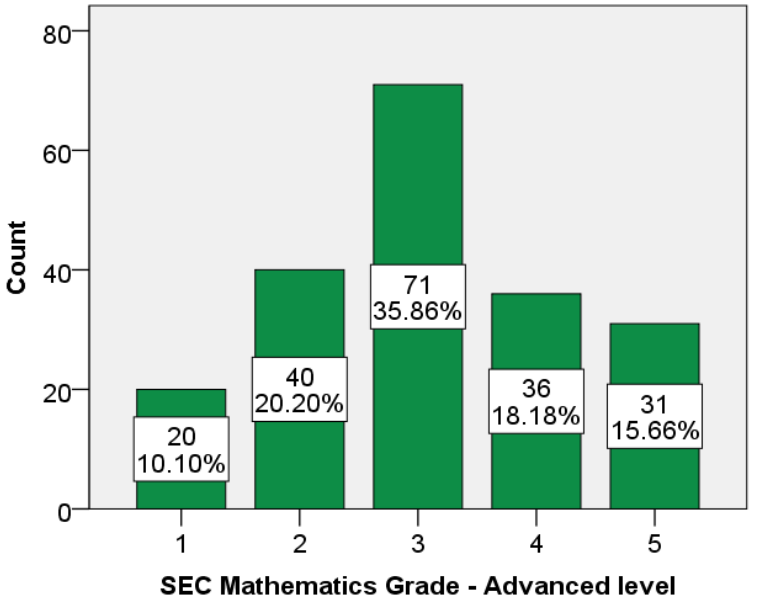


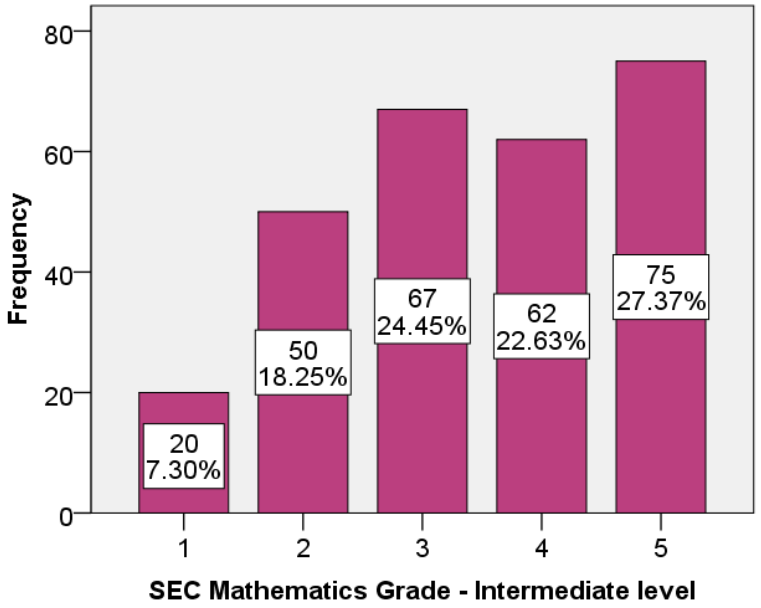
Results – SEC level Physics

Q1 – 30							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	32.80	Grade 1	23.72	Grade 5	9.08	YES	0.000
Intermediate	29.78	Grade 1	22.16	Grade 5	7.62	YES	0.005
Advanced	37.33	Grade 1	26.13	Grade 4	11.20	YES	0.017
Q31 – 32							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	87.39	Grade 2	67.31	Grade 5	20.08	YES	0.007
Intermediate	89.06	Grade 2	67.65	Grade 5	21.41	YES	0.002
Advanced	85.29	Grade 2	66.67	Grade 5	18.62	NO	0.827

SEC level Maths



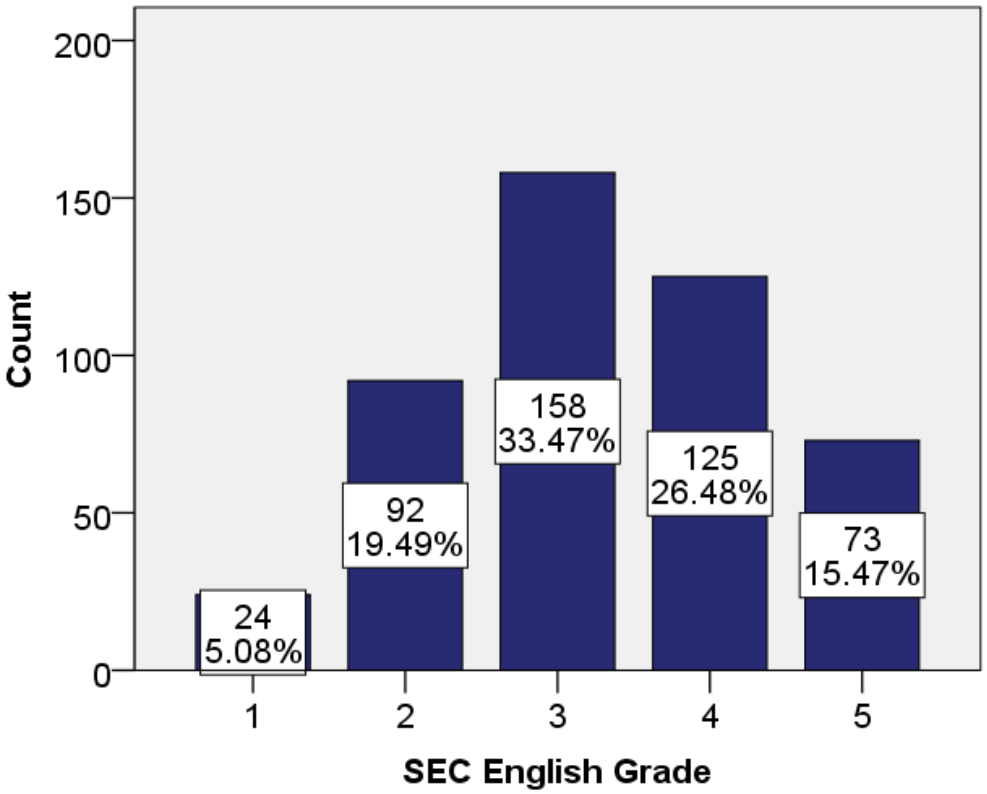


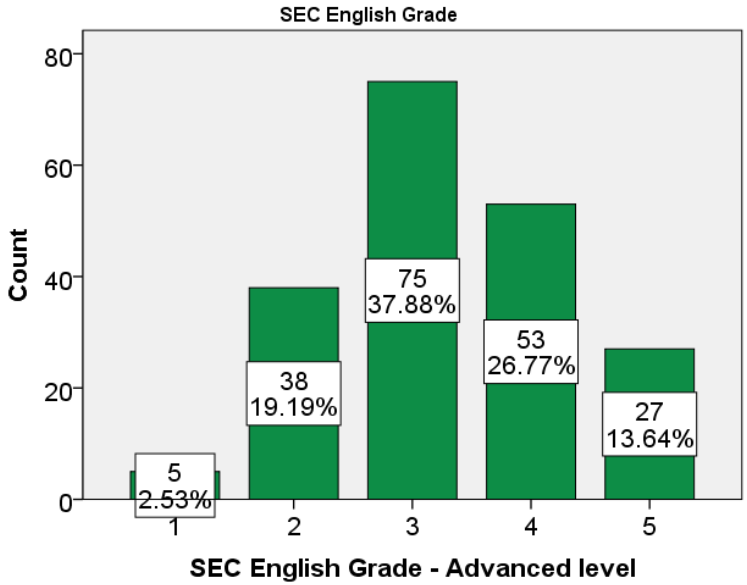


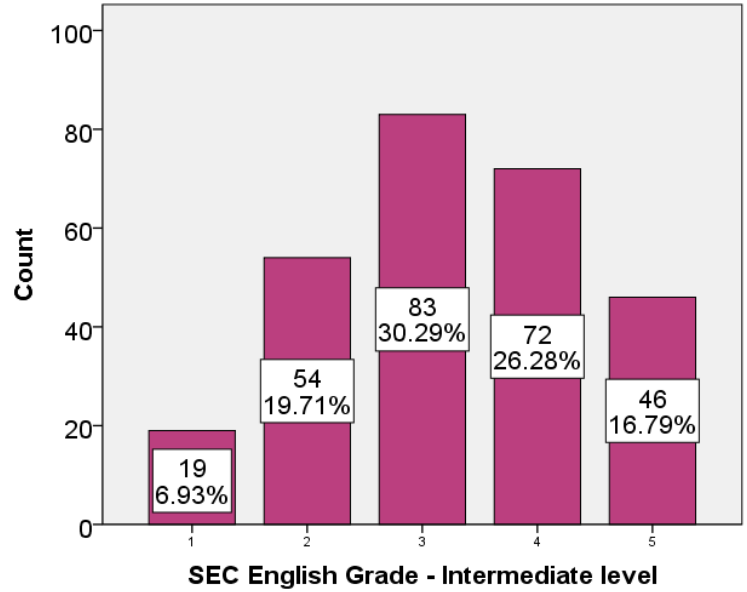
Results – SEC level Maths

Q1 – 30							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	30.17	Grade 1	23.14	Grade 5	7.03	YES	0.000
Intermediate	27.00	Grade 1	22.67	Grade 5	4.33	NO	0.202
Advanced	33.33	Grade 1	24.30	Grade 5	9.03	YES	0.020
Q31 – 32							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	91.25	Grade 1	74.06	Grade 5	17.19	YES	0.001
Intermediate	95.00	Grade 1	73.33	Grade 5	21.67	YES	0.004
Advanced	87.50	Grade 1, 2	75.81	Grade 5	11.69	NO	0.436

SEC level English







Results – SEC level English

Q1 – 30							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	28.88	Grade 2	25.94	Grade 3	3.53	NO	0.222
Intermediate	28.95	Grade 1	23.84	Grade 5	5.11	marginal	0.053
Advanced	32.98	Grade 2	26.00	Grade 1	6.98	NO	0.124
Q31 – 32							
Group	Max mean		Min mean		Difference	significant	P-value (0.05)
All	87.50	Grade 2	77.40	Grade 3	10.10	NO	0.095
Intermediate	85.19	Grade 2	77.11	Grade 3	8.08	NO	0.543
Advanced	90.79	Grade 2	77.36	Grade 4	13.43	NO	0.133

Conclusions – Q1-30 (FCI)

- Male participants have less misconceptions than female participants.
- Repeating participants have less misconceptions than newly-admitted ones in general but is insignificant for intermediate level participants.

Conclusions – Q1-30 (FCI)

- A good grade in SEC physics helps in having less misconceptions.
- A good grade in SEC Maths helps in having less misconceptions but is insignificant for intermediate level participants.
- A good grade in SEC English makes no difference to the misconceptions.

Conclusions – Q31 & 32

- In general for these questions about linear motion graphs, the average percentage score did not make a significant difference.
- Intermediate level participants showed less misconceptions with a good grade in SEC Physics and SEC Maths grade.

Acknowledgements

- Prof. Liberato Camilleri , statistics and operations research.
- Dr. Charles Bonello, Mathematics and science education.
- Mr. Paul Xuereb, Principal of Junior College.
- Mr. Russell Mizzi, the subject coordinator.
- Physics staff participating in administration of the survey.
- Participants in the survey.

Thank you for listening

- Any questions?