Differentiating in the Physics Classroom for Academic Success.

In this poster: teacher variables in yellow; classroom variables in grey; student variables in green.

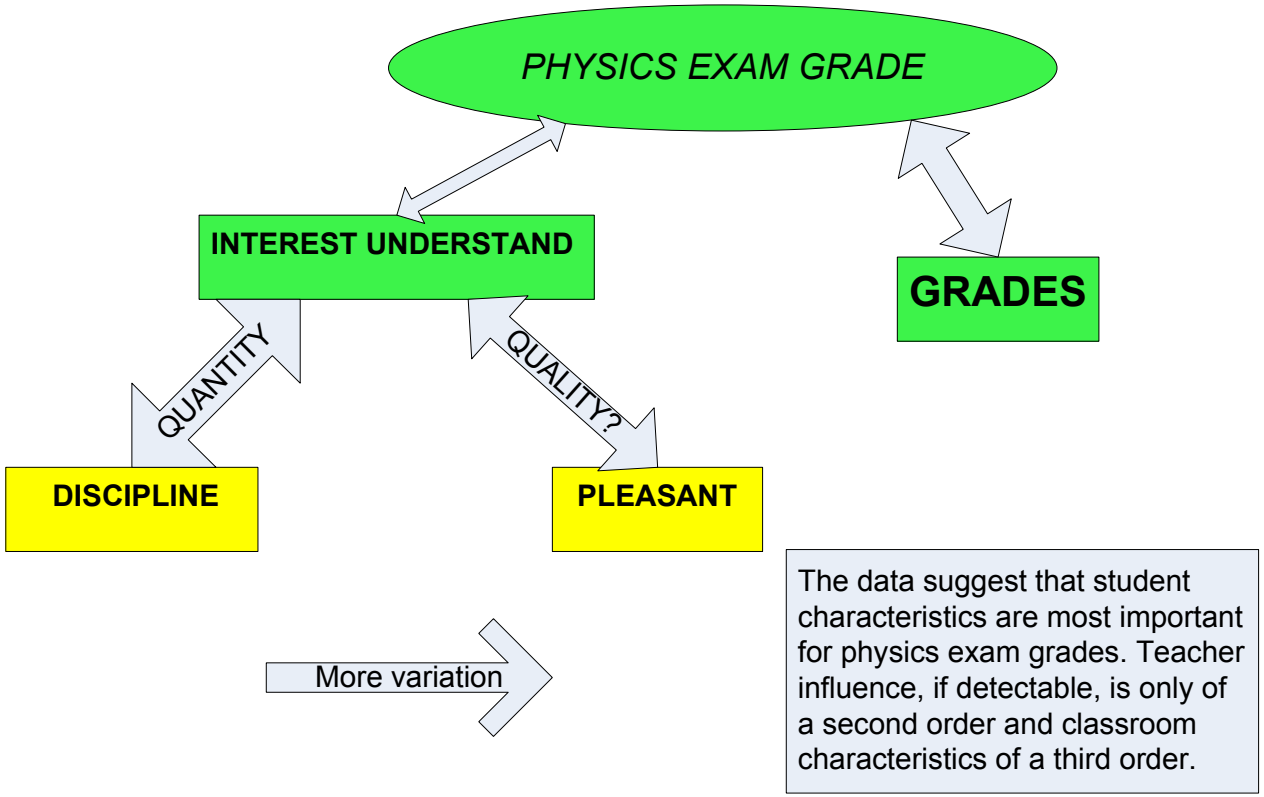
Instrument and background information – Dutch educational sytem:

- **Survey about classroom, teacher, and student characteristics focusing on physics lessons in the junior year in pre-academic high school.**
- **Target group: Freshman students in their first weeks in a science related field of study (population: around 10 000; sample: 3230).**
- **Questions in survey derived from Harvard FISCC and PRiSE questionnaires adapted to the Dutch educational and cultural context.**
- **Digital questionnaire send to 9 000 students through university channels accompanied by faculty members promoting the survey.**
- **In order to enter science related courses of study a student has to graduate at least in regular physics (pre-academic level), sometimes advanced physics is recommended.**
- **Advanced physics always included regular physics as well.**
- **Final exam grades are composed for 50% of a national exam at the end of the senior year in high school, and for 50% of school exams, practical and theoretical exams made by the teacher. 10-point scale. A student fails to graduate with more than two 5's or 1 4 for his final subjects.**

Method:

- **Analysis in four groups of 2008 graduates: MR = male regular physics (316); FR = female regular (742); MA = male advanced (1123); FA = female advanced (457).**
- **Physics final grades are used as preliminary indicators for Academic Success (proven to be an important predictor of academic success).**
- **Principal Component Analyses on all results together (grades, interest and understanding); on all other student, school, lesson, and teacher variables together – resulting in independent components within every group – only data of 2008 graduates (recognized by capital letters).**
- **Total variance explained: 68-70%; KMO: 0.64 – 0.83; Crombach's α: 0.45 – 0.90.**
- **Some variables were not included in the components (not correlated enough with others or correlated with all) – analyzed separately.**
- **Linear Regression on physics final grades (PFG) + on the most important predictors of these final grades – only 2008 graduates.**
- **MR pfg: R^2 = 0.57, Durbin Watson: 1.97, N = 316 (16% of population); FR pfg: R^2 = 0.66, Durbin Watson: 1.97, N = 742 (27% of population); MA pfg: R^2 = 0.64, Durbin Watson: 2.01, N = 1123 (36% of population); FA pfg: R^2 = 0.63, Durbin Watson: 2.01, N = 457 (76% of population).**

THE GENERAL PICTURE



GRADES: 'Competence of student' independent of physics.
INTEREST UNDERSTAND: # lessons understood and interesting.
DISCIPLINE: The teacher being disciplined in the eyes of student.
PLEASANT: The teacher being pleasant in the eyes of student.
More variation & PLEASANT seem to stimulate students.

MOST IMPORTANT COMPONENTS

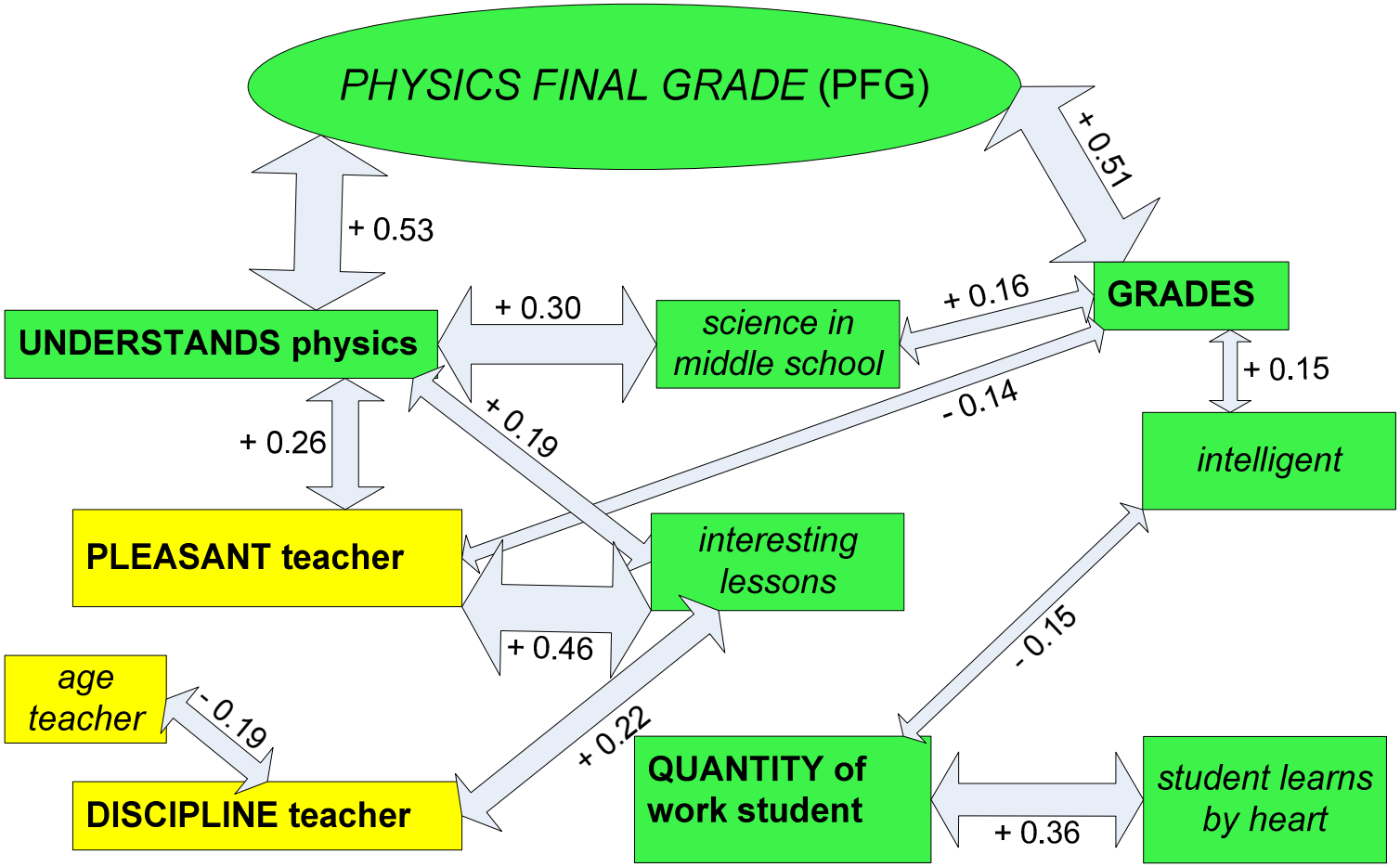
GRADES				
	MR	FR	MA	FA
Math finals	0.65	0.85	0.85	0.83
Chemistry finals	0.77	0.83	0.82	0.84
Dutch finals	0.78	0.61	0.63	0.60
Part of physics test marked satisfactory	< 0.1	0.66	0.64	0.63
# lessons understood by student	< 0.1	0.24	0.27	0.25
+ other variables				

- **Correlates with general intelligence, middle school grades, home influence.**
- **No influence of teacher (possible use: to select students for success?)**
- **For MR totally no co relationship with physics!!**

UNDERSTANDING (INTEREST)				
	MR	FR	MA	FA
# interesting lessons for student	not included	0.86	0.84	0.86
#lessons understood by student	0.81	0.83	0.76	0.82
Part of physics test marked satisfactory	0.82	0.46	0.46	0.53
Math finals	0.44	< 0.1	0.11	0.19
Chemistry finals	0.31	0.12	< 0.1	0.11
Dutch finals NOTE the NEGATIVE	-0.22	< 0.1	-0.12	-0.13
+ other variables				

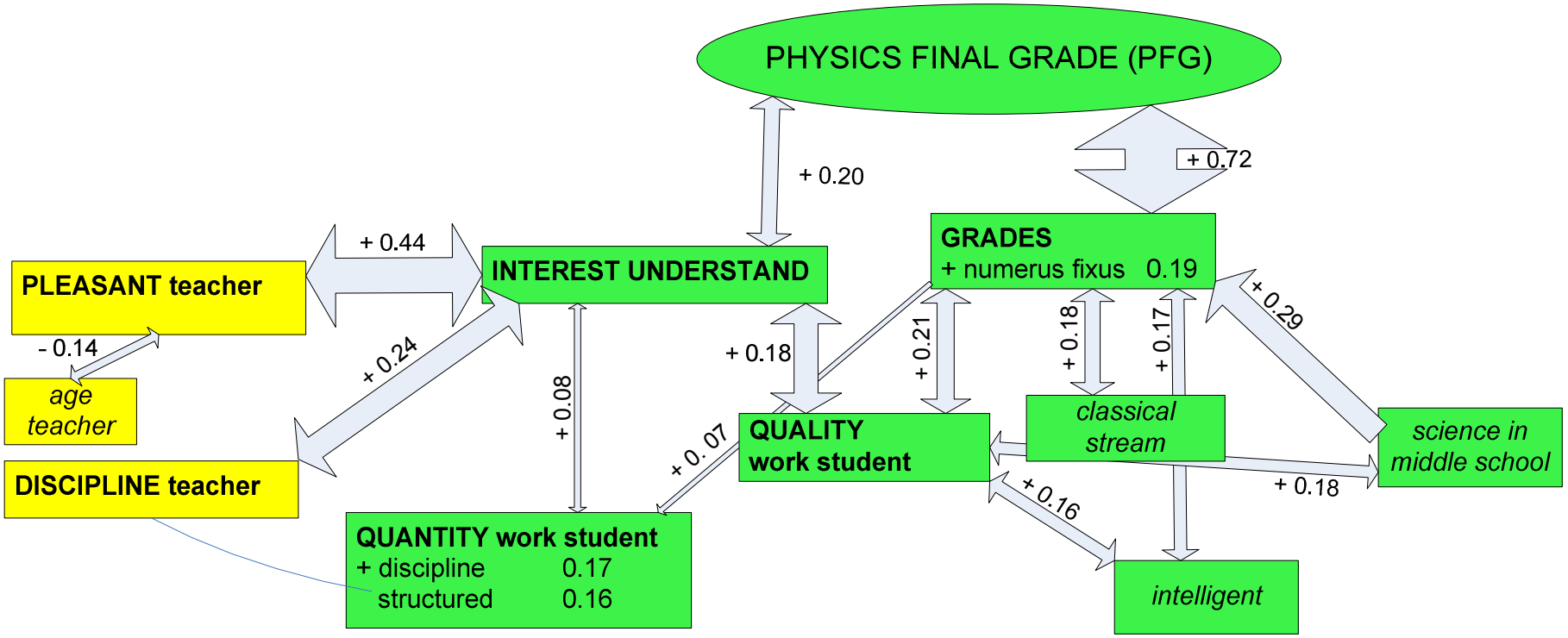
- **Interest of MR-student is almost unrelated to anything else.**
- **Correlated with teacher and student characteristics.**
- **Almost unrelated to GRADES.**

THE MALE REGULAR PHYSICS STUDENT (MR)



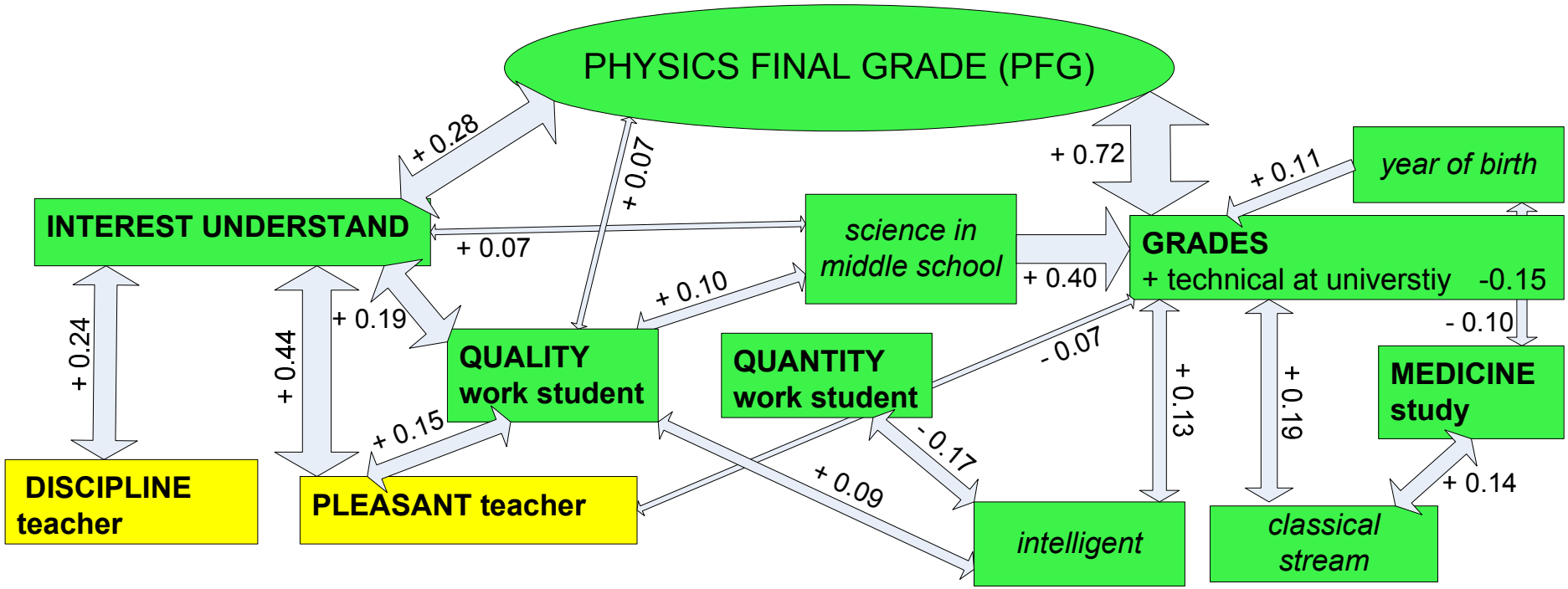
- **PLEASANT teachers stimulate understanding (but no higher PFG).**
- **DISCIPLINE only has influence on interest not understanding.**
- **MR-students start to work only when they do not understand.**

THE FEMALE REGULAR PHYSICS STUDENT



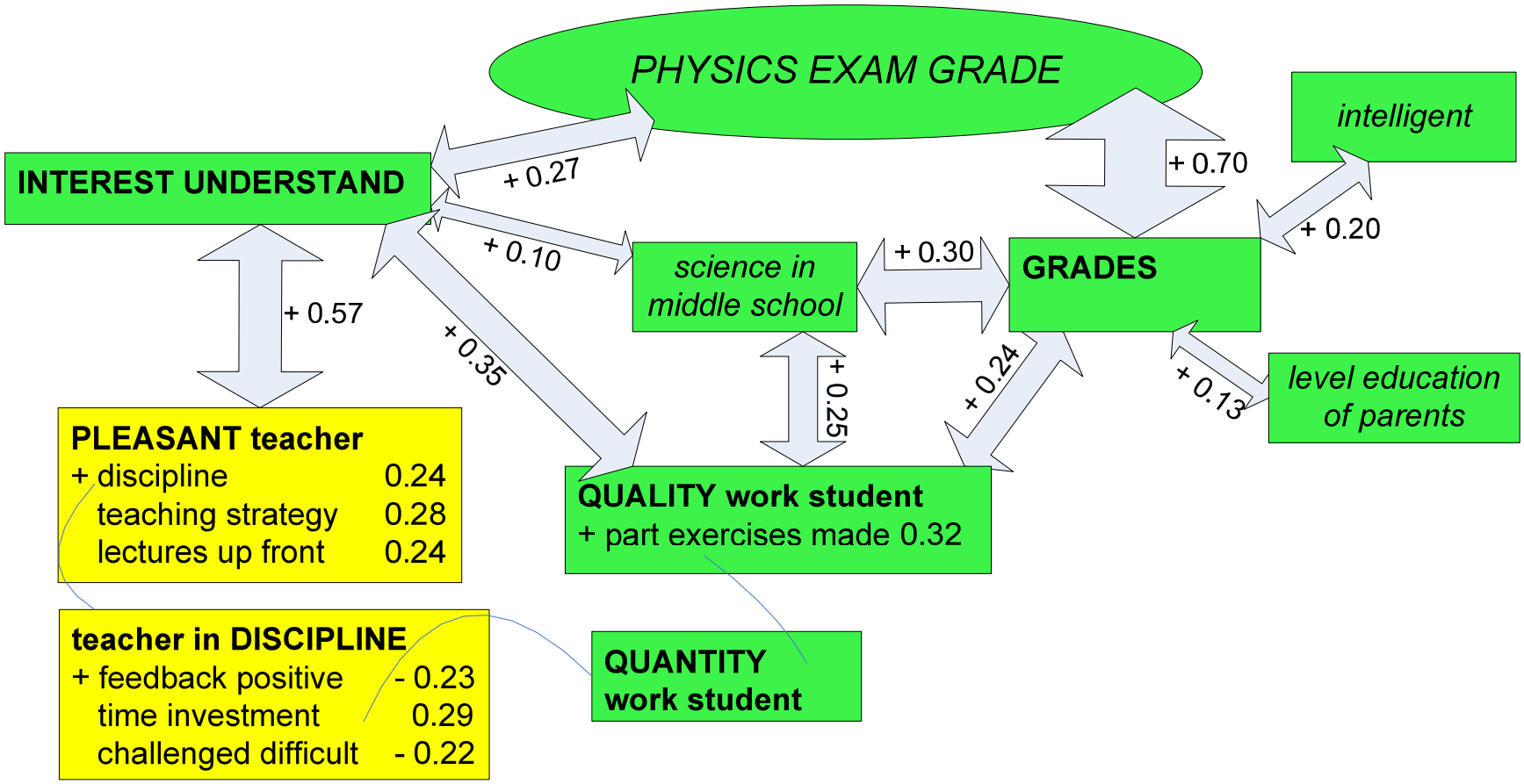
- **On average females report to work much more than male students, but the quality is less (more rote learning and less insight).**
- **DISCIPLINE stimulates more work.**
- **PLEASANT teachers coincide with interest and understanding most, especially when they are also a disciplinarian.**
- **The expected first order correlation between the PLEASANT disciplinarian and PFG is almost nonexistent.**

THE MALE ADVANCED PHYSICS STUDENT:



- **MA-students continuing in a technical course of study rarely aim for high grades (lazy?!).**
- **Less intelligent MA-students (who do not understand much) work harder then more intelligent students (similar but less so as MR).**
- **There are relatively more MA-students with low potential who report a PLEASANT teacher. Is this teacher more stimulating? This seems to be a general male characteristic.**

THE FEMALE ADVANCED PHYSICS STUDENT:



- **FA-students report DISCIPLINED teachers to give more negative feedback; this seems to discourage the FA-student (less challenged).**
- **A friendly disciplined teacher is seen as PLEASANT.**
- **Practice helps the FA-students to learn more through insight.**

THE PLEASANT TEACHER

PLEASANT teacher				
	MR	**FR**	**MA**	**FA**
Pleasant **teacher**	**0.86**	**0.87**	**0.86**	**0.88**
Teacher gave verbal ***feedback*** **- = negative; + = compliments**	**0.76**	**0.83**	**0.78**	**0.74**
Understanding **with class**	**0.82**	**0.79**	**0.76**	**0.82**
Teacher being ***enthusiastic***	**0.69**	**0.62**	**0.73**	**0.81**
Variation **in explaining**	**0.68**	**0.70**	**0.67**	**0.64**
Structured	**0.37**	**0.37**	**0.40**	**0.69**
Consequent attitude **- = unpredictable; + = predictable**	**0.32**	**0.42**	**0.33**	**0.69**
Competence	**not included**	**0.44**	**0.55**	**0.73**
Demonstrations **in lessons**	**0.14**	**0.17**	**0.19**	**0.21**
Working together **in lessons**	**< 0.1**	**0.16**	**0.15**	**0.22**
Explain exercises up front **in lessons**	**< 0.1**	**0.15**	**0.10**	**0.15**
+ other variables				

- **The FA-student perceives her teacher different from the others. This is to be analyzed more thoroughly.**
- **Advanced physics teachers are perceived as more PLEASANT than regular physics teachers. Take into account that AP-students see their teacher more often than RP-students.**
- **The perception of PLEASANT teachers and interesting lessons correlate highly, to a lesser amount the lessons are also understood.**

THE DISCIPLINED TEACHER:

DISCIPLINEd teacher				
	MR	**FR**	**MA**	**FA**
Teacher being *disciplined*	**0.78**	**0.82**	**0.76**	**0.80**
Structured	**0.71**	**0.75**	**0.71**	**0.40**
Consequent attitude	**0.70**	**0.64**	**0.65**	**0.35**
Competence	**not included**	**0.58**	**0.40**	**0.18**
Understanding **with class**	**< 0.1**	**0.30**	**0.29**	**< 0.1**
Enthusiastic	**< 0.1**	**0.40**	**0.23**	**< 0.1**
Pleasant	**0.23**	**0.18**	**0.12**	**< 0.1**
Part Mandatory Exercises Made **by students**	**< 0.1**	**0.22**	**0.16**	**0.17**
+ other variables				

- **In general discipline is just a little more appreciated as leaving the pupils to themselves. For some FA-students there seems to be a pleasant kind of discipline and an unpleasant kind that differ considerably. This is going to investigated further.**
- **Stimulates QUANTITY of work (not for MR-students).**
- **Correlation between DISCIPLINE and the number of lessons understood is highest for FR- and MA-students (majority in their class).**

IN GENERAL: Teachers seem to be perceived as competent when they make their lessons more interesting and understandable.

QUANTITY OF WORK STUDENT:

QUANTITY of work for physics - student				
	MR	FR	MA	FA
Student reports to work hard	0.83	0.83	0.83	0.84
Time investment outside class	0.84	0.78	0.82	0.77
Part Mandatory Exercises Made	0.79	0.75	0.79	0.74
Learning physics by heart before tests	not included	0.64	0.61	0.64
Challenged when difficult	not included	0.40	not included	0.24
+ other variables				

- **Some variables in QUANTITY have a positive influence on the physics final grades some negative. Added together the influence is nil.**
- **Reported time investment per week is higher for regular than for advanced physics and than females >> males.**
- **FA-students work more in classes with more girls.**
- **FR-students work more in schools with more students taking physics (more attention for physics among her friends?)**
- **MR-students work more in small classes (less social pressure to keep to the male role?). Is the quantity of hard a social concept?**
- **Males only start working when they really don't understand.**
- **The data suggest that teacher activities that stimulate males to work harder could be beneficial for their physics exam grades.**

QUALITY OF WORK STUDENT:

QUALITY of work for physics - student			
	FR	MA	FA
Learning physics through insight	0.84	0.94	0.78
Challenged when difficult	0.66	not included	0.72
Learning physics by heart	- 0.41	-0.30	-0.45
Part Mandatory Exercises Made	0.17	< 0.1	0.32

- **Mean QUALITY reported by advanced physics students higher than reported by regular physics students.**
- **Mean QUALITY reported by males higher than reported by females.**
- **With females their reported QUALITY has more influence on interest and understanding. And this is the kind of interest and understanding that correlates positively with physics exam grades.**
- **For females practicing exercises helps increase QUALITY.**
- **The data suggest that teacher activities that improve the QUALITY of work in females could be beneficial for their physics exam grades.**

CONCLUSIONS:

THE INTERACTION BETWEEN LESSONS TEACHERS AND PUPILS ARE DIFFERENT FOR DIFFERENT KINDS OF PUPILS (different in gender and physics level).
DIFFERENTIATION IN THE CLASS IS ADVISED.
I hope that the interrelationships between student, teacher and classroom characteristics as reported in this poster give enough suggestions to use in the practice of your everyday physics lesson in high school.

CONTACT

I am sorry I was not able to be present in person. Please, contact me with questions or comments. You are invited to visit my site.

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