How does mentoring with female pupils work?

- Results of multivariate analyses of the effects of a German mentoring program in the STEM field

Claudia Quaiser-Pohl, Martina Endepohls-Ulpe, Catharina Meyer
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Ada Countess of Lovelace (1815-1852)
birth name: Ada Byron

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- She has written the first programming codes for “calculating engines” of Charles Babbage.

- She is a role model for the female mentors and the female mentees in the project.

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Locations and History

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Formation of the project:

- 1997 at University of Koblenz
- 1997-2011: > 500 female mentors
- > 75.000 girls reached

2013:

- roughly 180 female mentors
- 10 universities resp. universities of applied science
- about 400 workshops and other activities with > 6.000 participants

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The Female Mentors

- are students of STEM subjects or apprentices of STEM occupations
- are looked forward as role models
- inform and consult the girls about STEM streams
- strengthen their interest and capabilities in STEM by working in a live environment, for example by arranging workshops on STEM topics
- enhance the girls‘ self-confidence

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General Aims and Activities

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1. to encourage girls aged between 11 and 18 years to develop an interest in STEM topics
2. to raise their awareness of the opportunities offered by study programs, occupations and scientific careers in the STEM field

by focusing on …

Development of Early Interest for STEM Topics	Orientation for Study and Job	Study Support/ Vocational Start	Sustainable Qualification
Workshops/Study Groups (Clubs) for Pupils, Summer Academies/Holiday Camps, Girls´ Days etc.		Mentoring for Graduate Students and PhD Students	Training and Encouragement for Mentors (= female students and apprentices)
	Vocational Mentoring	Mentoring for University Fresh(wo)men	
DIVERSITY MENTORING (for special groups, e.g. girls from migrant families or with no academic background in their families)			
Fairs and Exhibitions	Special activities e.g. „azubi und studientage“, STEM Action Days/Weeks	Stays in firms (e.g. „Taster Occupational Training“)	Teacher Training/ Advanced Teacher Training
	Assessments (e.g. Taste MINT)		
MENTORING	EMPOWERMENT	EDUCATION	

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Quality Management

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1. *Continuous evaluation through questionnaires for students after having attended an ALP activity* (e.g. workshop, summer academy/holiday camp, taster vocational training)

→ An annual evaluation report (all activities) and several evaluation reports for different locations, activities etc., and for specific questions

2. *Secondary Analyses of Official Data*
3. *Trainings for female mentors*: about e.g. gender competence, performing, communicating and teaching

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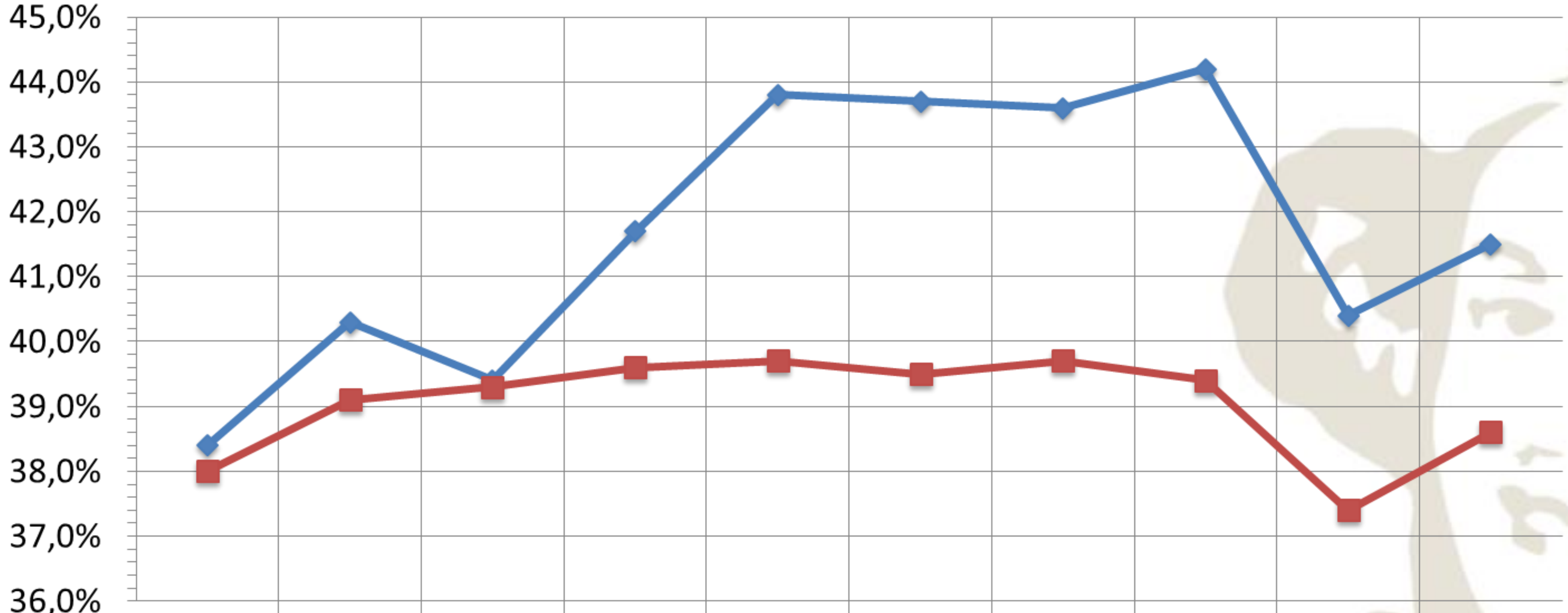
Success over the last decade:

Percentage of Female Fresh(wo)men in Natural Science Subjects at Universities in Rhineland-Palatinate compared to national average (winter terms 2003 to 2013)



	WS 03/04	WS 04/05	WS 05/06	WS 06/07	WS 07/08	WS 08/09	WS 09/10	WS 10/11	WS 11/12	WS 12/13
L	38,4%	40,3%	39,4%	41,7%	43,8%	43,7%	43,6%	44,2%	40,4%	41,5%
B	38,0%	39,1%	39,3%	39,6%	39,7%	39,5%	39,7%	39,4%	37,4%	38,6%

L= Rhineland-Palatinate
B= Federal Republic of Germany

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Success over the last decade:

Percentage of Female Fresh(wo)men in Engineering at Universities in Rhineland-Palatinate (winter terms 2003-2013)

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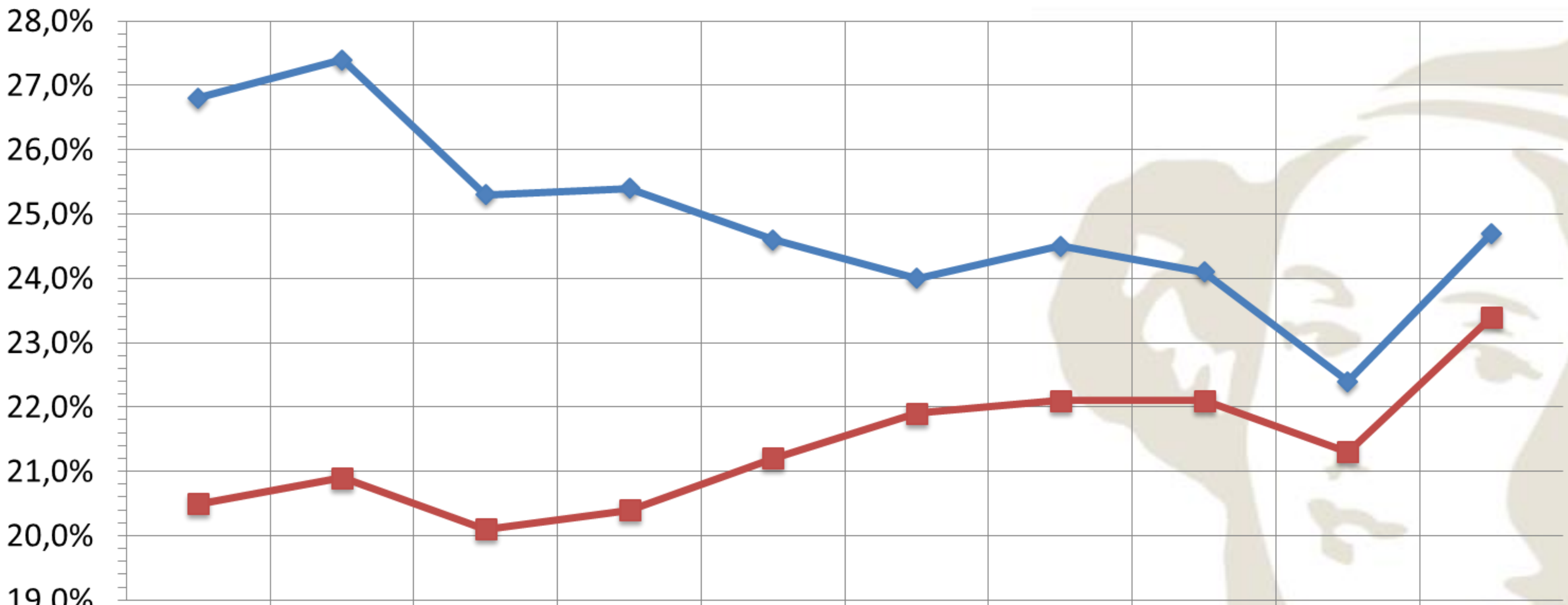

	WS 03/04	WS 04/05	WS 05/06	WS 06/07	WS 07/08	WS 08/09	WS 09/10	WS 10/11	WS 11/12	WS 12/13
L	26,8%	27,4%	25,3%	25,4%	24,6%	24,0%	24,5%	24,1%	22,4%	24,7%
B	20,5%	20,9%	20,1%	20,4%	21,2%	21,9%	22,1%	22,1%	21,3%	23,4%

L= Rhineland-Palatinate
B= Federal Republic of Germany

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Preconditions and barriers for effective mentoring: the part of families and schools

Martina Endepohls-Ulpe & Claudia Quaiser-Pohl

Introduction

- Evaluation studies of mentoring projects in raising and maintaining girls‘ interest in the field of STEM are
  - not easy to finance and organize
  - show results that at first sight seem not to be very encouraging.

Introduction – first evaluation studies

- Evaluation study (Ebach, Jesse & Sander, 2004)
  - Longitudinal study
  - Objective: effects of the participation in project activities on girls' attitudes and interests in direction of the projects' aims
  - 263 girls from the 9th grade of 8 secondary schools.
  - Design:
    - Experimental group: One half of the students participated in several ALP activities during one year
    - Control group: did not have any contact with ALP measures in this period.
    - 2 mps: girls filled in a questionnaire in which they amongst others rated their interests in different fields of occupations from the field of STEM. Students who participated in ALP measures also evaluated these courses and workshops.

Introduction – first evaluation studies

- No consistent interpretable results with respect to possible effects of the measure
- Using differences in attitudes against the offered measures as a covariate statistically significant differences in the effects of the measures could be shown.
  - Girls who started their participation in the ALP measures with a high degree of acceptance of the measure changed their interests in occupations from the field of STEM in the intended direction
  - The group of girls who did not like the courses at the beginning as well as the girls who did not participate in the measure did not show any changes in their interests.

Accompanying research – theoretical background

- Theories of gender role development
  - Socal learning theory
    - Influcence of parents, peers, teachers
  - Cognitive theory
    - individuals own activity, development of a gender realted identity
  - Social psychology
    - Interplay of situational variables and varables in social systems
- Theories of vocational choice
  - Godfredson
    - Developmental approach
    - career aspiration as an attempt to integrate one's self-concept into social reality

Biographical studies on possible influences on interest and engagement in STEM

- 1. Interview study (Endepohls-Ulpe, Sander, Geber & Quaiser-Pohl, 2013):
  - Research questions:
    - Is it possible to identify specific events and experiences in the biography of females who are successful in a professional STEM career at a university?
    - Which were the socialization influences that mainly promoted the occupational careers of the interviewees?
  - Subjects:
    - 15 women graduated in a STEM subject, working at one of the universities or at a research center in Vienna,
    - 6 women pursuing a scientific career in a STEM subject and either working at Koblenz University or at Koblenz University of Applied Sciences,
    - age 27 to 65.
  - Method:
    - Semi-structured interview
    - Analysis by content analyses according the suggestions of Mayring (2010).

Biographical studies

- Results study 1
  - Primary socialisation
    - Interest in STEM was mainly awakenend by
      - parents in early childhood,
      - mostly fathers, by mothers and sisters in some cases
  - Secondary socialisation
    - Teachers and schools were less important and had only influence in some cases
  - Tertiary socialisation
    - Sharing of interest in STEM with female peers

Biographical studies

- Results study 1
  - Adulthood
    - Seizing of career opportunities given by chance
    - Importance of formal and informal networks
    - Subjects were convinced that it is important to resist gender stereotyped role behavior consciously.

Biographical studies

- 2. Questionnaire study (Endepohls-Ulpe, Ebach, Seiter & Kaul, 2012):
  - Research questions:
    - search for biographical incidents or circumstances that young women studying in a technological field remembered as encouraging or discouraging for their choice
    - search for education related variables in which these students (students of courses in engineering) differed from students in non-STEM subjects
    - Search for differences between national subsamples (Germany / Austria) which could give information about the effects of differences in the school systems.

Biographical studies

- 2. Questionnaire Study
  - Sample:
    - Germany:
      - 179 non-engineering students (49 male and 130 female), (University of Koblenz-Landau)
      - 141 engineering students (79 male and 62 female), (several universities of applied sciences in Rhineland-Palatinate, federal state of Germany)
      - age: 19 – 48 (mean 23)
    - Austria:
      - 88 non-engineering students (7 male, 81 female), (teacher training college Vienna; University for agricultural and environmental pedagogy Vienna)
      - 100 engineering students (50 male, 50 female), (University for technical sciences Graz)
      - age: 18 to 43 (mean 22)

Biographical studies

- Questionnaire study
  - Method
    - Measuring instrument: Two questionnaires according to the two target groups (engineering students / non-engineering students),
      - Subscales
      - Primary school education
      - Middle and secondary education
      - Self-image
      - Self-efficacy related to technological competences (currently as a student)
    - Statistical analysis:
    - Principal Component Analysis followed by Varimax Rotation,
    - Testing of reliability by Item-analysis (Cronbachs α) was used for the Likert-scales.
    - Analysis of Variance (ANOVA), with gender, course of study, and nationality as fixed factors and values on the dimensions of the subscales of the questionnaire as dependent variables.

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Biographical studies

- Results
  - Gender differences – female students:
    - Lower self-efficacy, lower intellectually and practically based interest in science and technology already in primary school.
    - Lower self concept with respect to cognitive and general technical abilities
    - Lower self-concept with respect to practical know-how in technology, ICT competencies and comprehension of technology
    - Teachers did not impart importance of technology or raise any interest for the subject in girls at an early age.

Biographical studies

- Results
  - Engineering students:
    - higher self-efficacy, and intellectually and practically based interest with regard to technical and science themes already in their primary school years.
    - more support by their fathers concerning technical activities and interests during childhood.
    - Austrian engineering students reported more support from teachers and parents in mathematics and science in their secondary school time.
    - higher self-concept with respect to general cognitive and technical abilities and a higher self- concept with respect to practical know -how concerning technology, ICT and comprehension of technology.
    - For these fields female engineering students had similar self-handicapping beliefs as their peers from non-engineering fields of study, at least in comparison to male students from their own field of study

Biographical Studies

- Results

  - Cross-national differences:

    - Austrian schools seem to be more supportive to students in the field of STEM.
    - Mainly males seem to benefit from institutionalized technology education

Summary and Discussion

- Main results of the two studies:
  - The role of families and schools
    - Interest and self-efficacy with respect to STEM subjects already seem to arise very early.
    - Families – especially fathers – play the leading part in this process.
    - Schools and teachers played only a minor role for the career choices of girls and women, neither in primary nor in secondary education.
    - Even in the Austrian school system where education in the STEM subjects seems to be more valued than in Germany mainly males profit from these circumstances.
  - Influences in tertiary education
    - Positve: Networking
    - Negative: self-handicapping beliefs with respect to ICT and comprehension of technology

Discussion

- Consequences for mentoring programs
  - Intervention programs have to start early.
  - Programs starting in secondary school have to work on the fundament of early installed differences in interests and self-concepts, which can act as barriers.
  - Mentoring programs are essential to counteract detrimental influences of schools, peers and media.
  - There is a need to support
    - female students attending university courses from the field of STEM
    - women who have successfully finished their studies.

Results of the continuous evaluation of the ALP:

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Short Questionnaire for Participants:

Every participant of an ALP activity has to answer questions on the following topics:

1. General conditions (title and type of activity, location, …)
2. The specific ALP activity they have attended (frequency of attendance, evaluation, suggestions, …)
3. Their personal dates (age, grade, type of school)
4. Attitudes towards STEM (e.g. aptitude-related self-concept, interests, favorite school subjects, …)
5. Career aspiration (desired job and job domain)

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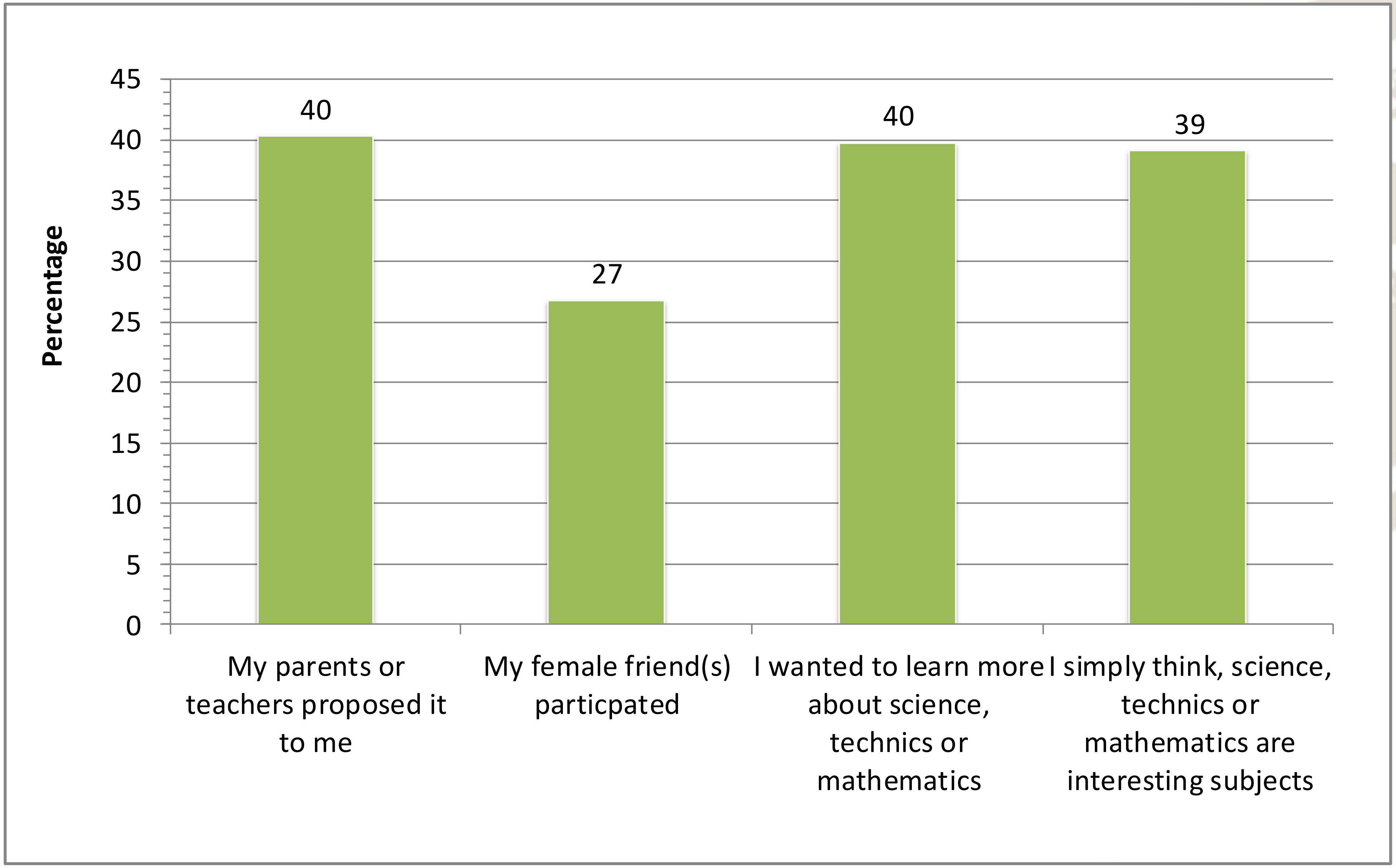
I. Descriptive Statistics: Motivation to Participate in an ALP Activity

(Sample: Survey 2011; N=1467)



Favorite School Subjects
(Sample: Survey 2011; N=1467)

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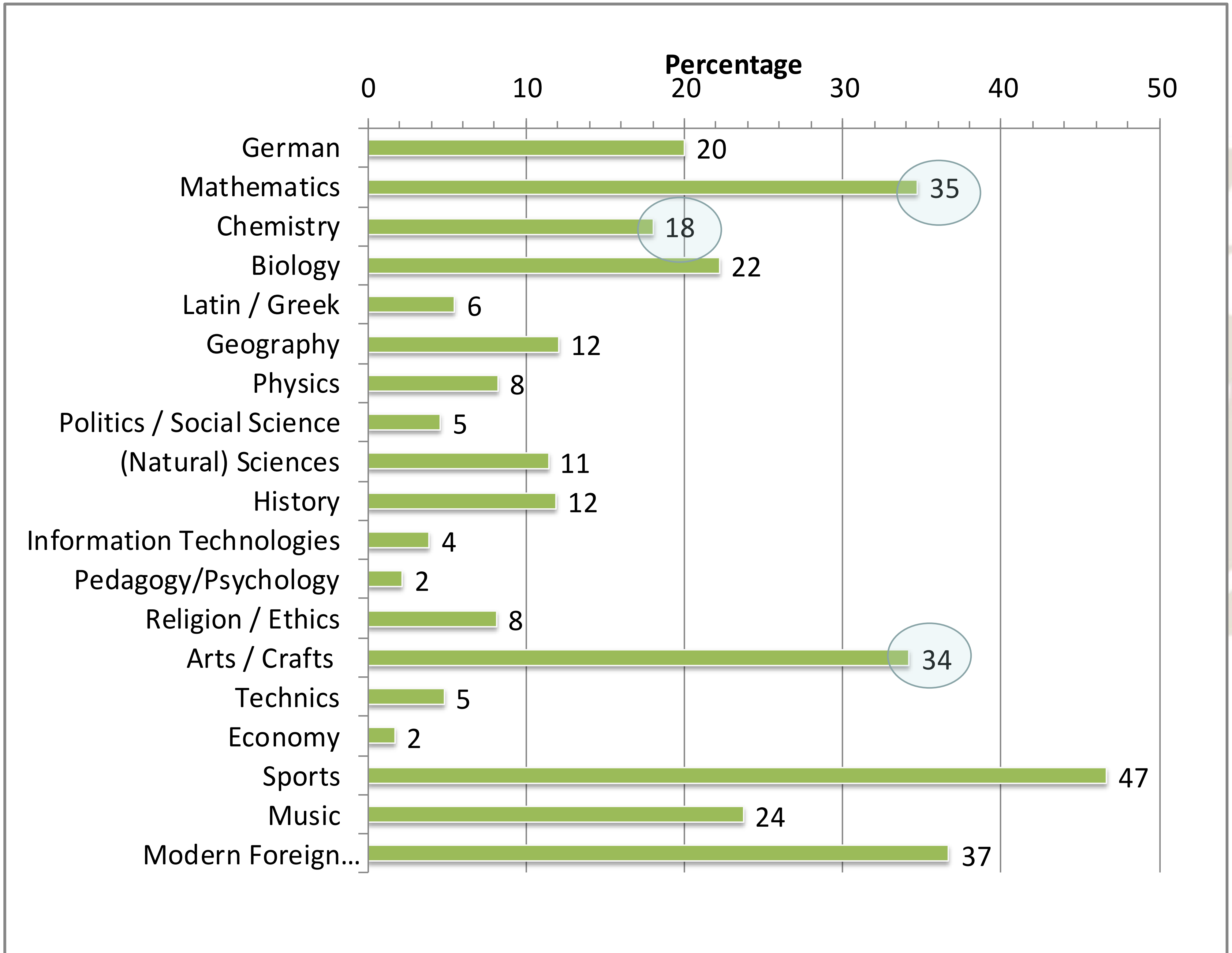
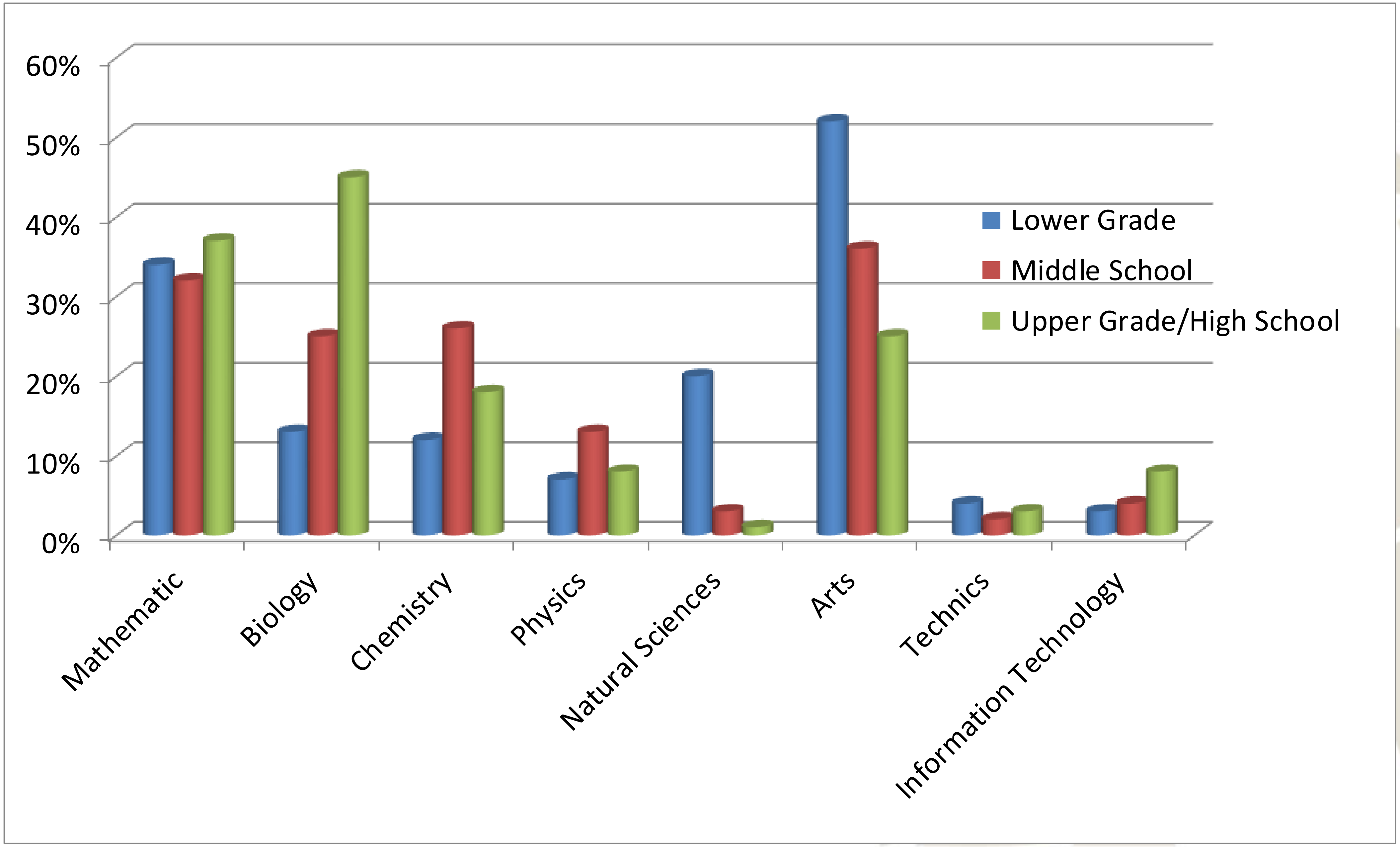


Favorite STEM Subjects at Different School Grades

(Sample: Survey 2011; N=1467)



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Wishful Job Domains

(Sample: Survey 2011; N=1467)

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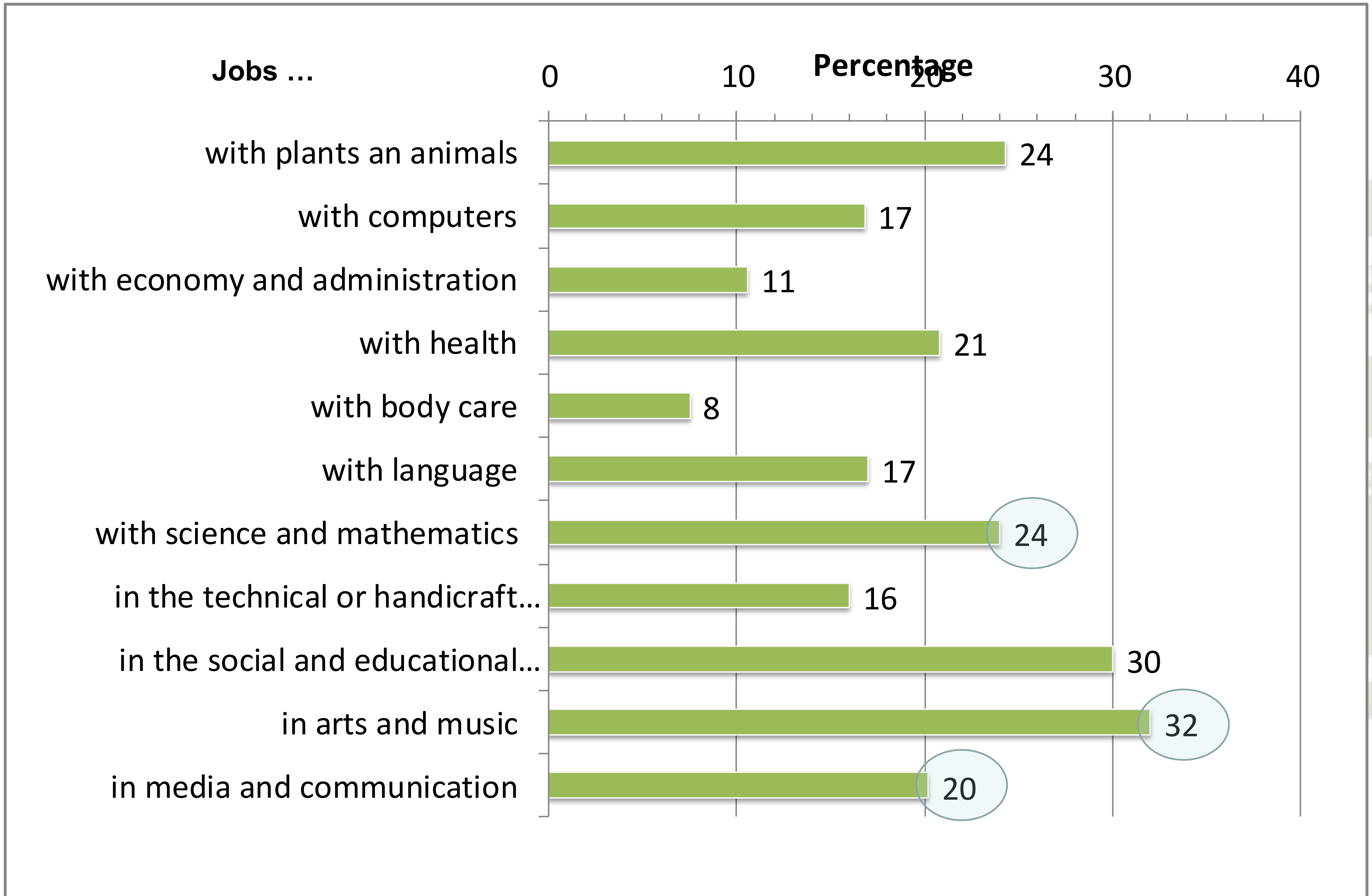

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Wishful Jobs - in the STEM field
(open question) (Sample: Survey 2011; N=1467)

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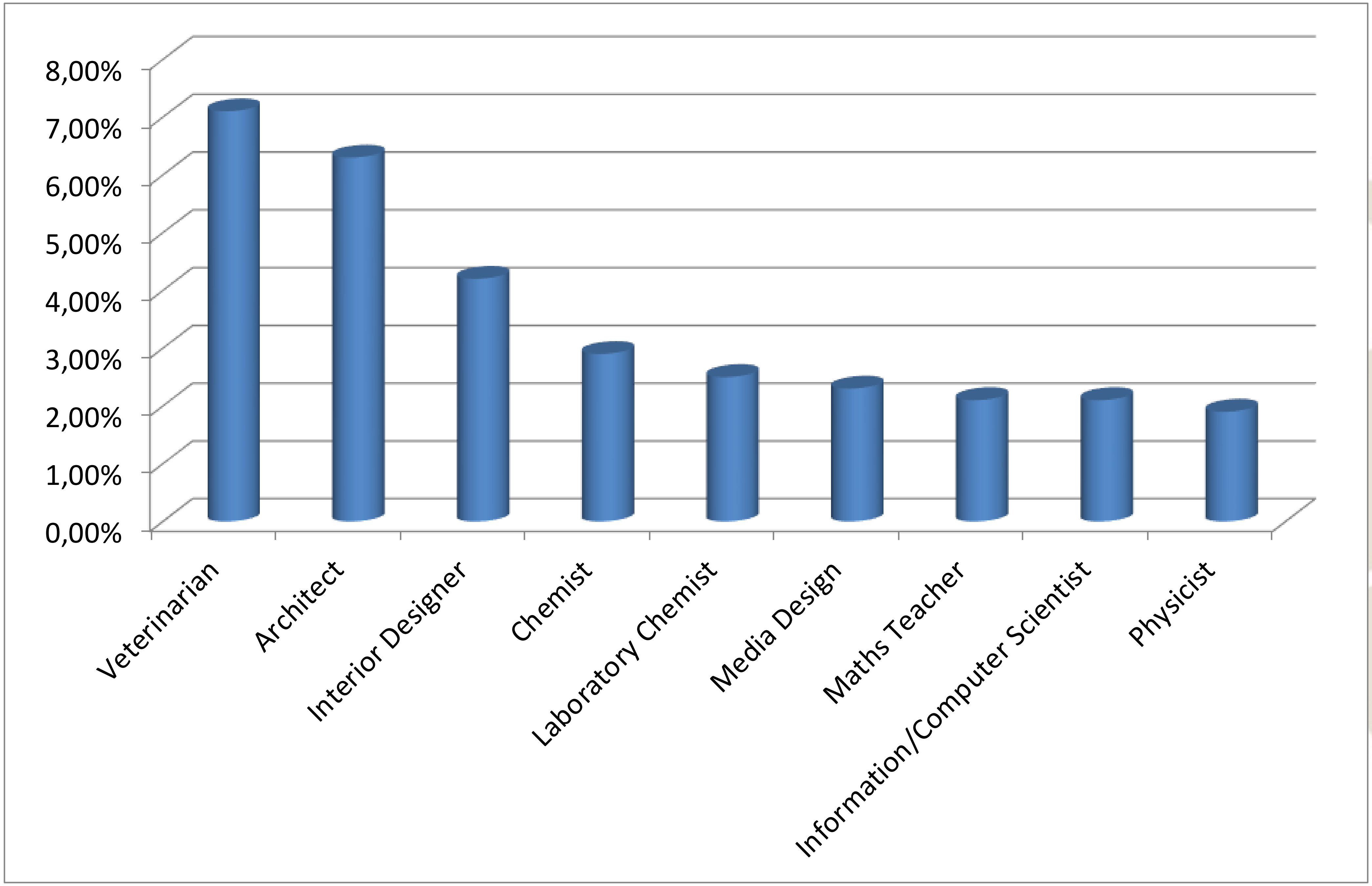

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II. Path Analyses:

Factors Predicting a STEM Occupation as a Wishful Job

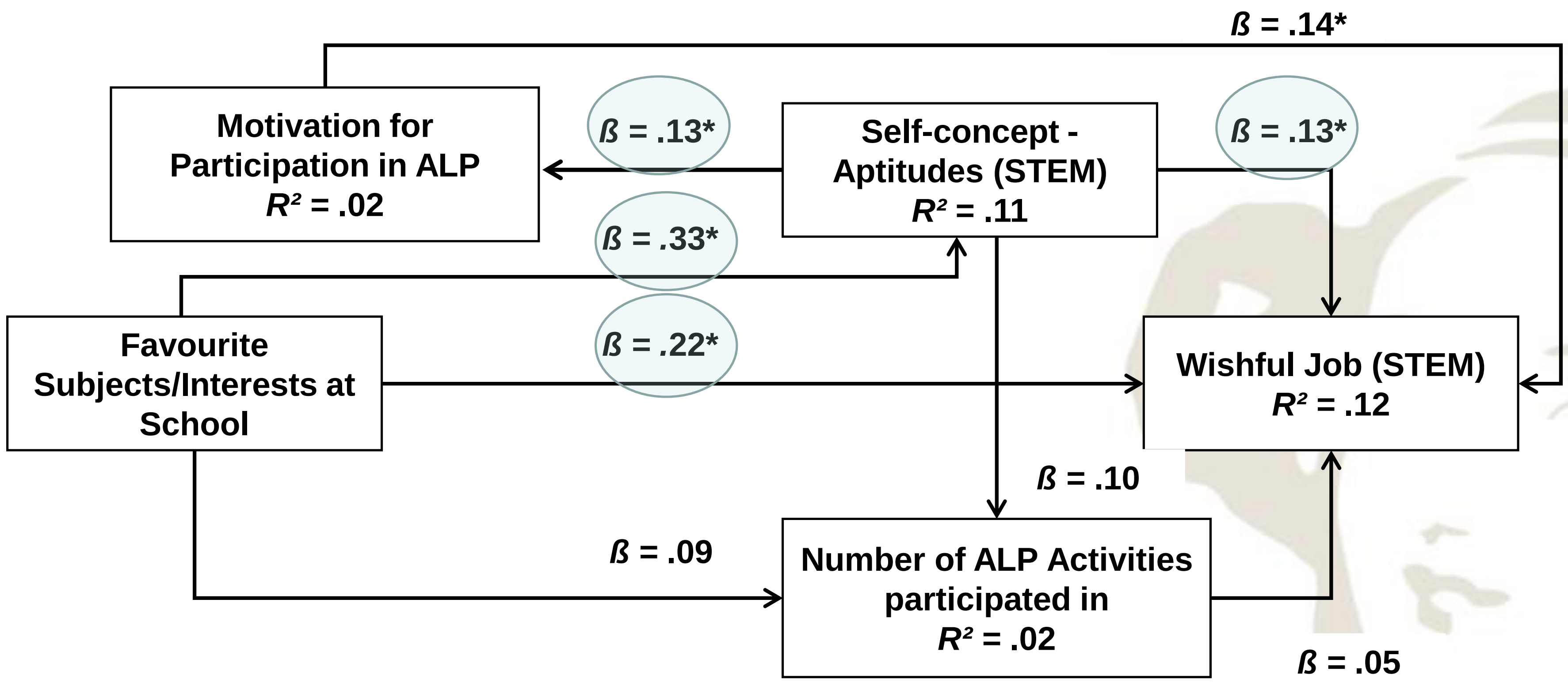
1. General Approach:

- only *high school students*, who participated in specific activities(e.g. *workshops, study groups, taster occupational training)* included
- separate analyses for the age groups **11-14** and **15-18** (→ Gottfredson)

2. Coding of the variables:

- **Motivation for Participation in ALP (M):** *0 (intrinsic) to 2 (parents/peer influence)*
- **Favourite Subjects/Interests at School**: STEM vs. no STEM subject (0/1)
- **Aptitude-Related Self-Concept (Total SC):**
  „In comparison to your peers, how would you rate your own abilities in the following fields“:
  1. Mathematics, 2. Science, 3. Technics
  Rating: 5= clearly better, 4= a little better, 3=as good as, 2= a little worse, 1=clearly worse
  → mean value (mathematics, science, and technics)
- **Number of ALP activities in which they particpated:** 0-5 (only the highest number, i.e. no repeated measurements)
- **Wishful Job in the STEM field:** *any STEM Job vs. no STEM Job (0/1)*

Empirical Model
Age group:11-14 years
(N = 817)



ML: χ^2 = 2.398; *df* = 2; *p* = .302; *CFI* =.998; *RSMEA* = .016; 90% *CI OF RMSEA* (.000 - .073)

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Empirical Model
Age group:15 -18 years
(N = 771)

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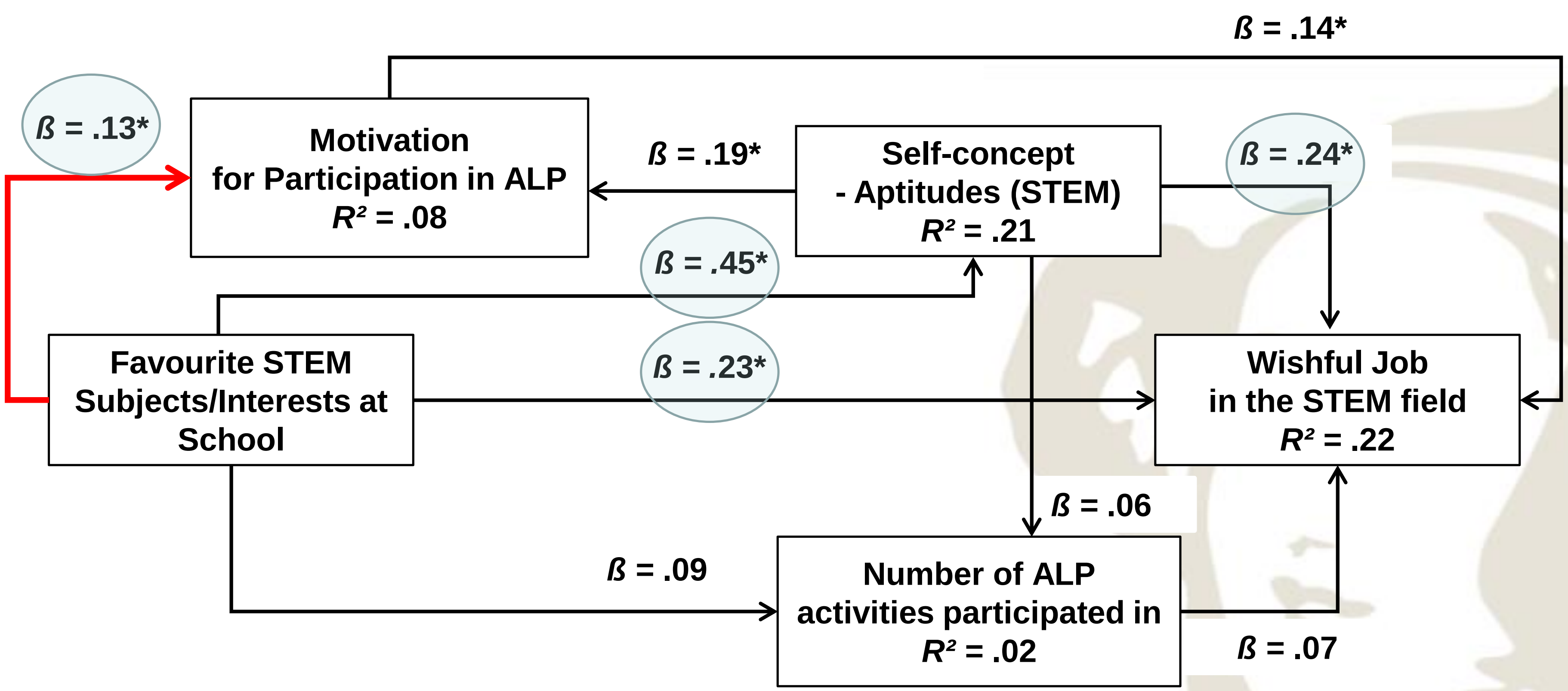

ML: χ^2 = 1.006; *df* = 1; *p* = *.313 CFI* =1.000; *RSMEA* = .003; 90% *CI OF RMSEA* (.000 - .095)

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Conclusions

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- The aptitude-related self-concept influences the motivation for participation and the importance of the aptitude-related self-concept (SC) for wishful job increases with age → Encouragement is important in both age groups!
- with the younger age group: main influence of favorite school subjects/interests on wishful job (although of similar importance in the older group) → STEM interests seem to develop earlier !
- motivation for participation is predicted by interests at school only at 15-18 → importance of school curricula and teachers increases with age!
- Wishful job is rather instable in the younger age group, however, well predicted in the older age group (15-18)
→ ALP can offer a useful support at this phase of study and job orientation

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Perspectives

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- only specific subgroups have been studied (e.g. high school pupils who attended specific activities)

→ different results in other subgroups ?

- Counting of the number of ALP Activities participated in (= quasi cross-sectional design without repeated measurement) - problematic?

→ longitudinal analyses necessary

- only general self-concept for STEM has been studied

→ to analyze the self-concepts e.g. for mathematics, chemistry, technics separately

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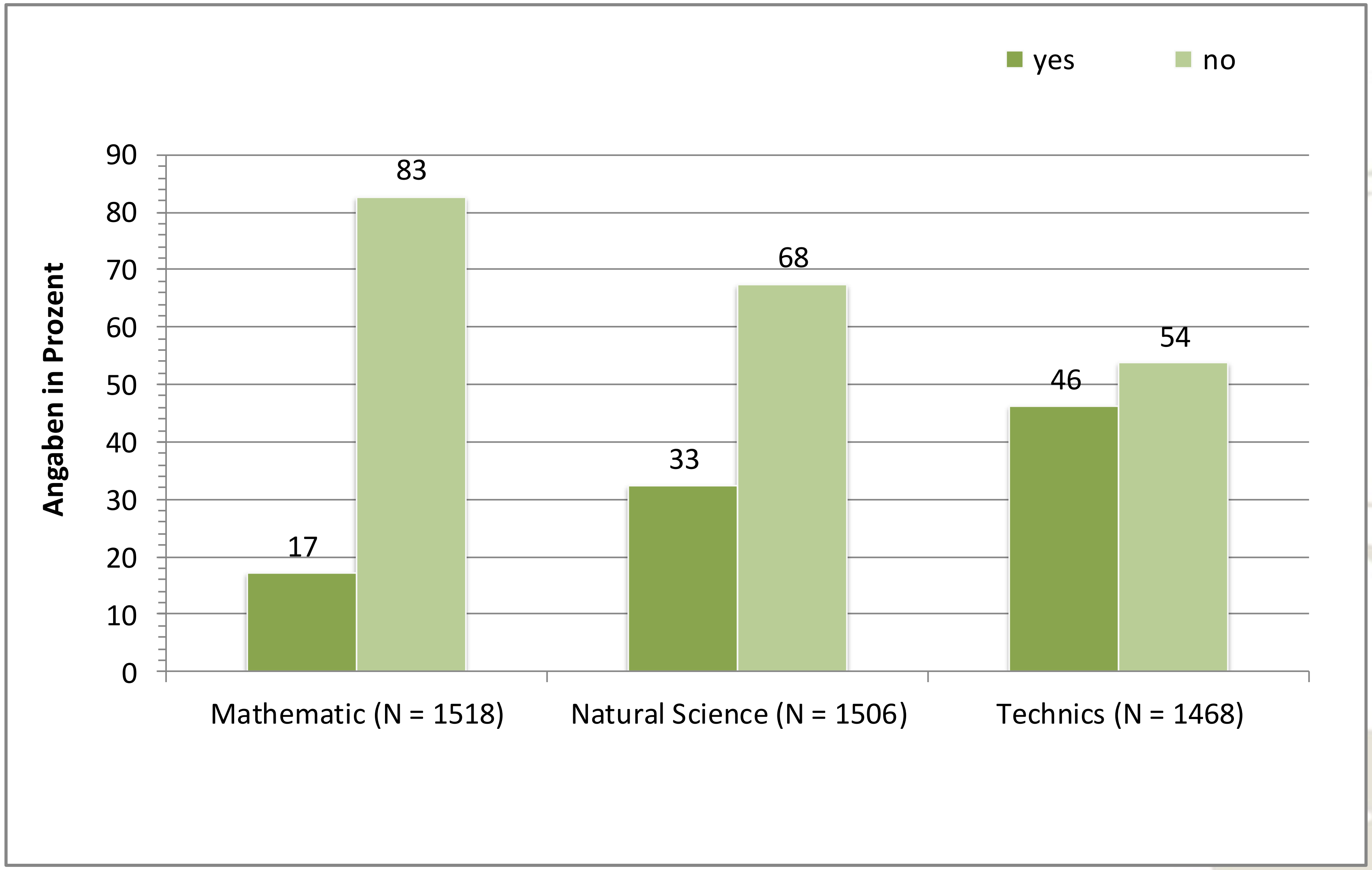
→ The ALP encourages especially concerning technics:



„How good are you at …? Better than before having participated in this ALP activity?“

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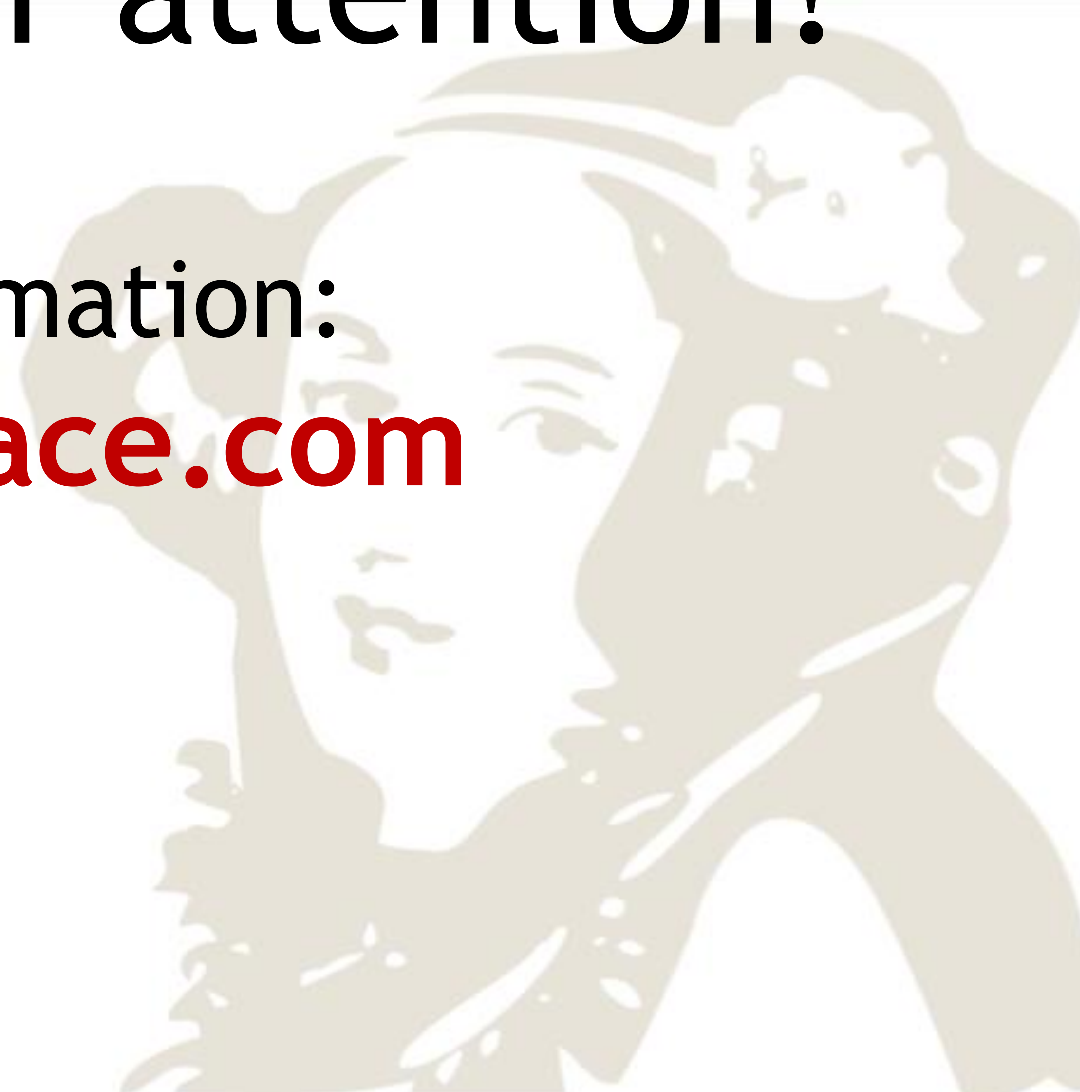

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