



NAZARBAYEV  
UNIVERSITY

# Plugging the Leaky Pipeline: Perceptions of Primary Teachers and Students towards STEM Education

Gulnara Namysova  
Janet Helmer  
Kathy L. Malone  
Gulfarida Myrzakulova



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# Agenda

- Background
- Purpose of the Study
- Methods and Methodology
- Participants
- Findings
- Conclusion



## Background

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Research shows an overall lack of interest in engineering

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Only 15% of students earn engineering degrees (OECD, 2014).

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Only 20 % of these degrees are completed by females.

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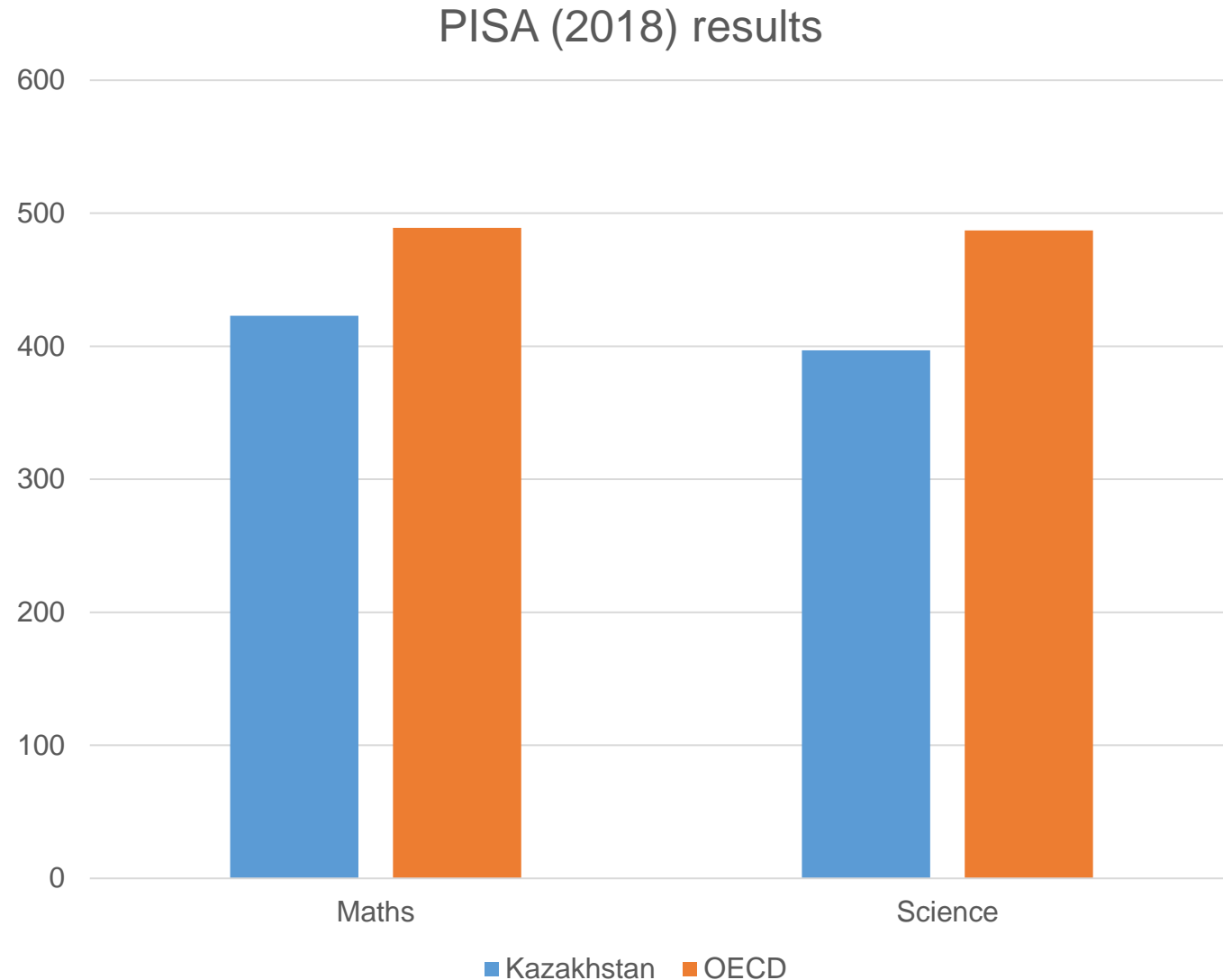
By the time students are in college it is too late to interest them in science or engineering (DeWitt, Archer & Osborne, 2014).

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Attitudes towards science & STEM careers decline once science is no longer a required subject

# STEM in Kazakhstan

- Teaching STEM subjects in English in secondary schools has been announced in a number of policy documents (MoES, 2015; MoES, 2016).
- PISA (2018) results
  - Mathematics: OECD (ave.) - 489 points; Kazakhstan - 423 points
  - Science: OECD (ave.) - 487 points; Kazakhstan - 397.



## Purpose of the Study

To investigate the STEM knowledge level of primary school students

To investigate primary school teachers' and pre-service teachers' perspectives on STEM education

## Methods & Methodology

“Draw an Engineer” test (Capobianco et al., 2011)

Focus groups with primary school teachers and pre-service teachers

# DRAW AN ENGINEER TEST — IN RUSSIAN

Пол: Мужской Женский

Класс: 1 2 3 4

Нарисуй инженера или инженеров на работе:

1) Опиши свою рисунок в нескольких словах и почему ты  
нарисовал(а) это

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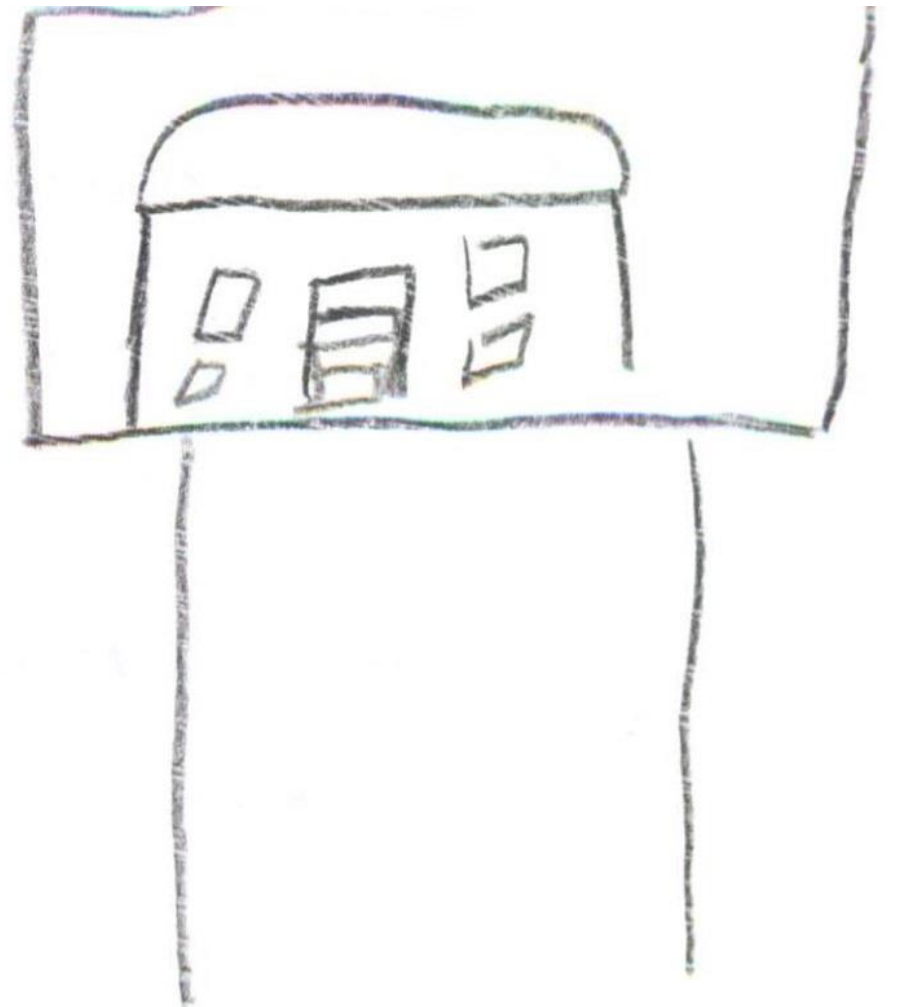
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# 2<sup>ND</sup> GRADER'S PICTURE



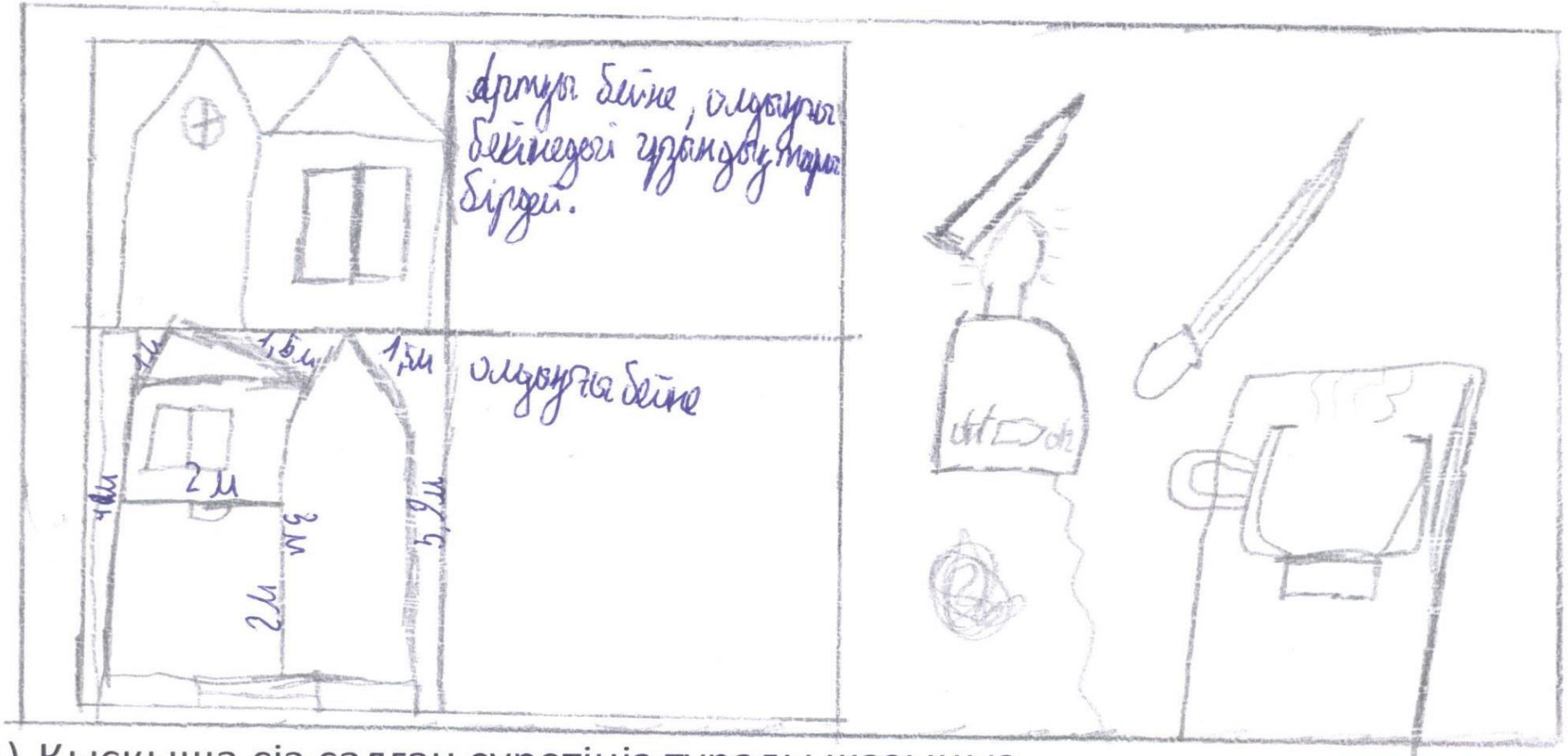


# 3<sup>RD</sup> GRADER'S PICTURE

carrying



# 4<sup>TH</sup> GRADER'S PICTURE



1) Қысқаша сіз салған суретіңіз туралы жазыңыз

# INTERRATER CHECK

Three raters

15 DAET test scored

Fleiss's Kappa – 0.776

Test and Rubric adapted from:

- Thomas et al. (2016)
- Chiang et al. (2020)
- Capobianco et al. (2011)

Rubric had 7 sections:

- Use of Maths
- Use of Science
- Gender Stereotypes
- Work of an Engineer Continuum
- Field of Engineering
- Engineering Process Tools
- Picture of an Engineer

# STUDENT PARTICIPANTS

1<sup>st</sup> graders – 210

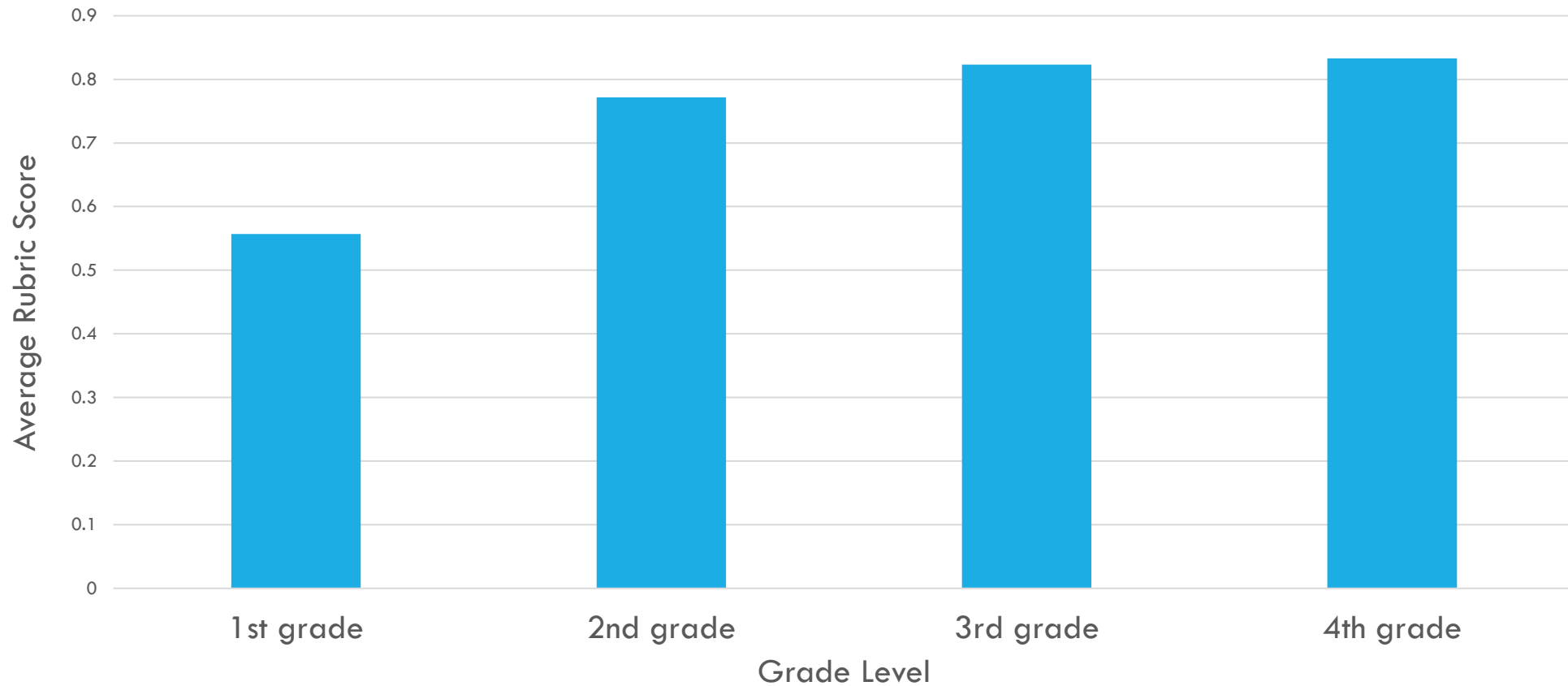
2<sup>nd</sup> graders – 206

3<sup>rd</sup> graders – 135

4<sup>th</sup> graders – 166

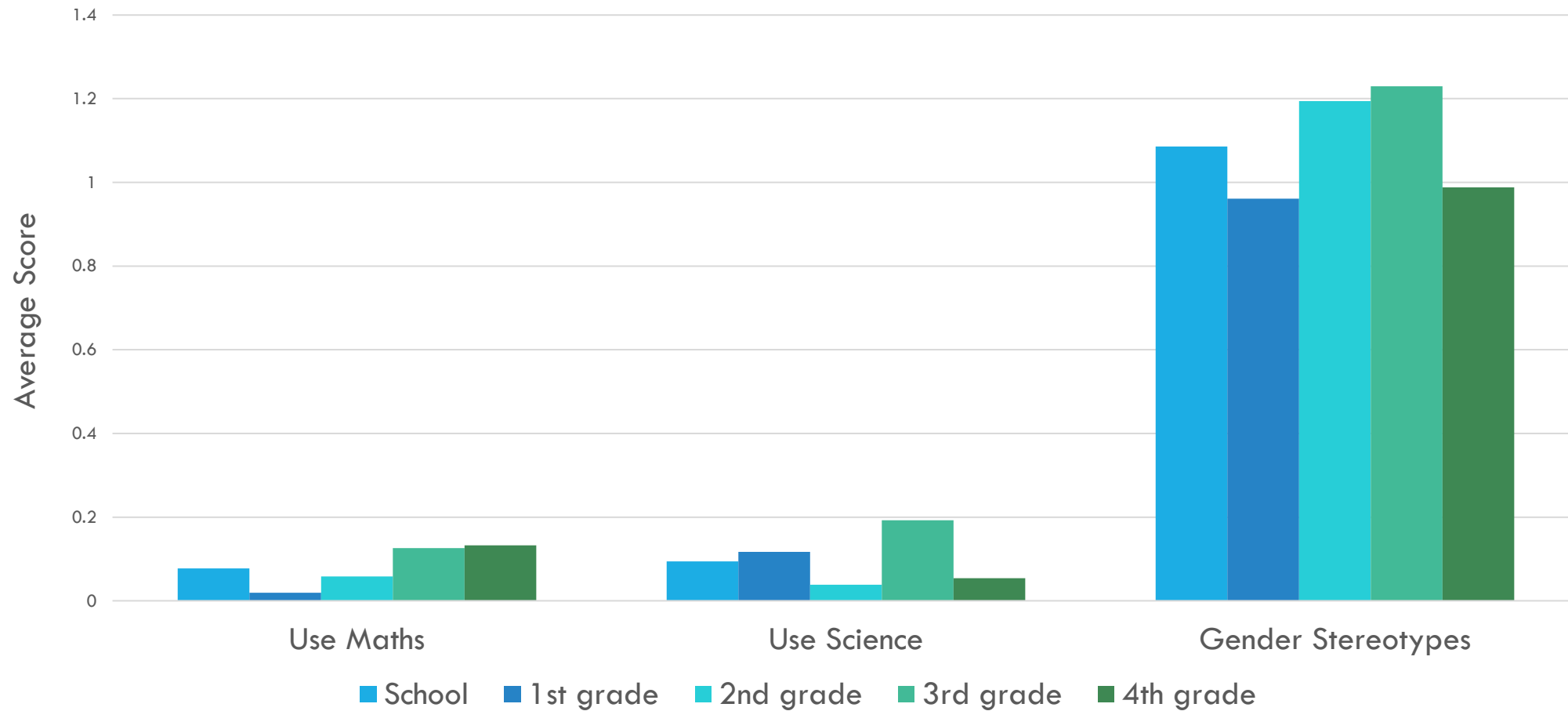
**TOTAL: 717 students**

# AVERAGE RUBRIC SCORE BY GRADE LEVEL — NOVICE UNDERSTANDING



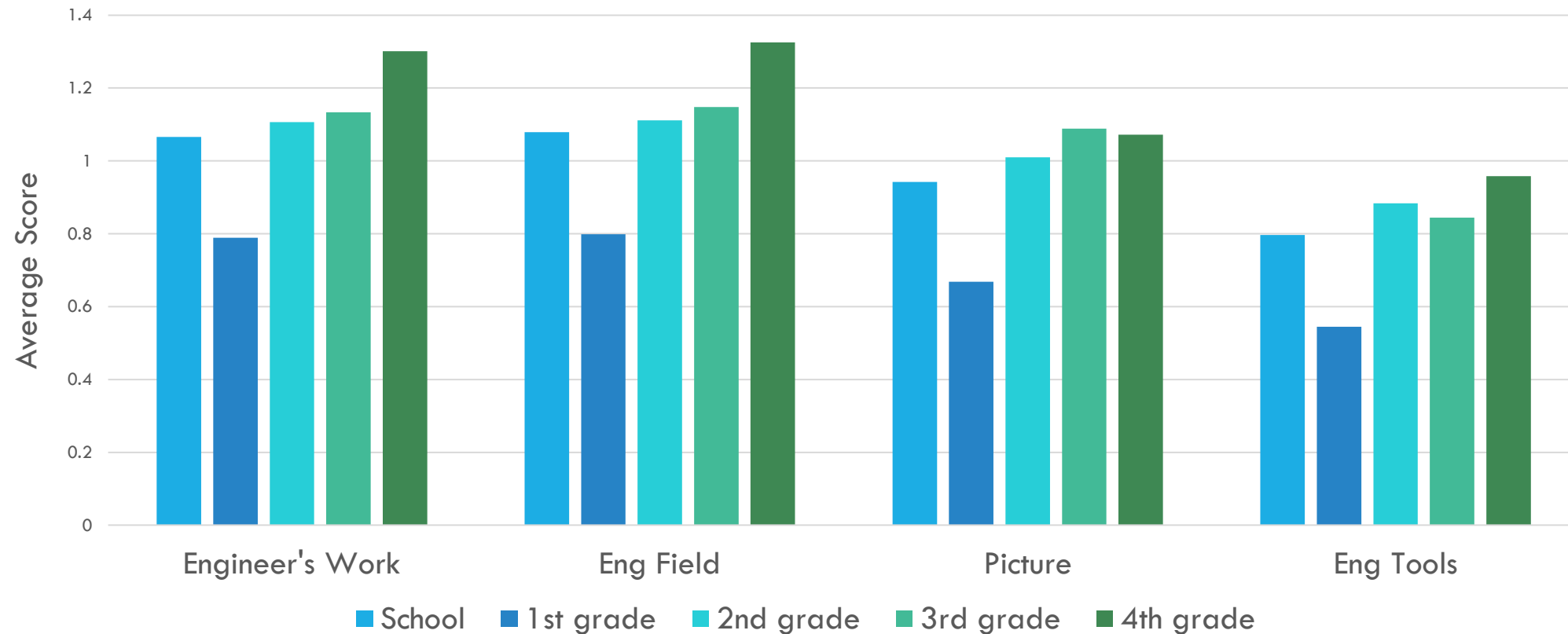
\* Max. score 3.0

# MATH, SCIENCE AND GENDER



\* Max. score 3.0

# SPECIFICS ABOUT ENGINEERING FIELD



\* Max. score 3.0

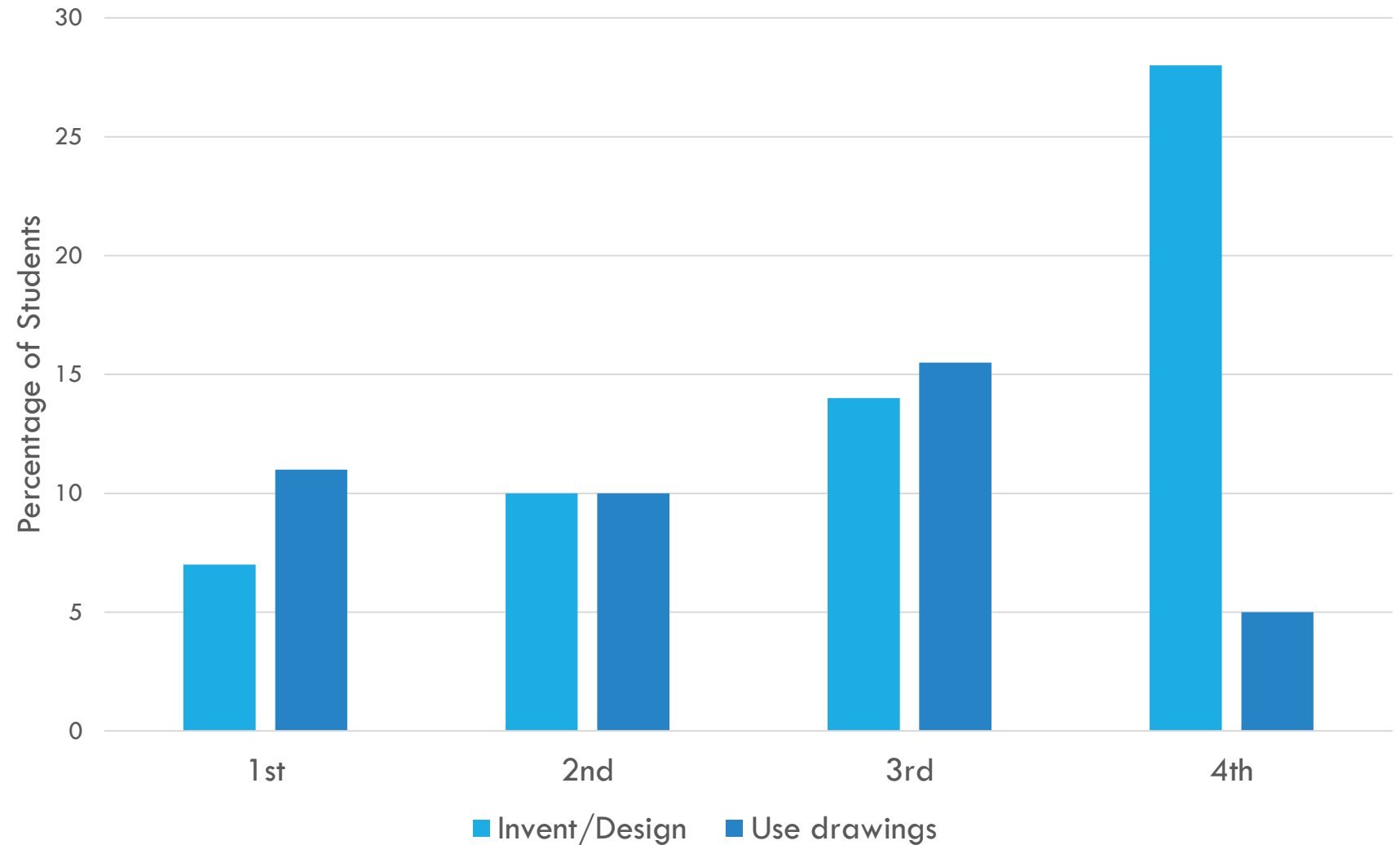
# DESIGNING OR INVENTING VS USING DRAWINGS

## Invent or design

- 4<sup>th</sup> – 28%
- 3<sup>rd</sup> – 14%
- 2<sup>nd</sup> – 10%
- 1<sup>st</sup> – 7%

## Use drawings:

- 4<sup>th</sup> – 5%
- 3<sup>rd</sup> – 15.5%
- 2<sup>nd</sup> – 10%
- 1<sup>st</sup> – 11%





# OVERALL STEREOTYPES

Majority of Students mention that engineers work on or building houses and buildings –over 80 %

Majority think they fix or make items (i.e., cars, computers, etc.) - over 75% overall

When a field was mentioned, it was mostly civil (3.5% total). The other two fields mentioned were computer (0.3%) and robotics (0.3%)

- So, over 95% of the students did NOT or could NOT name a field of engineering.

## In-service teachers' perspective

3 focus groups with 5 teachers per group  
primary schools from different grades  
(1-4)

- Teachers lack understanding of STEM:
  - *The relationship between objects*
  - *This is the development of the child's creative abilities.*
  - *Technology education, technology, engineering, robotics and artificial*
- Teachers lack preparation in STEM:  
*Since I'm a young specialist, I haven't heard much about STEM. I think it is for the development of creativity and imagination*

## Pre-service teachers' perspectives

Focus group interview with 10 student teachers

- Lack of preparation in pre-service
  - *Stem? What is it?*
  - *I didn't have such a STEM course in my school.*

# Conclusion

- Engineering and STEM needs to start in primary school and build through upper grades
- In-service: Teachers need professional development on STEM and Engineering Design topics
- Pre-service: Dedicated courses on STEM and Engineering Design



## STE(A)M in Early Childhood

Necessary to  
introduce STEM in  
early childhood

- ✓ could shift student interest in STEM careers
- ✓ Improve understanding of what engineers do
- ✓ Improve self-efficacy

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THANK YOU!!!!