robotics ✛ Swiss National Centre of Competence in Research

Are Primary School Computer Science curricular reforms achieving equity goals? Impact on student perception

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Early exposure to Computer Science (CS) & Computational Thinking (CT) is important

To broaden participation in the field & promote equity, two types of barriers need to be addressed (Wang & Hajazi Moghadam, 2017)

- **Structural barriers :** lack of access to Computer Science and Computational Thinking experiences
- **Social barriers :** often stereotype induced, arising despite equal access and similar socio-economic status

→ Lead to under-representation in the field

→ Require a system-wide implementation of Computer Science and Computational Thinking curricula for all students starting early foundational years (Ottenbreit-Leftwich & Yadav, 2022; Bers et al., 2022)

Early CS & CT experiences can help address perception gaps

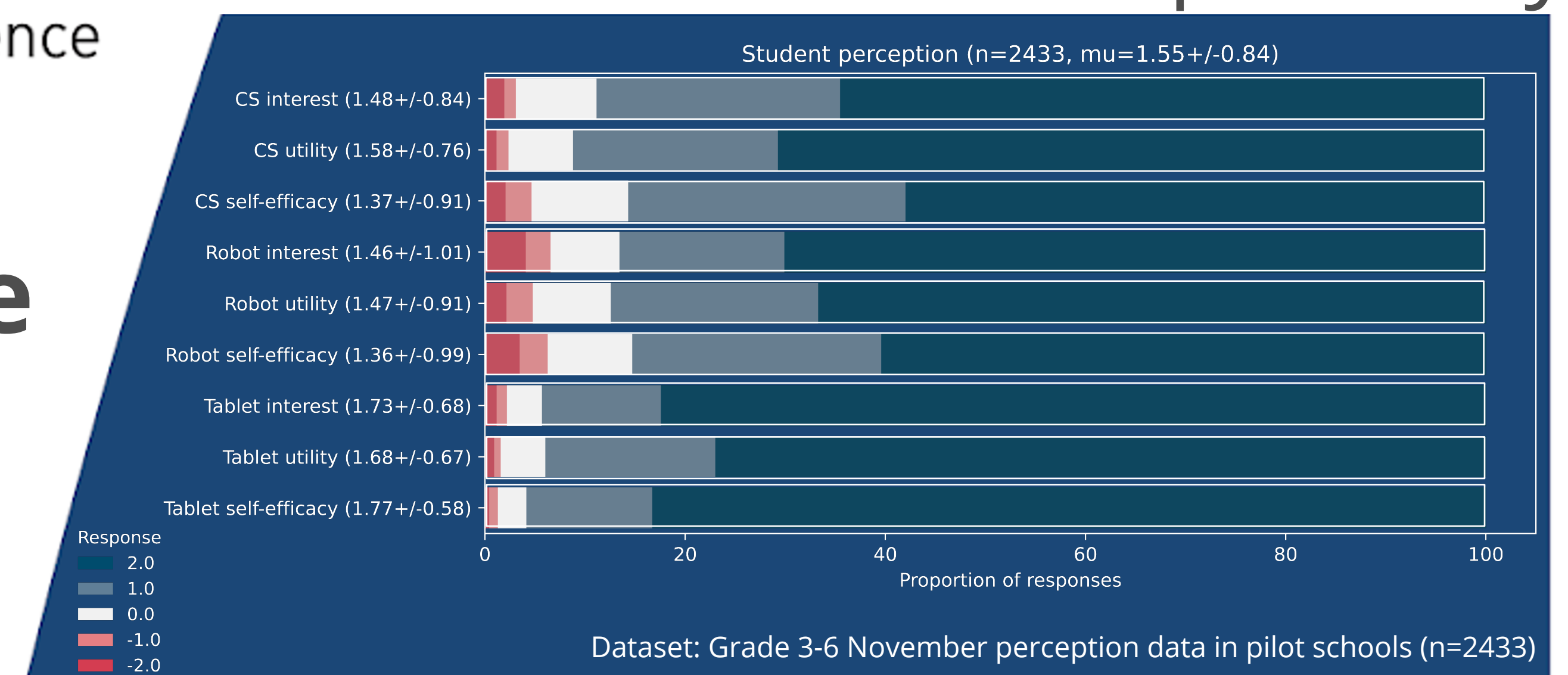Perception biases cause disparities and under-representation w.r.t:

- **Gender** (Wang & Hejazi Moghadam, 2017; Rachmatullah et al., 2022)
- **Under-represented minorities** (Lishinski et al., 2022; Warner et al., 2022)

→ Due to stereotype threat (i.e., knowing that a stereotype exists is enough to induce it , Plante et al. 2013) which can start as early as 2-3 years old

→ The consequence is that CS-related stereotypes are identified in young children (Master et al., 2021, and kindergarten, Sullivan & Bers, 2016)

→ Girls perceive CS more negatively, have lower sense of belonging, self-efficacy, and interest, which affects performance and career decisions (Master and Meltzoff, 2020; Plante et al., 2013; Vandenberg et al., 2021

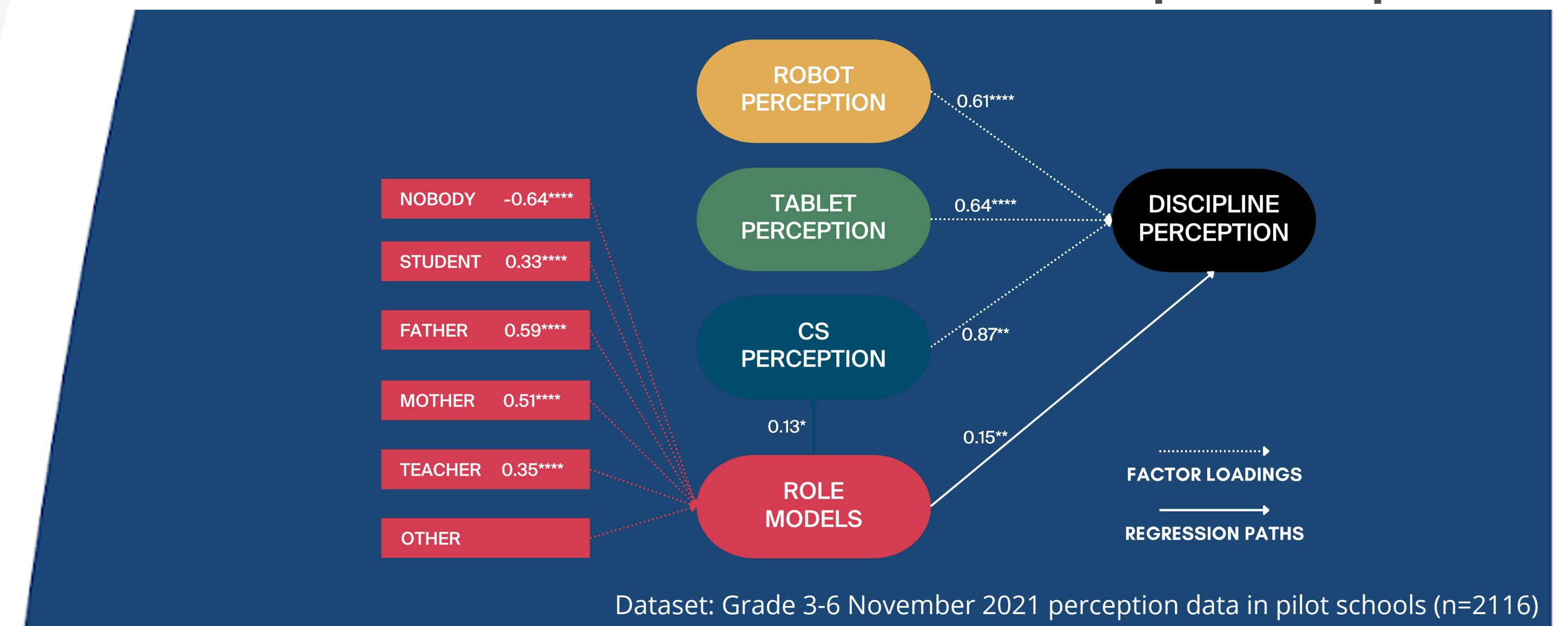## But are curricular reforms contributing to improving perception & reducing gaps?

- Many initiatives are introducing CS & CT into formal K-12 education
- Curricular reforms and professional development programs are seldom evaluated at the student-level (Mason & Rich 2019; Kong & Lai 2022).
- The effectiveness of CS-curricular reforms in terms of student perception and perception gaps must be established to
  i) improve the proposed curricula and PD programs (Hickmott & Prieto-Rodriguez al. 2018)
  ii) sustain the changes in teachers' practices
  iii) alleviate concerns of funding agencies and government bodies (Hickmott & Prieto-Rodriguez al. 2018)

→ We evaluate the implementation of a regional CS-curricular reform with two student perception datasets from 4077 grade 3-6 students from 9 schools through structural equation modelling
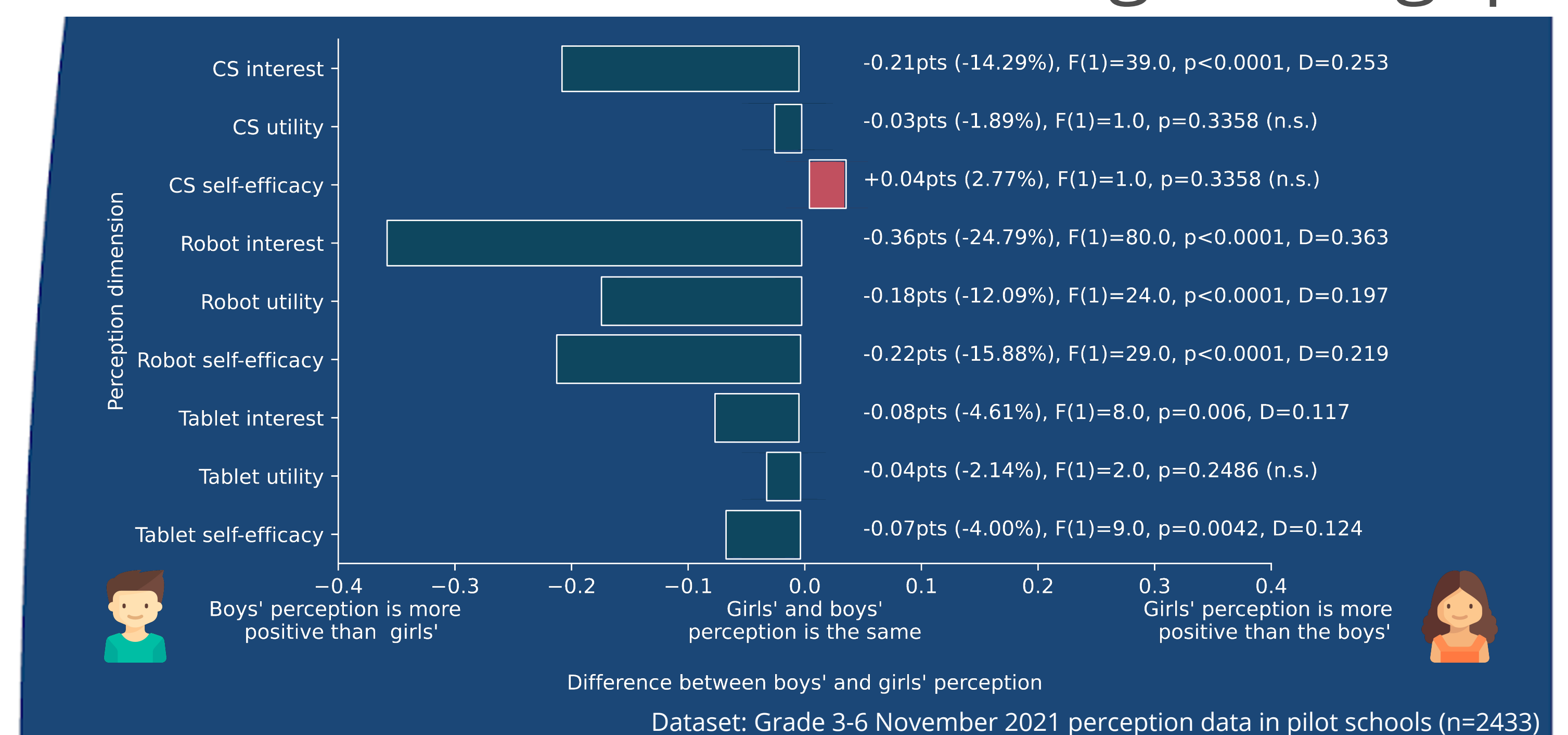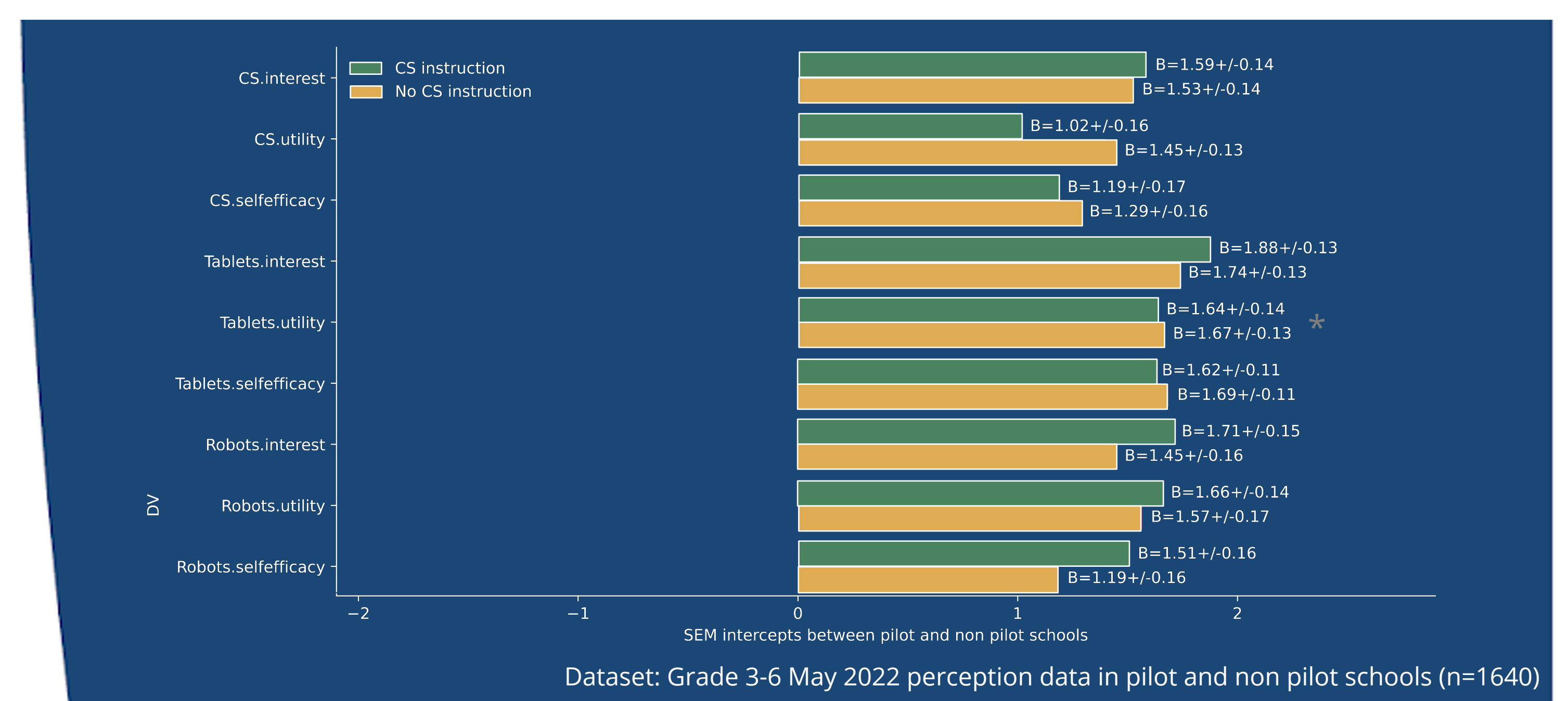
Students view CS positively

Student perception (n=2433, mu=1.55+/-0.84)

Dataset: Grade 3-6 November perception data in pilot schools (n=2433)

Role models influence perception

Dataset: Grade 3-6 November 2021 perception data in pilot schools (n=2116)

But there are gender gaps

Perception dimension	Difference
CS interest	-0.21pts (-14.29%), F(1)=39.0, p<0.0001, D=0.253
CS utility	-0.03pts (-1.89%), F(1)=1.0, p=0.3358 (n.s.)
CS self-efficacy	+0.04pts (2.77%), F(1)=1.0, p=0.3358 (n.s.)
Robot interest	-0.36pts (-24.79%), F(1)=80.0, p<0.0001, D=0.363
Robot utility	-0.18pts (-12.09%), F(1)=24.0, p<0.0001, D=0.197
Robot self-efficacy	-0.22pts (-15.88%), F(1)=29.0, p<0.0001, D=0.219
Tablet interest	-0.08pts (-4.61%), F(1)=8.0, p=0.006, D=0.117
Tablet utility	-0.04pts (-2.14%), F(1)=2.0, p=0.2486 (n.s.)
Tablet self-efficacy	-0.07pts (-4.00%), F(1)=9.0, p=0.0042, D=0.124

Boys' perception is more positive than girls' — Girls' and boys' perception is the same — Girls' perception is more positive than the boys'

Difference between boys' and girls' perception

Dataset: Grade 3-6 November 2021 perception data in pilot schools (n=2433)

Interest, and perception of robotics, increase with access to CS-instruction

DV	CS instruction / No CS instruction
CS.interest	B=1.59+/-0.14 / B=1.53+/-0.14
CS.utility	B=1.02+/-0.16 / B=1.45+/-0.13
CS.selfefficacy	B=1.19+/-0.17 / B=1.29+/-0.16
Tablets.interest	B=1.88+/-0.13 / B=1.74+/-0.13
Tablets.utility	B=1.64+/-0.14 / B=1.67+/-0.13
Tablets.selfefficacy	B=1.62+/-0.11 / B=1.69+/-0.11
Robots.interest	B=1.71+/-0.15 / B=1.45+/-0.16
Robots.utility	B=1.66+/-0.14 / B=1.57+/-0.17
Robots.selfefficacy	B=1.51+/-0.16 / B=1.19+/-0.16

SEM intercepts between pilot and non pilot schools

Dataset: Grade 3-6 May 2022 perception data in pilot and non pilot schools (n=1640)

Some gender gaps close while others increase with access to CS-instruction

DV	CS instruction / No CS instruction	
CS_interest	B=-0.24+/-0.05 / B=-0.11+/-0.05	Increasing gap
CS_selfefficacy	B=-0.13+/-0.06	Increasing gap
Robots_interest	B=-0.33+/-0.07 / B=-0.45+/-0.08	Decreasing gap
Robots_selfefficacy	B=-0.27+/-0.07 / B=-0.41+/-0.07	Decreasing gap
Robots_utility	B=-0.12+/-0.06	Increasing gap
Tablets_interest	B=-0.13+/-0.04	Increasing gap
Tablets_selfefficacy	B=-0.18+/-0.04	Increasing gap
Who_Teacher	B=0.1+/-0.04 / B=0.11+/-0.04	Decreasing gap

Boys' perception is more positive than girls' — Girls' and boys' perception is the same — Girls' perception is more positive than the boys'

Significant influence of gender on the DV (boys=0, girls=1)

Dataset: Grade 3-6 May 2022 perception data in pilot and non pilot schools (n=1640)