Marie Skłodowska-Curie
grant agreement n° 956124

Stella Malkogeorgou, Gavin Duffy,
School of Electrical and Electronic Engineering,
Technological University of Dublin
Grangegorman, Dublin,
D07 EWV4, Ireland

Dear Principal and/or STEM teachers,

We would like to invite 1st, 2nd and 3rd year students in your school to participate in a study of spatial abilities of 11 to 16-year olds and how they are related to attitudes towards science, technology, engineering and mathematics (STEM). Our study is motivated by recent changes to the curricula, particularly around new approaches to teaching STEM and by supporting the Government's STEM Implementation Plan. Data collected in this study could support your school improvement plan if numeracy is a focus of your SSE.

Participation in the study involves the collection of consent from parents and setting aside 40 minutes to administer tests and surveys using electronic devices to 1st, 2nd and 3rd years. Below, we will elaborate the study and what participation entails.

Motivation for the study: Spatial abilities play an important role in STEM learning. They are strongly linked with attraction towards and success in STEM education and careers. Students with high levels of spatial ability tend to perform better in mathematics, including problem-solving, and other STEM subjects, and are more likely to pursue a career in STEM than those with low levels of spatial ability. Many can fail to develop their spatial abilities to their full potential and this group is over-represented by girls and children of low socio-economic status. By knowing more about how current levels of spatial ability are related to STEM motivation and how this relation varies by age, gender and region, we can suggest ways to improve STEM teaching and learning.

Spatial abilities: They are a set of skills that determine how we visualise images – graphs, diagrams, processes, any type of image perceived or imagined – and manipulate or transform these images, e.g. mentally rotate, created 3D image from 2D, etc. Spatial abilities help us in numerous everyday tasks such as rearranging furniture, packing a suitcase, parking our car, or using a map. They support mathematics learning from kindergarten onwards, are used to visualize concepts in physics, assist in data visualization and forming accurate, schematic representations in problem-solving. Spatial ability is also a major component of working memory.

This project: This project is longitudinal and has two phases. In phase 1, we will collect data from students aged 11 to 16 years old and this phase occurs now. In phase 2, we will ask participants when they are aged 20 and 25 years old what career choices they have actually made. We will email parents/guardians when the students become adults at 18 years old, and ask them to forward a request to participate in phase 2 to their children to which they can consent or decline. Your support is being requested for phase 1 only. This cross-cultural study will collect data from several European countries and is conducted in collaboration with SellSTEM (Spatially enhanced learning linked to STEM), a European research network funded by Horizon 202 (https://sellstem.eu/).

Data that are collected

Students complete: (1) **a short sociodemographic survey**, (2) **a spatial abilities test**, (3) **a working memory test**, (4) and **a questionnaire about their personal attitudes towards STEM courses** and their **aspirations for following a career in STEM**. It takes approximately 40 minutes to complete all surveys and tests.

GDPR and Ethics

Approval for this study has been obtained from the TU Dublin Research Ethics & Integrity Committee. For a student to participate, parents/guardians must complete an informed consent form and students must assent. The consent form explains:

- that participation in the study is **voluntary**, participants can withdraw from the study at any time, for any or no reason,
- how the data are stored and processed in line with GDPR and best practice in research ethics, and
- that the identities of all participants will be pseudonymised when processing the data and reporting research findings.

What we are asking you to do.

- We kindly invite your school to participate in this study. If required by your school, obtain approval from your board of management, or equivalent. To accept this invite, please email Stella Malkogeorgou at styliani.malkogeorgou@tudublin.ie.
- Prepare to organise the parental consent process through your school app or online system (e.g. Microsoft or Google forms). Stella will provide the consent form in a ready to upload format to suit your preferred system.
- When you're ready, notify parents/guardians of relevant class groups and ask them to complete the consent form.
- When all have consented or declined to consent, schedule a time (40 minutes) to run the survey with students whose parents/guardians have provided consent. The survey, including an assent form for students, is contained in a single link to a Qualtrics web page.
- Make the survey available to the students during the scheduled class time. Each will need an internet device – PC, tablet, laptop or phone - to complete the survey. The students should be supervised. A summary of the process will be provided to you.

Feedback and benefit to your school

All participants will be provided with the scores on the spatial and working memory tests at the end of the survey. We will provide your school with descriptive statistics for the data collected from your school (means, standard deviations, etc. of the data by year, not individual scores of participants). This will give you an insight into the relation between spatial ability and attitudes to STEM within your school. We will also provide you with a report of the findings from the study based on data collected from all the schools to give you an insight into how spatial ability and STEM attitudes in your school compare to others.

You may communicate directly with Stella or Gavin, her supervisor, at any time by email about any aspect of the study.

Stella Malkogeorgou - styliani.malkogeorgou@tudublin.ie

Dr. Gavin Duffy - gavin.duffy@TUDublin.ie

Kind regards,

Stella Malkogeorgou

Ph.D. Candidate at the Technological University of Dublin