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## CREATE Research Symposium 2022 Book of Abstracts

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**CREATE  
RESEARCH  
SYMPOSIUM  
BOOK OF  
ABSTRACTS**

**THURSDAY 19TH MAY 2022  
12.00PM - 4.00PM**

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**ST LAURENCE'S CHURCH, GRANGEGORMAN**

# PROGRAMME OF EVENTS

12.00pm - Welcome by Mr Eddie Conlon

12.00pm - 1.00pm

## **An Ongoing Spatial Intervention Project in Irish Secondary Schools**

Ursa Benedicic, Gavin Duffy, Sheryl Sorby

## **An investigation into the mathematical preparedness of students who transfer from the further education sector to higher education STEM courses**

John Mc Hugh, Michael Carr

## **Empirical studies that compared comics to non-comics STEM education material.**

Marianna Pagkratidou, Neil Cohn, Gavin Duffy

1.00pm - 2.00pm - Lunch and Networking

2.00pm - 3.00pm

## **Does Social Justice Have a Place in Engineering Education**

Eddie Conlon, Mike Murphy, Steen Hyldgaard Christensen

## **EthiCo: Designing Ecological-Ethics for Technological Education.**

Jye Benjamin O Sullivan

## **An argument for incorporating sociological approaches into phenomenological analyses in engineering education research**

Sandra Cruz, Shannon Chance, Brian Bowe

3.00pm - 4.00pm

## **Spatial ability individual differences in and of STEM learning**

Stella Malkogeorgou, Gavin Duffy

## **Spatial awareness and mathematics education**

Marten Westerhof

Wrap Up

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## **AN ONGOING SPATIAL INTERVENTION PROJECT IN IRISH SECONDARY SCHOOLS**

Authors: Urša Benedičič, Gavin Duffy, Sheryl Sorby

**Keywords:** *Spatial Skills, Spatial Intervention, Post-Primary Education, Professional Development Program*

### **ABSTRACT**

Spatial skills have been shown to strongly predict STEM attainment and can therefore be a determining factor in choosing to pursue high-paying engineering careers. This strong reliance on spatial skills particularly limits students with low spatial skills – a group over-represented by girls and students of low socioeconomic status. It has also been demonstrated that spatial training leads to meaningful improvements in skill development. In Ireland, as in most countries, spatial thinking is not explicitly taught at the pre-college level, even though it could influence students' eventual career paths. Currently, a person's previous experiences outside the classroom often influence spatial skill development. In order to increase the number of students who select STEM occupations as a career path, an explicit emphasis on training spatial thinking is likely to be very beneficial. An established spatial intervention course was selected for delivery to secondary schools in Ireland, in collaboration with the PDST (Professional Development Service for Teachers). Through a small-scale pilot study (in 2021/22) and a large-scale pilot study (in 2022/23) an effective spatial professional development program for secondary school teachers will be developed and delivered on a national scale. In this presentation, the entire structure of the intervention and preliminary findings from the small-scale study from the teacher participants are presented.

## INVESTIGATING THE LEVEL OF MATHEMATICAL PREPAREDNESS OF STUDENTS WHO TRANSFER FROM THE FURTHER EDUCATION SECTOR TO HIGHER EDUCATION STEM COURSES

*John McHugh, Dr Michael Carr, Dr Fiona Faulkner*

**Keywords:** *Mathematics Skills, Further Education, Mathematics Curriculum, Problem Solving, Education Transfer, Progression Pathways*

### ABSTRACT

A student's level of mathematics as they begin degree courses at Higher Education (HE) in the Science, Technology, Engineering, and Mathematics (STEM) disciplines has been recognised as a key indicator of their success in those courses. Much research has taken place into the teaching of mathematics at second level, and much work has gone into a reshaped Leaving Certificate syllabus designed to better equip students to succeed at third level, with greater emphasis on applicable rather than procedural knowledge. A comparatively under-researched area has been that of Further Education (FE), a sector which supplies a smaller proportion of HE's student intake, typically in the form of one- or two-year Post-Leaving Certificate (PLC) courses.

Such considerations have led the author to investigate the mathematical preparedness of students at FE level, with a particular emphasis on those students hoping to progress to a STEM degree course. The project is being conducted using a mixed-methods approach, incorporating analysis of both quantitative and qualitative data.

The quantitative analysis component will involve analysis of diagnostic testing and examination results from both FE and HE in mathematics, and an application will be made to SOLAS/ETBI to access administrative data linked to education and employment outcomes for students who have progressed from the FE to HE sectors.

The qualitative analysis component will consist of surveys, focus groups and interviews, aiming to explore students' experiences of progressing from FE to HE, difficulties they may have with mathematics, and whether they are at risk of dropping out or failure because of mathematical issues. The principal participants in this component at this point of the research are those studying Engineering-focussed PLC courses for the purposes of progression to courses at HE level, with an intention to broaden this out to other STEM disciplines at a later point.

## EMPIRICAL STUDIES THAT COMPARED COMICS TO NON-COMICS STEM EDUCATION MATERIAL

*Marianna Pagkratidou, Neil Cohn, Gavin Duffy*

**Keywords:** *comics, visual language, visual language fluency, spatial cognition, STEM education, STEM interest*

### ABSTRACT

Research on visual language and spatial cognition indicates a growing use of comics in Science, Technology, Engineering, and Mathematics (STEM; Downs & DeSouza, 2006; Tribull, 2017) education. However, it is still unknown if the use of comics, as the use of visual language and writing in sequential images that convey education material, can be an effective tool for STEM education. While comics can be useful education material, they also require a visual language reading fluency to be understood (Cohn, 2020). Thus, the present study is the first comprehensive quantitative review of empirical studies that compared comics to non-comics STEM education material. Specifically, the study reviewed 1230 papers to better understand to what extent and under which conditions the use of comics vs. non-comics STEM education material is effective and moderated by comic reading fluency, grade level and spatial abilities. Findings not only will contribute to the Visual Language Theory (Cohn, 2013) and spatial cognition, but will also shed light to the circumstances under which comics in STEM education can promote interest and participation in STEM subjects and careers.

Cohn, N. (2013). Visual narrative structure. *Cognitive science*, 37(3), 413-452.

Cohn, N. (2020). Visual narrative comprehension: Universal or not?. *Psychonomic Bulletin & Review*, 27(2), 266-285.

Downs, R., & DeSouza, A. (Eds.). (2006). *Learning to think spatially: GIS as a support system in the K-12 curriculum*. Washington, DC: National Academies Press.

Tribull, C. M. (2017). Sequential science: A guide to communication through comics. *Annals of the Entomological Society of America*, 110(5), 457-466.



## DOES SOCIAL JUSTICE HAVE A PLACE IN ENGINEERING EDUCATION

*Eddie Conlon, Mike Murphy, Steen Hyldgaard Christensen*

### ABSTRACT

This paper examines the potential for social justice (SJ) education within engineering education. It aims to examine whether the focus in some American engineering programs on social justice issues resonates with students and faculty in engineering education in a large Irish university.

The paper explore two questions. What are engineering students' attitudes towards including social justice issue in engineering education and what are the barriers to doing so?

The paper is based on survey data from first and final year engineering students from three engineering degree programs combined with semi-structured interviews with program chairs from the respective programs.

The survey aimed to examine student attitudes towards social justice and their perceptions of its relevance for engineering education and practice. The objective of the semi-structured interviews with program chairs was to examine their attitudes to social justice, and to what extent, if any, degree programs have sought to develop students' understanding of, and commitment to social justice issues in engineering education and practice.

Our data show a positive attitude by a majority of students to including social justice in their engineering curricula. The data suggests that their engineering education might be effective in educating them about the broad responsibilities of engineers and the wider impacts of engineering without framing these issues in narratives linked with SJ or inequality. Most students would support more curricular content that could be supportive of SJ. The data also show the difficulty for programs chairs to come to terms with the role of social justice within engineering education and how to find a place for it. They struggled with how to integrate content related to SJ into programmes which have a predominantly technical/scientific content. Their approach to the issues was framed by a technical/social dualism and seeing non-technical knowledge as being of lesser value than technical knowledge.

## ETHICO: DESIGNING ECOLOGICAL-ETHICS FOR TECHNOLOGICAL EDUCATION

*Jye O'Sullivan*

**Keywords:** *Ecological-Ethics, Virtue Ethics, Pedagogy, Technological Education, Teacher Training*

### ABSTRACT

There is an urgent need for 21<sup>st</sup> century education to be able to address the complex problems of the Anthropocene and questions of technological development. A radical new approach is required that begins with the teaching of Ethics and Ecology in Technological Education. Ethics in this context needs to be understood as a form of praxis, an individual practice that has collective implications. It is the sum of micro-decisions which when brought together have a global impact.

The Ethico project, as part of European Cultural and Technology Lab+ which is part of the European University of Technology, aims to design innovative, ethico-ecological education methods which are transferable to different disciplines in the Technological University, from arts and humanities to engineering and the environmental sciences. This is accompanied with the development of an expanded understanding of technology, technology not simply as an application of science but techne as the mode through which we become human. In the long term, the goal of Ethico is to transform technological education.

This presentation seeks to introduce the Ethico project to a wider transdisciplinary audience. We begin with an introduction to the leading concepts of the project and what we have already achieved. We then break down the different work-packages that Ethico is comprised of with a specific focus on Intellectual Output 3 - teacher training. For IO3 we will survey teachers taking the micro-credential workshops before and after in order to gauge changes in participants' understanding of environmental and social sustainability topics and how to incorporate such topics into the modules they teach. We will end the presentation with a discussion of how we intend to process this data and how it will inform the outputs of IO3 and the wider Ethico project to develop Ethics and Ecology in Technological Education.

# AN ARGUMENT FOR INCORPORATING SOCIOLOGICAL APPROACHES INTO PHENOMENOLOGICAL ANALYSES IN ENGINEERING EDUCATION RESEARCH

*Cruz, S.<sup>1</sup>, Chance, S<sup>2</sup>. & Bowe, B<sup>3</sup>.*

**Keywords:** *Gender, Phenomenology, Methodology, Sociology, Socialization processes*

## ABSTRACT

Despite numerous research studies that have examined why women are underrepresented in engineering education programmes, the phenomenon is still not fully understood, and no effective general solutions have been found. In this context, analysing women's experiences in engineering education can provide insights regarding the evolution of the students' learning strategies and socialization processes as well as contextual factors that influence their choice to persist in or leave their courses. At this stage of the research we explore the pertinence of enhancing phenomenological analyses conducted in engineering education research by incorporating sociological perspectives, drawing on sociological studies that search the relationship between gender, STEM education and persistence in STEM courses. The aim is to contribute to building a conceptual framework that, on the one hand, captures lived experience in engineering education and, on the other hand, analyses the social settings around engineering itself, i.e., the objectively significant circumstances, that condition female students' attitudes, behaviours, and expectations towards persisting or not in engineering courses. Conclusions suggest the conceptual framework around *subjectively meaningful experiences*, proposed by Alfred Schutz, who followed the phenomenological school of thought initiated by Edmund Husserl, might be useful in understanding not only (a) the representations of the subjective social world for women in engineering education (that induces feelings of identification, security, symbolic values, and ultimately social actions), but also (b) the intersubjective social system that structures daily life, legitimizes behavioural patterns, assigns roles, and defines group membership along education in engineering. Expanding engineering education researchers' conceptions of phenomenology, to consider more of the structural issues that influence women's experiences and choices, can help generate increasingly meaningful research findings.

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<sup>2</sup> Supervisor, TU Dublin

<sup>3</sup> Co-supervisor, TU Dublin

## SPATIAL ABILITIES INDIVIDUAL DIFFERENCES IN AND OF STEM LEARNING

*Malkogeorgou S., Duffy G.*

**Keywords:** *spatial abilities, STEM, gender, gender gap, socioeconomic status*

### ABSTRACT

Spatial abilities remain an active thread of research spreading throughout many disciplines with implications for almost every technical field. It is well illustrated by previous findings that spatial abilities play a crucial role for academical and occupational achievements in Science, Technology, Engineering and Mathematics (STEM) disciplines. Evidence from cross-sectional and longitudinal studies well support the important relationship between spatial skills and STEM and suggest that successful STEM students possess good spatial skills. There are few factors that affect the development of spatial abilities, as well as achievements in STEM disciplines, factors such as age, cultural background, gender, and socioeconomic status. Socioeconomic status appears to be a stable factor that affects academic performance and development through the years, as demonstrated by previous studies and the international assessments PISSA and TIMSS. Regarding gender, scientific literature has well documented the gender differences in spatial abilities, with boys usually performing better in some spatial abilities 'tasks. Additionally, boys tend to show more interest towards STEM courses and later STEM careers in comparison with girls, leading again to a gender gap in some STEM areas. One possible explanation for this gender gap that has gained a lot of support the last years is gender stereotypes and strong gender roles among societies. Constant exposure to stereotypes may affect one's self-image and ultimately influence life choices, for example occupation. This project aims to investigate these factors that may lead to underdeveloped spatial skills and gaps in STEM, by conducting cross-cultural research across Europe. The goal is to test children's spatial abilities and see how their ethnicity, socioeconomic statuses, gender, and exposure to stereotypes influence their performance and academic preferences.

## MAKING SPATIAL PEDAGOGY: USING INSIGHTS FROM SPATIAL ABILITY RESEARCH TO DEVELOP MAKER EDUCATION PEDAGOGY

*Marten B. Westerhof, Colm O’Kane, Gavin Duffy*

**Keywords:** *Maker Education, Spatial Ability, Pedagogy, STEM, Hands-on learning*

### ABSTRACT

Maker education has been shown to effectively raise children’s interest for STEM subjects. Creative maker activities, which usually take place in informal learning environments such as museums and libraries, hold potential to teach children scientific concepts and train cognitive abilities that are critical to success in engineering in an engaging way. One of these often-overlooked skills fundamental to STEM is spatial ability, which is known to commonly function as a gateway skill to STEM disciplines. Spatial ability is malleable, and training can effect gains not only in psychometrically assessed spatial skills but also in mathematical skills, further demonstrating its importance to STEM learning. However, in practice maker education often lacks explicit pedagogical attention to the development of scientific skills and cognitive abilities such as spatial ability, instead overemphasising technological skills, and thus limiting its potential to increase learning related to science and engineering. Maker education practice would greatly benefit from a pedagogy that recognises spatial elements and scaffolds spatial ability development. The opposing epistemologies that lie at the roots of the maker education and spatial ability education are examined, as a prerequisite step to redesigning maker education practice. The final aim is to transform maker education practice from its current status as an engaging way to increase interest in STEM, into a STEM learning practice through which spatial ability development is scaffolded and can be assessed, realising its potential for scientific learning and allowing a wider audience to meaningfully partake in STEM-related activities from a young age.

