

Cultural perceptions to the teaching of mathematical problem solving: A case study of a curricular transfer experience between UCL and NGU

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This paper presents itself as a first step into a larger work-in-progress project that aims to capture the cross-cultural curricular transfer experience of a problem-based module in the Higher Education Sector. Situated in a UK Higher Education Institution, the transfer transcends cultural boundaries and is envisioned for implementation in the Egyptian context. The study is theoretically underpinned by the work of Ernest which distinguishes between three types of curricula. For the scope of this study, the first author reports on how the curriculum was locally enacted. This is compared to the second author's original intention of the curriculum. Underpinned by the contextual investigation theory as an analytical framework, the study calls for a structured research design initiative to capture the cross-cultural transfer experience with the help of a framework.

Keywords: mathematical problem solving; curricular transfer; Higher Education

Setting the scene

In academic collaboration, a module that aims to foster problem solving skills has been designed by academic consultants from the Faculty of Engineering Sciences at University College London (UCL) in the United Kingdom to be delivered at NewGiza University (NGU); the latter being based in Giza Egypt. The module carries the title Engineering Design Practice: Challenge 1 (EDP.1). It has been designed as a project-based learning (PBL) module that is the first of a series of PBL modules or "spine" of PBL that runs as a vertical thread throughout the newly designed degree programme. EDP.1, shown in Figure 1, below, is founded on a real-life complex challenge. The module aims to equip learners with the necessary problem-solving skills that would enable them to address a real-life challenge. As problem-solvers, students are equipped with the necessary transferrable skills that would enable them to solve complex mathematical problems. The NGU curriculum has been designed with influence of the design project spine that is central to the Integrated Engineering Programme (IEP) which is widely recognised globally as an innovative and future-focused teaching framework. The IEP has been established at UCL Engineering and embedded within the majority of the existing undergraduate degree programmes since 2014 (Graham, 2018; Mitchell et al., 2021).

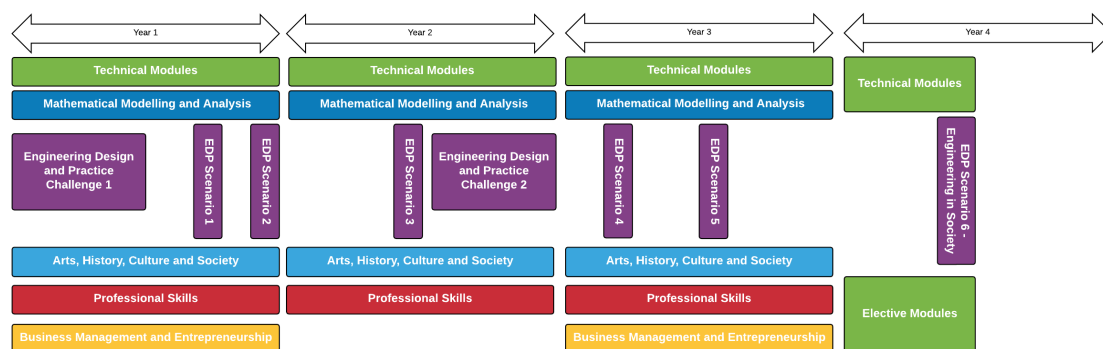


Figure 1. Integrated Engineering Program

Figure 1 illustrates how at the heart of the newly designed curriculum, the series of EDP modules (i.e. purple blocks in image above) aim to bring together the acquired professional and technical skillsets, in a constructive attempt to foster an interdisciplinary learning experience that is centred around a challenge (problem).

In this study, the curriculum designer (i.e. UCL) and the curriculum implementer (i.e. NGU) report on their joint experience working together on the first of the EDP modules. The reporting of this joint experience is emphasised by the work of Ernest (2009) as an underpinning theoretical framework and on the contextual investigation of curricular transfer (Bradfield & Exley, 2020) as an analytical framework. These will be presented in more detail in the next sections. Ernest’s work is supported by the typology set out by Goodlad (1979) as a theoretical framework for curriculum development under the basis of recognising the significance of intention, implementation, and attainment in the process of creating, developing and/or reforming curricula.

Beyond the specific geographical context of this study, this work showcases a collaborative curriculum design and curriculum implementation experience that takes place between a long-established public UK based higher education academic institution and a newly formed private Middle Eastern higher education academic institution. This curricular transfer experience, hence, transcends the boundaries between individualistic and collective learning cultures as it depicts the implementation of a module and a PBL curriculum thread that is very collaborative in the nature of its design and implementation. As digital networks form and develop, the transcending of cultural and societal learning boundaries is becoming a question that needs to be revisited by both curriculum designers and curriculum implementers. Hence, we believe that this study presents itself as an excellent prototype to this growing trend of cross-cultural boundary academic and curricular exchange.

Theoretical framework: Three types of curricula

In his study of curricular transfer experiences, Ernest (2009) refers to Goodlad’s (1979) typology of curriculum, which differentiates between three types of curricula; namely: the intended curriculum, the implemented curriculum and the attained curriculum. These are visually depicted in Figure 2.

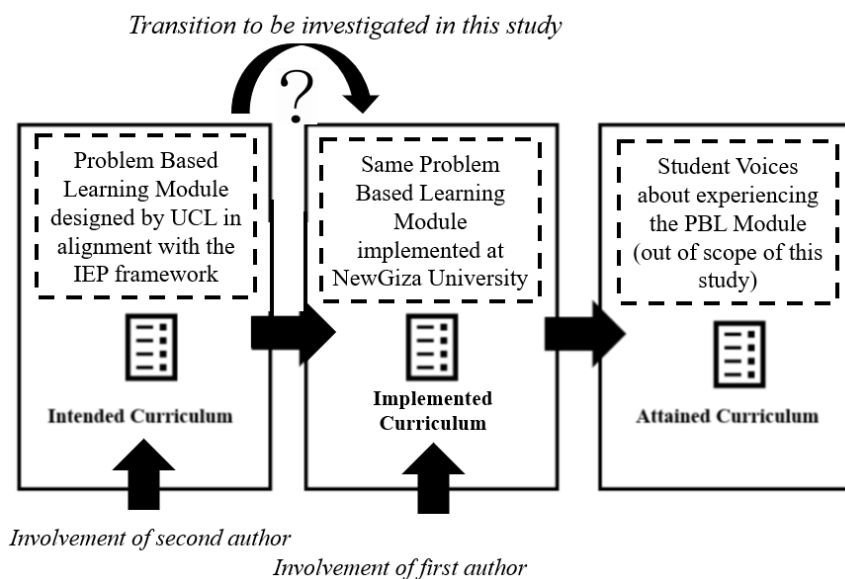


Figure 2. Three Types of Curricula (Adopted from Ernest, 2009)

According to Ernest (2009), a mathematics curriculum is “no neutral” enterprise. In other words the curriculum is shaped by the context in which it gets implemented. The learning experience for mathematics learners is hence bound to questions of social and cultural situatedness. Makramalla (2021) builds further on this argument by claiming largely that the teaching and learning of problem-solving is culturally related to the context, wherein it gets implemented. The perception of what the act of problem-solving entails and hence the adoption of it as an underpinning teaching philosophy is a complex construct that is intertwined with multiple contextual threads, as will be more elaborately discussed in the next section. Ernest (2009) goes on to describe how it is important to recognise the typologies of curricula in the context of mathematics, those being the intended curriculum, the implemented curriculum and the attained curriculum. Since the learning experience hinges on factors other than the curricular design, we believe it is important to investigate areas that could cause a gap between intended curricular ethos and the one that gets attained by the students.

For the purposes of this study, the *intended curriculum* represents the curriculum as it was envisioned by the curriculum designer; in our case being UCL (discussed by the second author and academic lead for the curriculum design of the NGU degree programme). *The implemented curriculum* represents the curriculum as it gets delivered by the instructor in class (implemented by the first author, who also acts as academic liaison for engineering degree programmes at NGU). *The attained curriculum* represents the content knowledge, values, metacognition, and skill sets embedded within the curriculum as it gets attained by the learners. The scope of this study focuses on the bridge between the intended curriculum and the enacted curriculum.

As indicated in Figure 2, this study aims to explore the cross-boundary curricular transfer experience which transcends cultural and societal boundaries in an attempt to uncover the gap between how problem solving is intended by a UK based Higher Education Institution and implemented within a Middle Eastern Higher Education Institution. Given the rise of cross-cultural educational collaborations within UK-based Higher Education networks, particularly during and after the pandemic, this study aims to show-case the often-overlooked side of curricular transfer by focusing on contextual buy in.

Education for problem-solving

To study the contextual transfer experience, it is important to first present the theoretical lens from which the authors perceive problem solving as a teaching and learning construct. Schoenfeld (1992) famously depicted the teaching and learning of mathematics as lying on a spectrum that extends between memorisation on the one end and problem solving on the other. According to Schoenfeld (1992), the teaching and learning of mathematical problem solving needs to go beyond the practical application of a taught formula. In line with this thought, in their work on mathematical problem solving, Stylianides and Stylianides (2013) argue for the importance of rooting the teaching and learning of mathematics in what they referred to as “problems of practice” (Stylianides & Stylianides, 2013, p.334). According to the authors (Stylianides & Stylianides, 2013), students needed to be exposed to practice based, real life, complex problems that do not resemble previous problems they had been exposed to and that do not have one fixed straightforward answer. Students need to experience a cycle of repetitive failed attempts (Siagan, et al., 2019) as they address the aforementioned problems. According to the authors, the peak of learning reveals itself in the reflective record-keeping of these repeated failed attempts, even if the problem at hand remains unresolved. It is this stance to problem solving that we, as authors, aim to take on as we develop our exploration throughout this study.

Contextual investigation of curricular transfer

In this study, we choose to use the work of Bradfield & Exley (2020) as an analytical framework. Bradfield and Exley (2020) report that a curriculum that gets implemented is flavoured by a multiplicity of contextual factors; some of which include: internal influences of the teaching and learning microculture, teacher beliefs, teacher readiness channelled through professional development, leadership endorsement (or the lack thereof) and the larger institutional prioritisation of teaching and learning values. The micro-culture where instruction takes place has a huge impact on whether or not problem solving as a teaching strategy will be endorsed as constructive for student learning (Bradfield & Exley, 2020). This aligns with other scholarly views (Makramalla & Stylianides, 2021) that have also established a connection between the readiness of a micro-culture and the beliefs of the leadership team within that microculture; the latter being a viewpoint that is also shared by Bradfield and Exley (2020). Furthermore, teacher beliefs about the nature of the subject matter being taught and the degree to which it presents itself as a non-static knowledge entity that could be challenged also plays a key role in the way the curriculum gets contextually implemented. Finally, the authors also argue for the importance of teacher readiness to teach mathematics (or any other subject matter) in a way that is non-static.

Building on the works of Goodlad (1979) and Ernest (2009) as a theoretical framework and the work of Bradfield and Exley (2020) as an analytical framework, this paper presents outlines of a yet ongoing study to address the following question:

What are the key factors that influence a potential gap between curricular intentions and curricular implementation?

The larger aim is to develop a contextual framework that would capture the different elements that need to be taken into consideration to ensure a smoother curricular transfer experience between intended and implemented curriculum; whereby there is minimal loss, and thus higher attainment by students, of curricular ethos.

Research design

As this study is still ongoing, there is yet no full account of findings, as such. In the following, we present the intended research design; highlighting how it would aim to capture the complexity of the research question.

The aim is for the wider study to adopt a multiple case study model (Yin, 2014); whereby each problem based curricular transfer experience would showcase one stance of how problem solving gets implemented in the respective context. The multiple case studies would be designed to achieve redundancy of data sources, which in turn increases the reliability of the study. Within each case study, the idea is to capture data through analysing a reflective journal written by the curriculum implementer.

The reflective journal would be kept throughout the length of the curricular implementation experience. The idea is for the reflective journal to highlight milestones along the problem-solving journey and how working on an unknown problem that is complex and does not have one straight-forward answer is received in the context where implementation takes place. The analysis of the journal would be based on the aforementioned analytical framework (Bradfield & Exley, 2020). The idea is also to triangulate the analysis of the regularly written reflection logs with two extended semi-structured interviews with the curriculum designer, who would be outlining in detail the intention of the problem-solving element envisioned in that module.

Utilising the Contextual Investigation Model as an analytical framework, a thematic content analysis aims to capture and contrast main patterns of thought and experience from each party. The aim is for this ongoing case study (of one module, EDP.1) to act as a pilot for a larger investigation that would aim to capture the main contextual elements that play a role in a curricular transfer experience between a UK context and a Middle Eastern Context.

Implications

Given the rising trend of the global classroom model; a model that has unfolded from the virtual classroom experience during the outspread of the pandemic (Makramalla, 2022), we believe it is vital to think of curriculum design beyond the formal boundary of the local classroom. Our choice of exploring curricular cross-boundary design and implementation between a UK-based institution and a Middle Eastern-based institution presents itself, in our opinion, as a building block to study cross-cultural and societal curricular transfer more widely from a theoretically viable stance. Hence, we believe that the creation of a theoretical framework that captures the unspoken dimensions of contextual curricular implementation would be of value to educators in an ever-growing world of global diversity and global cross-boundary collaboration.

Furthermore, given the growing reality of displaced learners (Hanson, 2009; Kirk, 2009), we believe that it is vital to develop a framework that would ensure that learners are understood and approached with a mindfulness of their cultural identity. We believe that this framework would be helpful for educators who work in contexts, where displaced learners are situated. The framework – to be designed – is meant to be academically rooted in research and practically oriented to serve practitioners in diverse curricular implementation contexts.

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