# Integrating research and practice: opportunities in computing education

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**Abstract:** A significant curriculum shift has taken place over the last decade, with computer science increasingly becoming included as a subject in countries around the world. Without an established literature relating to how and what to teach within K-12 computing education, there is a need for academic research that investigates how we can best support all learners of computing and facilitate positive learning outcomes. In response to this, the number of research papers and projects focusing on K-12 computing education has grown substantially in recent years. But does that research involve practitioners and is it actually impacting on classroom practice? If not, what are the mechanisms that we can use to ensure that it does? In this short discussion paper accompanying my keynote, I discuss some of the debates around the area of 'research-to-practice' and how the framework of knowledge mobilisation can provide insights into approaches that we might consider when working with practitioners in our research.

**Keywords:** computing education; teacher professional development; K-12 education; knowledge mobilisation

## 1 Introduction

Education has a diversity of research agendas, epistemological and methodological perspectives and strategies [Ke21]. Theorists over many decades have argued that the ultimate purpose of educational practice is the 'holistic pedagogical formation of the individual within society' [Ho21, p.1456], although there is some debate around the way in which research can inform this ultimate purpose [Ho21]. While there is an increasing interest in 'what works' in education [Go13, Wi10], often drawing on randomised controlled trials for evidence, others have expressed concern at such a dependence on evidence alone, given that educational practice is highly contextualised [Ke21, Bi10]. Teachers may lack agency around research [LC17], and policy makers, practitioners and researchers may view the purpose of education research through different lenses [BW08, Th18]. It's a challenge to us all to rethink our research around the actual purpose of education and classroom practice, lest our research become too distant from educational practice [Ho21].

For discipline-based research this debate is important: computing education research should be useful for educators and relevant to practice. Many research projects described in recent

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computing education literature are developed in close collaboration with teachers and are motivated by issues faced by teachers and schools (e.g. [De19, GMC14]). This goes some way to focusing on the collaborative nature of educational research as an exchange between researcher and practitioner [Pa21], and alongside this we need to have the impact on educational practice in mind as we design, implement and disseminate research projects.

In this short discussion paper accompanying my keynote presentation I outline how we can use *knowledge mobilisation* as a framework to support our understanding of research integrating with practice in computing education, and briefly highlight examples that demonstrate ways in which the integration of research and practice can be viewed through this lens. However this account only lightly touches the surface of the complexities of the interaction between research and educational practice; I believe this is an issue which warrants further debate and discussion within the computing education research community.

## 2 Knowledge mobilisation

Knowledge mobilisation can be defined as *'the process through which research and data become integrated (or fail to become integrated) into educational policies and practices.'* [CKM17, p.191]. What we mean by knowledge in this context is the knowledge generated by research and how it is mobilised into practice. Knowledge generated by research has different characteristics from the type of knowledge that teachers use, as shown in Figure 1. For example, academic research seeks generalisable and sometimes abstract findings and conclusions, and research knowledge may be accumulated slowly and focused on a very specific context. In contrast, teachers' pedagogical knowledge is valued for its fitness for purpose, being context-specific, and being broad enough to encompass a range of issues [Ca15]. This suggests that knowledge mobilisation is not as straightforward as simply sharing research knowledge with teachers.

| **Knowledge generated by research** |
|---|
| Propositional & theoretical knowledge |
| Generalized, abstract and impersonal |
| Narrowly-focused on single, isolated issues |
| Accumulated slowly and logically, with an attitude of principled skepticism |
| Valued for its significance, originality and rigour |

| **Teachers' pedagogical knowledge** |
|---|
| Procedural & practical knowledge |
| Context-specific, based on personal values |
| Broadly focused on many issues |
| Knowledge that informs intuitive, tacit, swift and fluent thinking |
| Valued for its practicality and fitness for purpose |

Fig. 1: A summary of different types of knowledge [Ca15, p.494]

Theoretical work around knowledge mobilisation is broad and extends beyond school education. However, one particular framework is particularly useful in the education context, describing knowledge mobilisation as taking three different forms [Ca04]:

- Knowledge transfer, where knowledge is taken into practice without alteration;
- Knowledge translation, where knowledge is translated into a form that can be used in practice; and
- Knowledge transformation, where knowledge is transformed by the practitioner to be used as applicable in their context.

An example of *knowledge transfer* might be when a research finding is implemented in schools using a top-down approach. A noteable example from the UK context is where research on formative assessment [BW98] radically changed the way schools conducted assessment, informing a policy-driven approach around assessment for learning. This example demonstrates how influential stakeholders can be persuaded of the importance of the problem the research is solving, and drive the implementation of conceptual and practical tools for addressing these problems [CA17]. However, the research itself is largely invisible to teachers [CA17].

In contrast, *knowledge translation* attempts to bridge the gap between basic research and the world of practice [JPY15]. It can take different forms, for example, translating research to lessons for practice, or providing research in a range of different formats. Examples of knowledge translation vary from shortened versions of research findings in magazines and infographics, to full programmes set up to collect and disseminate easily accessible research findings [Yo18].

*Knowledge transformation* is more difficult to exemplify as it involves action on the part of the teacher to process and use the research in their own context [Ca15]. It can be said to take place when practical knowledge is brought into focus in order to modify personal knowledge [Wi16]. Research may generate knowledge that something can work, but teachers need knowledge of how to actually make it work reliably over diverse contexts and populations [Br15], which involves transformation of that knowledge. Knowledge transformation approaches include researchers and educators working together in a participatory and inclusive way [Pa21] and classroom-based research [Ma19, El93], through which teachers start to belong to the process of research [Ho21]. In computing education, participatory research can be seen in the development of research-practice-partnerships in the US [Mc21].

In the next section, I relate some examples of knowledge mobilisation of research to practice in the context of computing education in England.

## 3 Knowledge mobilisation examples: computing education in England

In 2014 England implemented a new computing curriculum, now being taught to all children aged 5 to 16 in schools adhering to the national curriculum [Br14]. This was followed in 2018 by a substantial investment in a programme to support teachers called the National Centre for Computing Education (NCCE) [Se19]. Resources for teachers included teaching materials, support with pedagogy and a range of professional development (PD) courses.

One of the first pieces of work within the NCCE was the creation of a ten-topic taxonomy embracing all aspects of school computing for children aged 5-18[2]. This taxonomy facilitated an investigation into the balance across these different topics areas in the NCCE resources, and became the backbone of a comprehensive curriculum for teachers[3]. The curriculum is divided into 78 6-week units with teacher guides, and its intention is to flesh out the government's programme of study for computing and support teachers by providing comprehensive and adaptable lesson materials.

A review of pedagogical approaches for teaching computing was also carried out [WS21], alongside consultations with teachers, researchers and stakeholders on key pedagogical principles that resonated in the classroom. This led to the development of a set of 12 pedagogical principles for computing that teachers could access and read, in an easy-to-access form[4]. Across this programme of work, we can consider the ways in which knowledge mobilisation takes place.

**Knowledge transfer via curriculum materials.** As described above, the NCCE developed a full curriculum including 500 hours of detailed lesson plans, together with resources and all assessments. Into these materials, they embedded the results of the research findings from the literature review and signposted the underlying research in the teacher guide, including the 12 research-informed pedagogical principles. Pair programming, semantic wave theory, levels of abstraction, PRIMM, etc. are embedded into lesson plans, slide shows, activities, and homework assignments; this can be seen as an example of knowledge transfer.

**Knowledge translation and pedagogical materials.** To support teachers too busy to engage with research more deeply, the NCCE developed a set of *Quick Reads*[5], which are 2-page summaries of particular pieces of research, including cognitive load, pair programming, peer instruction, the Block Model and worked examples. These short summaries include examples of the way in which the pedagogical approaches could be applied, and pointers to additional reading; this represents an example of knowledge translation.

[2] Blog post: https://blog.teachcomputing.org/categorising-national-centre-content/
[3] Examples of curricuum materials: http://raspberrypi.org/curriculum
[4] Available at: https://static.teachcomputing.org/pedagogy/Pedagogy-principles.pdf
[5] Available at: https://blog.teachcomputing.org/tag/quickread/

**Knowledge transformation.** Classroom research is often cited as a way of enabling practitioners to be deeply involved in research and transform their own practice in context [Ma19]. Within the NCCE materials, a structured course was developed for teachers to conduct an action research project over six months, building on a previous classroom research project conducted in England [Se18] but this has had low take-up. Teachers are also encouraged to write for a computing education magazine exploring their own practice, which may or may not draw on research. Other than that, the NCCE has not yet incorporated any obvious mechanisms for encouraging teacher participation in research and the transformation of research knowledge by teachers for practice. However, a non-NCCE example from England of teachers working in a participatory and collaborative way with researchers can be found in a recent highly contextualised project on culturally responsive computing teaching [Hw23]. In this study, researchers provided a structure for teachers to use to examine, reflect on and develop research-informed practice in their own classrooms, giving space for teachers' engagement with the research on culturally-responsive teaching in an autonomous way. Another example of knowledge mobilisation, of a different flavour, can be seen in the ways that teachers in England have engaged with the programming structure known as PRIMM [SWK19]. Some teachers have taken available PRIMM lessons and used them in their classroom (knowledge transfer) while others have developed PRIMM for use in their own context, for example in the primary classroom (perhaps this is knowledge translation). Yet other teachers have developed their own acronym, that draws on the underlying principles of PRIMM but represents their own particular context and school ethos[6] (knowledge transformation).

## 4 Discussion

Every country or jurisdiction engaged in computing education research has their own examples of the ways in which they work collaboratively with teachers towards mobilisation of research knowledge into practice. The examples given are not intended to highlight best practice but rather to provide illustrative examples of the ways in which research knowledge can be mobilised into practice.

While focusing on 'what works' is an effective way of linking research to practice, it is not always appropriate. As K-12 computing education research is in its infancy and many practitioners are new to teaching the subject, I would argue that a more collaborative approach is needed. We may also take Cain's view that our research may not ever directly impact practice, but be a vehicle that teachers can use to inform their own development of personal knowledge:

> *"Despite the increased interest in research impact, there is very little empirical evidence that educational research can inform practice directly, and further-*

[6] See for example, KPRIDE at https://create.withcode.uk/kpride/

> *more, a body of literature which suggests that this is, in principle, impossible."* [Ca15, p. 488]

However, even with knowledge transformation as our ultimate goal, we should not automatically dismiss mechanisms around knowledge transfer and translation that attempt to support teachers at scale by sharing new research. A difference between some examples of knowledge transfer and the example we have shared here from the NCCE around embedding research in curriculum materials is that it attempts to provide *good examples for practice* rather than *examples of good practice* [Ke21]. This might seem a minor distinction to make, but is an important one: the latter opposes ideas of what is good or bad, or 'what works' (or doesn't work). Instead, our example of knowledge transfer seeks to give teachers well-crafted examples of lessons that embody suggestions from research without any particular judgement attached. Hence lessons may embody research-informed approaches, but all can be adapted to a teacher's own context. As we do not want to present research to teachers in a way that is deskilling or implies a deficit [Ke21], care has to be taken with the way research knowledge is presented.

For knowledge transformation to take place, teachers need to be actively engaged with research and be able to make critical judgements on how research findings can be implemented in their classroom [Ca16]. Examples of activities might be reading and putting into practice research texts [Ca15] and engaging with classroom-based research [Ma19]. One obstacle may be that knowledge transformation activities require a certain autonomy on behalf of the teacher, and also time, both of which might be in short supply.

## 5 Conclusion

In this short discussion paper, I have attempted to consider the ways in which educational research, particularly computing education research, might not just reach practice, but go hand in hand with practice. This paper has drawn on models of knowledge mobilisation as a framework, with illustrative examples. My hope is for us to see research as a collaborative activity between researchers and practitioners reflecting complementary competencies [Ke21]; knowledge transfer of research to practice does not need to imply a deficit or deskilling mentality. By enabling computing education researchers and practitioners to work collaboratively on research, we can hopefully contribute to the development of individuals (young people) within society.

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