



Edge Hill  
University

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***New STEM knowledge; emerging through collaboration***

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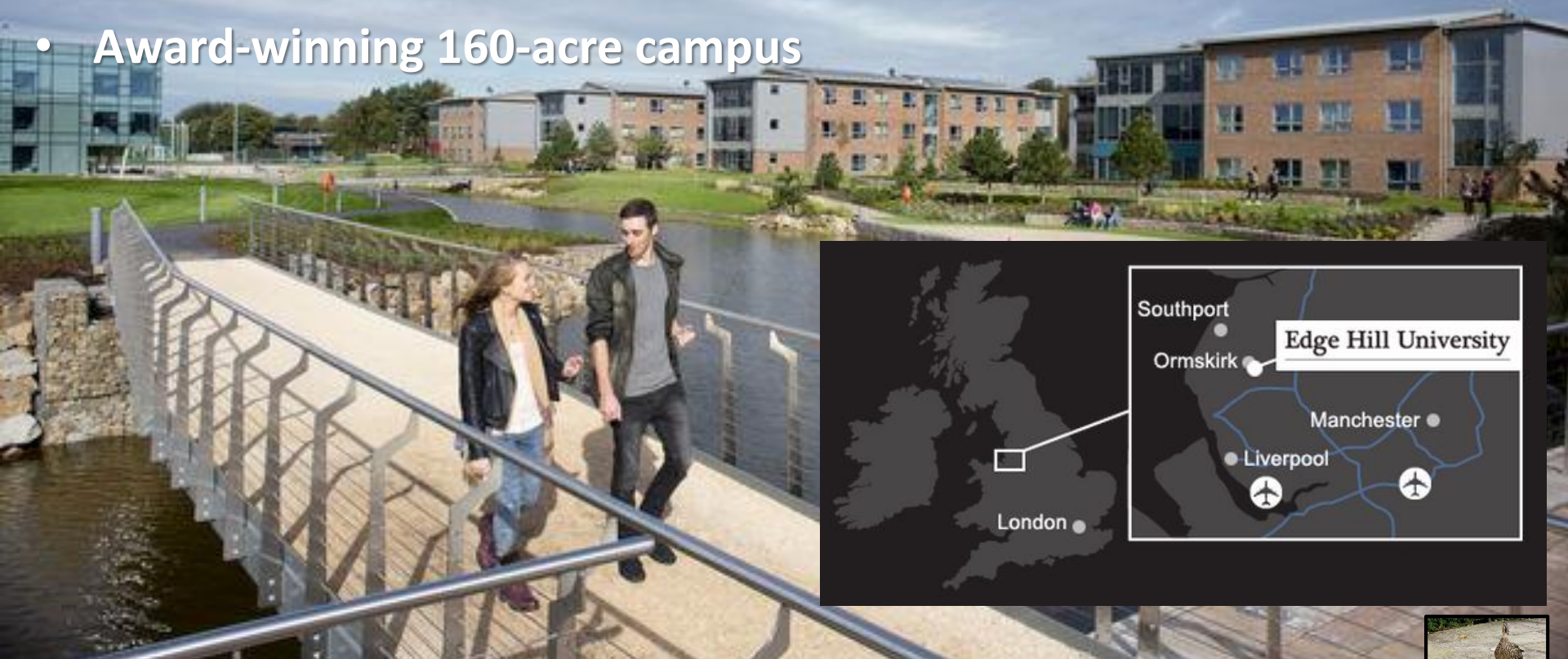
Dawne Bell and David Wooff

Before we begin, a little bit about who we are and where we come from ...





- University of the Year
- One of the fastest growing universities in the UK
- 128-year history, reputation of excellence for training Teachers and Health professionals
- Award-winning 160-acre campus



...and very well know for our ducks





Focussed within the context of STEM education, and the conference theme, this study seeks to explore how participants collaborate to build a diverse STEM-literate society

*The research questions how do participants:*

- *perceive D&T's contribution to STEM education?*
- *acquire new (STEM) knowledge, and embed it into their own practice?*
- *personal understandings of STEM pedagogy help empower, and support the positioning of D&T's place as a valued subject within the curriculum?*



***Research method:***

**Constructivist grounded theory (Charmaz 2006), underpinned an interpretivist ontology.**

**This approach was adopted because it takes account of the reflexive and biographical stance of the researcher (Finlay and Gough 2003, Alvesson and Skoldberg 2009), and in this study participants were encouraged to relate the positioning of design and technology within the field of STEM education.**



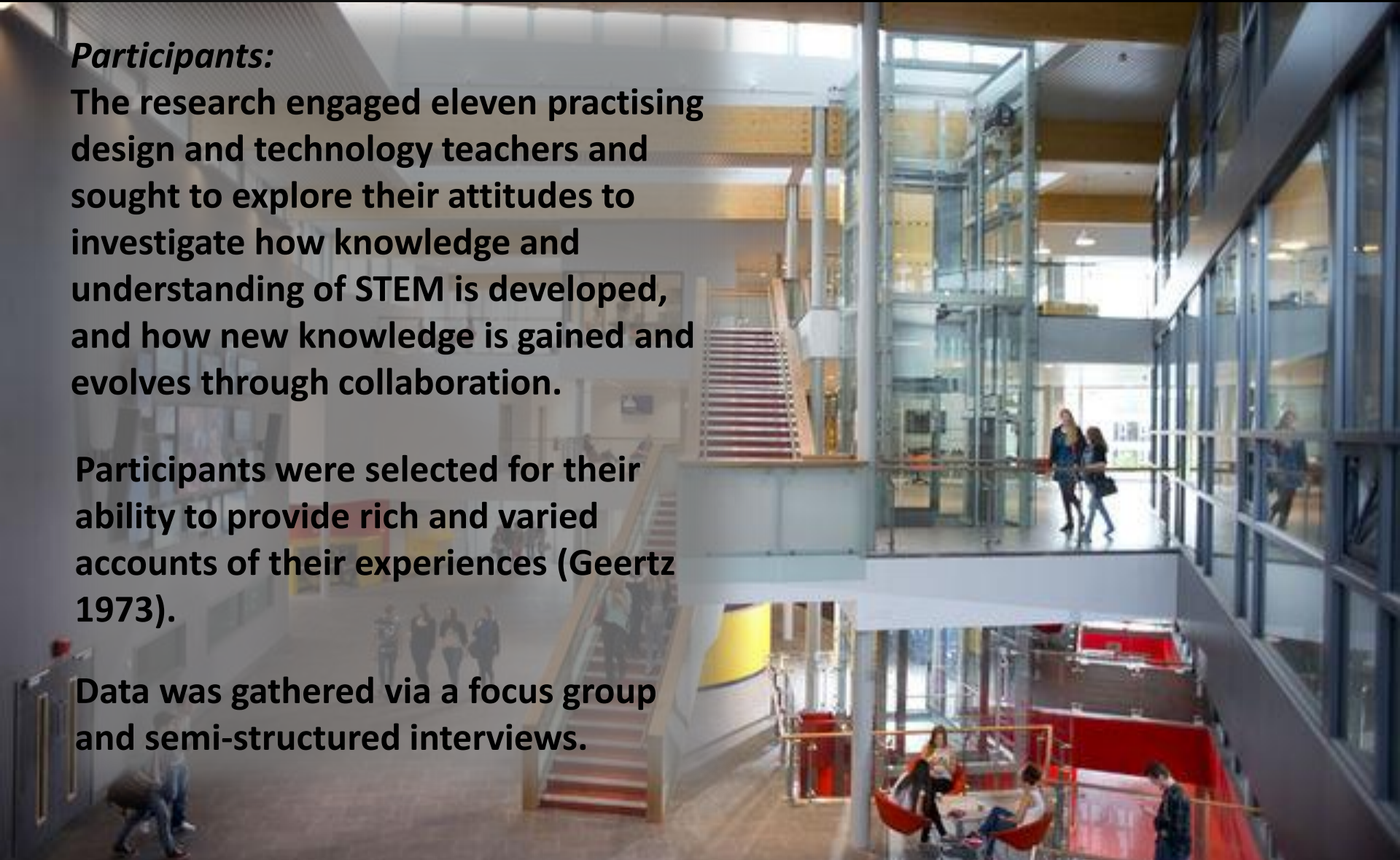


## *Participants:*

The research engaged eleven practising design and technology teachers and sought to explore their attitudes to investigate how knowledge and understanding of STEM is developed, and how new knowledge is gained and evolves through collaboration.

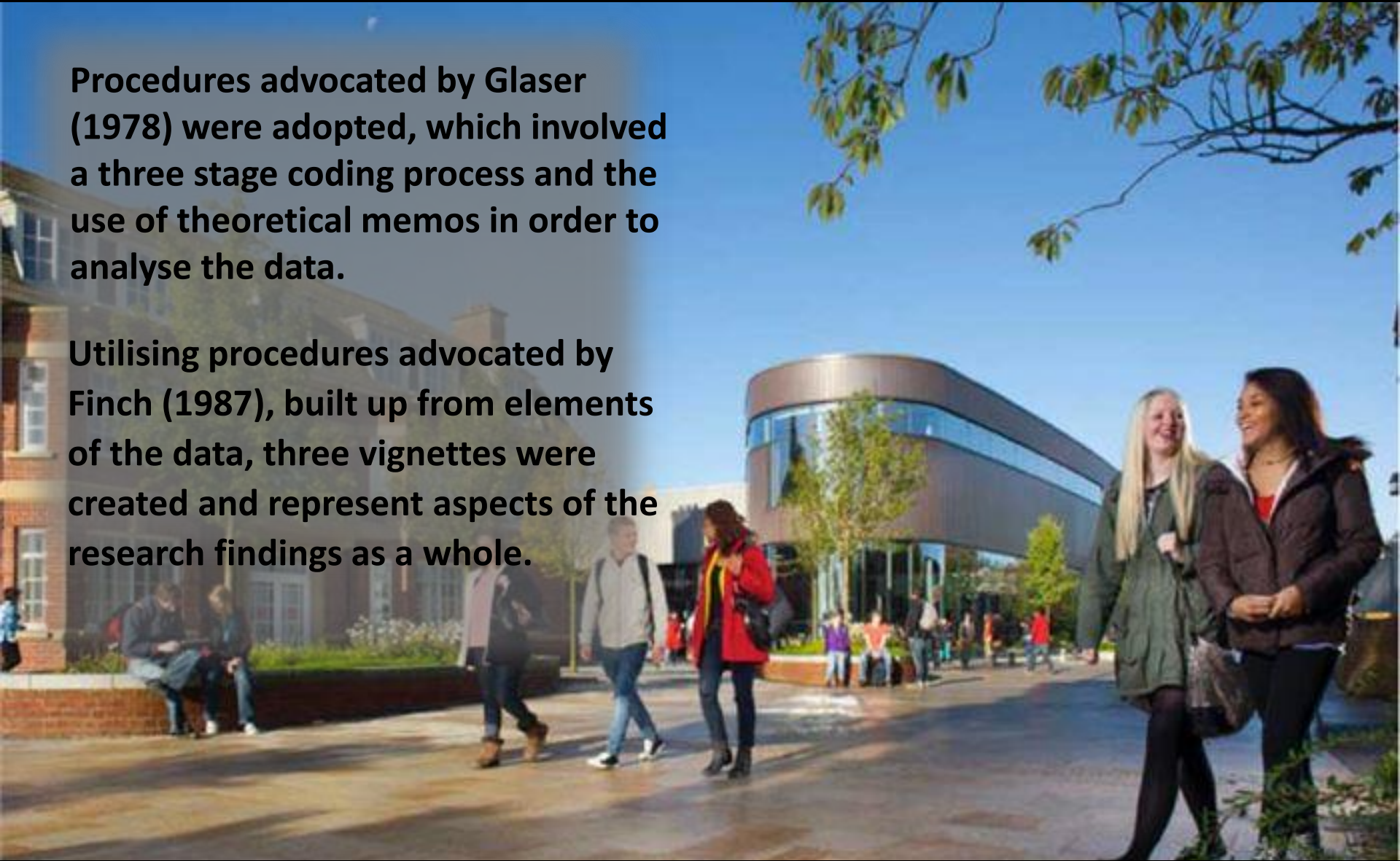
Participants were selected for their ability to provide rich and varied accounts of their experiences (Geertz 1973).

Data was gathered via a focus group and semi-structured interviews.



Procedures advocated by Glaser (1978) were adopted, which involved a three stage coding process and the use of theoretical memos in order to analyse the data.

Utilising procedures advocated by Finch (1987), built up from elements of the data, three vignettes were created and represent aspects of the research findings as a whole.





**Following preliminary analysis emergent theory suggests that participants acquire STEM related skills, knowledge and understanding in three ways;**

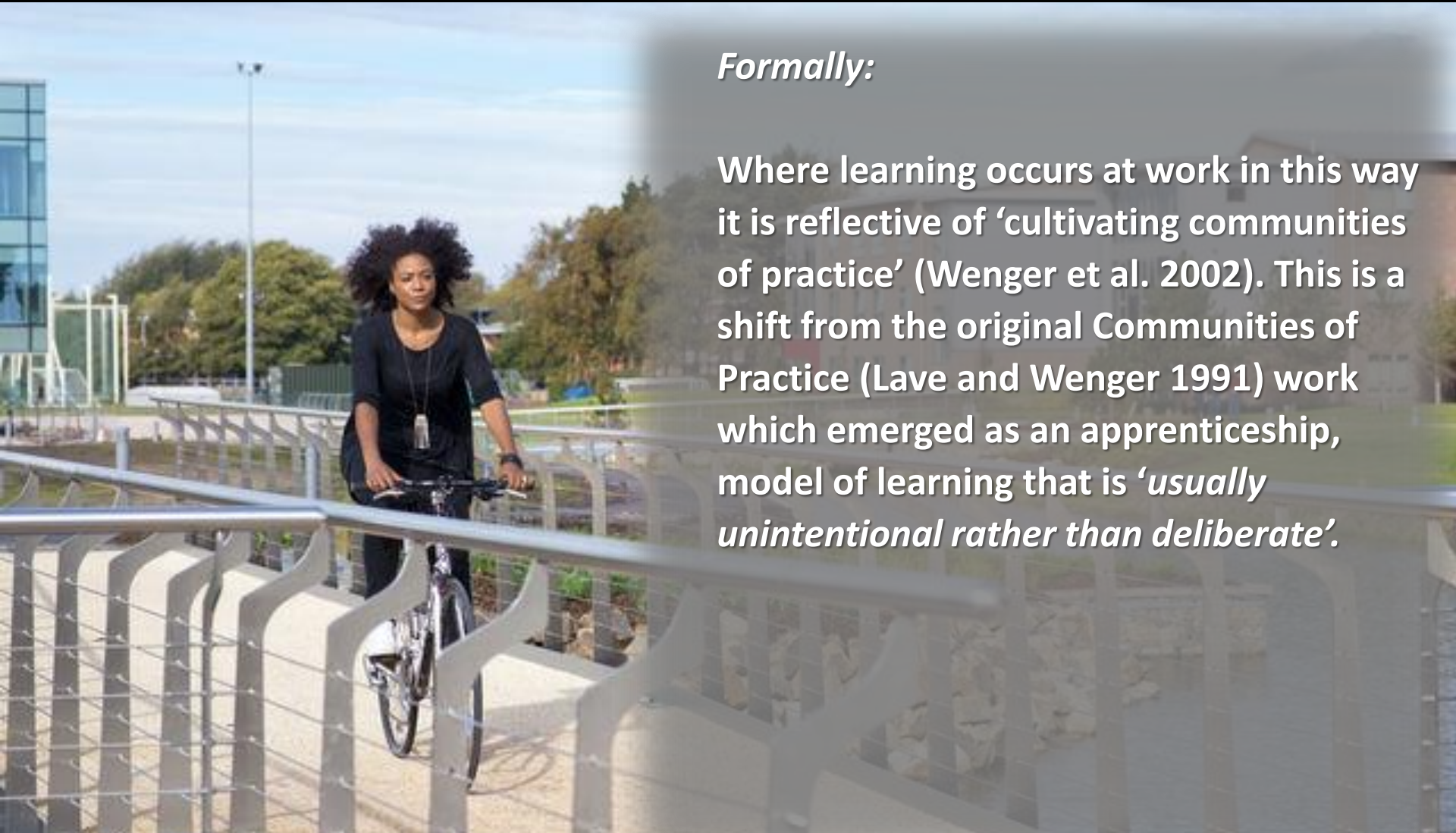
- 1. Formally**
- 2. Informally**
- 3. Independently**





## *Formally:*

Where learning occurs at work in this way it is reflective of 'cultivating communities of practice' (Wenger et al. 2002). This is a shift from the original Communities of Practice (Lave and Wenger 1991) work which emerged as an apprenticeship, model of learning that is '*usually unintentional rather than deliberate*'.



*Formally:*

Limited access to formal training due to Science and Mathematics funding foci. Perceived as divisive, due to didactic dissemination by those in control.

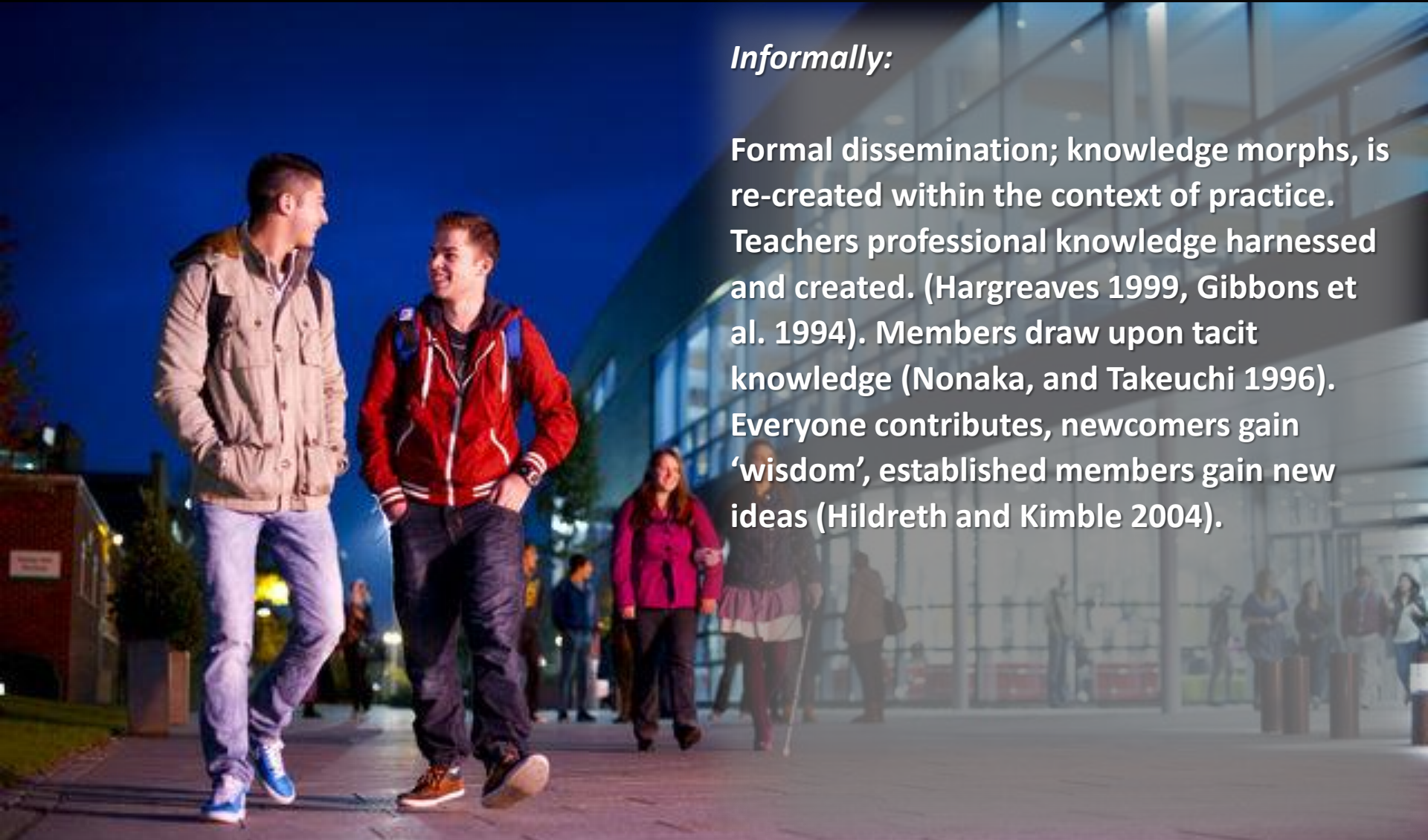
Participants reported limited access to formal training due to costs. Perceived [by the majority] as divisive. Authoritarian and didactic dissemination.





## *Informally:*

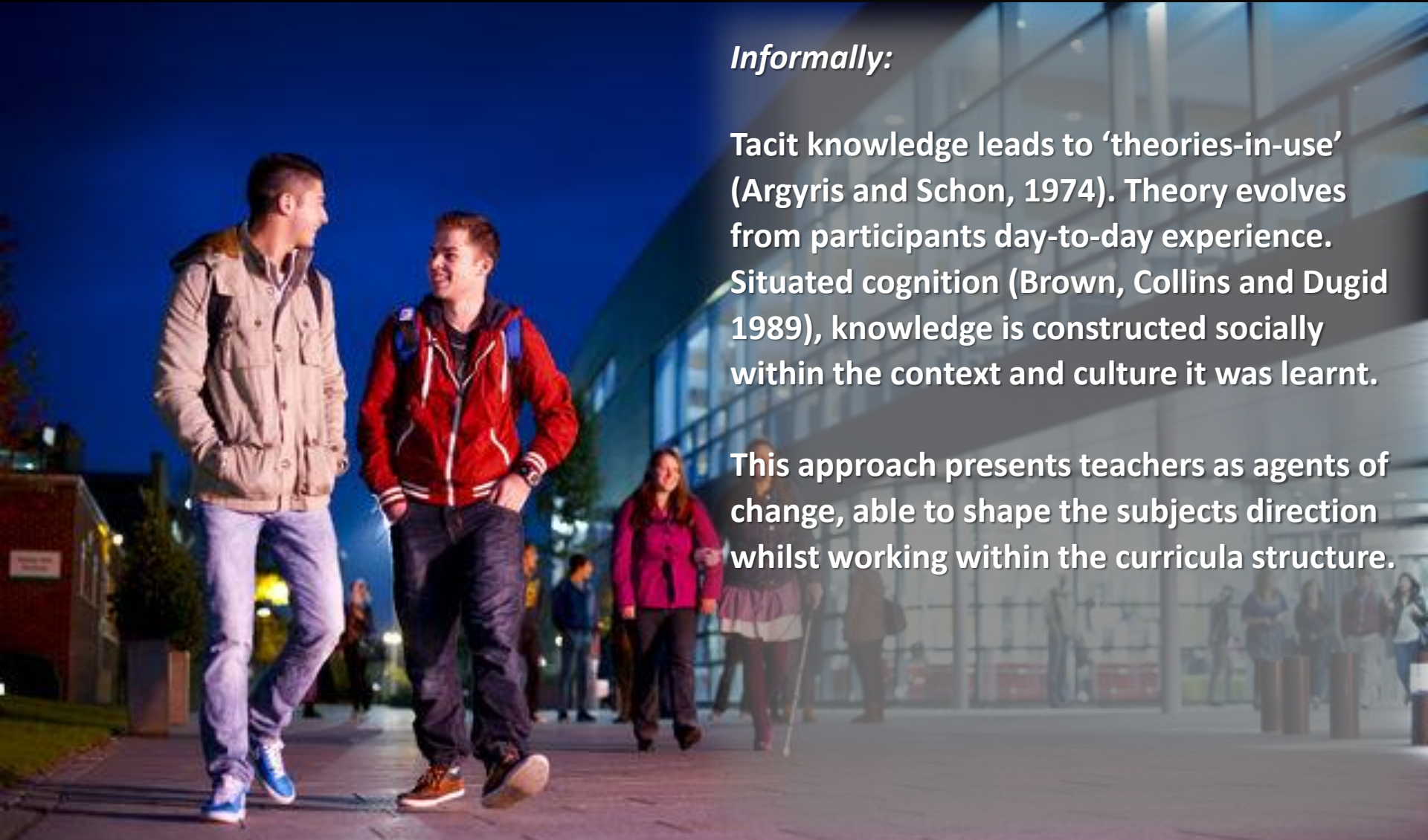
**Formal dissemination; knowledge morphs, is re-created within the context of practice. Teachers professional knowledge harnessed and created. (Hargreaves 1999, Gibbons et al. 1994). Members draw upon tacit knowledge (Nonaka, and Takeuchi 1996). Everyone contributes, newcomers gain 'wisdom', established members gain new ideas (Hildreth and Kimble 2004).**



## *Informally:*

Tacit knowledge leads to 'theories-in-use' (Argyris and Schon, 1974). Theory evolves from participants day-to-day experience. Situated cognition (Brown, Collins and Dugid 1989), knowledge is constructed socially within the context and culture it was learnt.

This approach presents teachers as agents of change, able to shape the subjects direction whilst working within the curricula structure.





*Independently:*

Beyond the boundaries of a physical workplace. The notion of 'common ground' (Clark and Brennan 1991). Membership is achieved through 'active' participation. Participants share ideas and knowledge. Mutual trust evolves, individuals become an effective, cohesive group.



## *Independently:*

The use of educational technology; the internet, MOOCs (Dolan et al. 2013, Moore 2013), e-learning. Findings suggest that this is an effective way to acquire new STEM knowledge. Information shared is unconfined, and subsequently learning is limitless (Dalkir 2005, Duguid 2005).

Participants develop practice independently, through virtual networks and professional online learning communities.

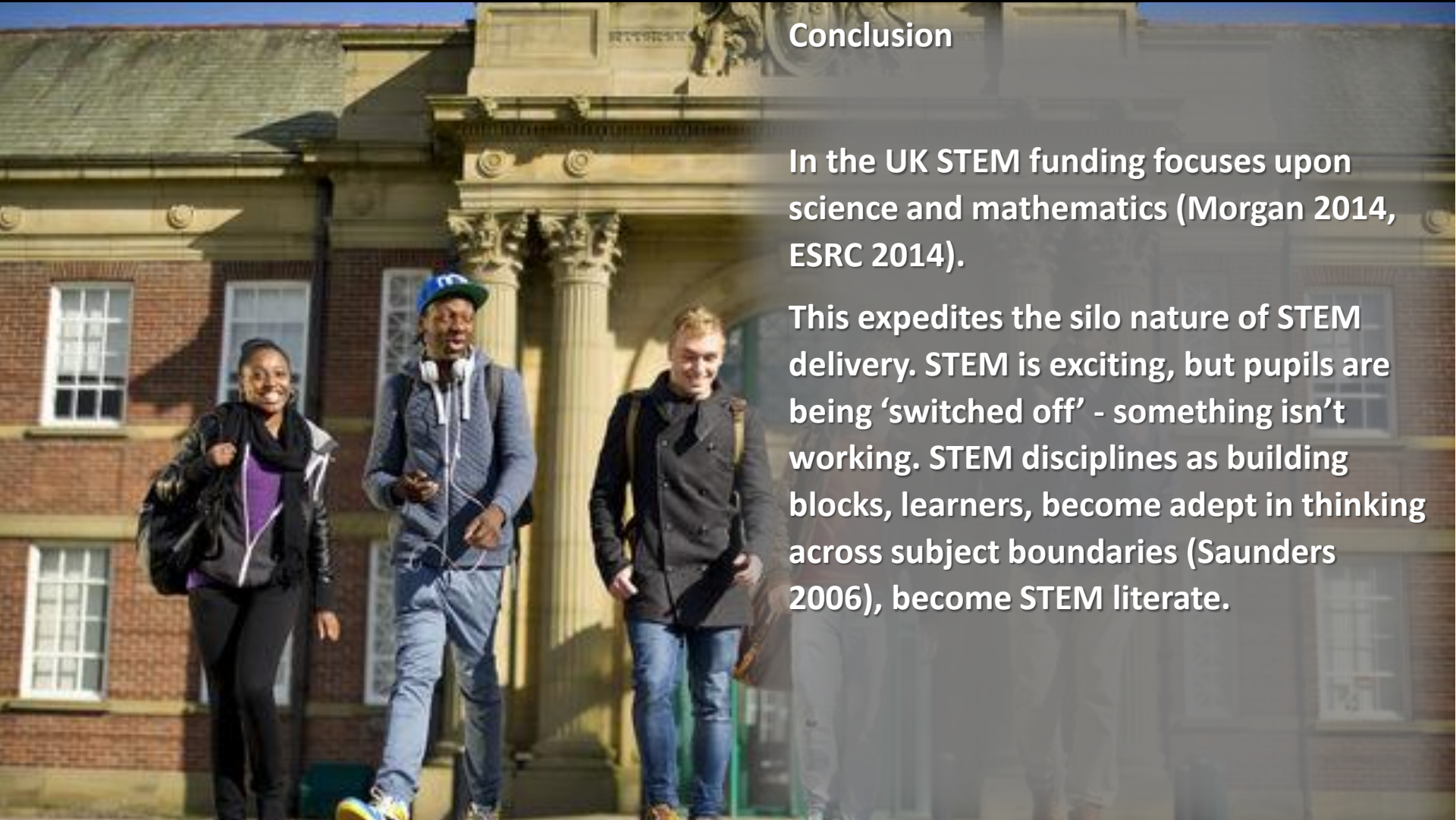




## Conclusion

In the UK STEM funding focuses upon science and mathematics (Morgan 2014, ESRC 2014).

This expedites the silo nature of STEM delivery. STEM is exciting, but pupils are being 'switched off' - something isn't working. STEM disciplines as building blocks, learners, become adept in thinking across subject boundaries (Saunders 2006), become STEM literate.



## Conclusion

For this to happen, policy makers must support teachers in their professional development to improve interdisciplinary pedagogical approaches to create new STEM knowledge.

Findings suggest that learning informally and independently, through self-organised physical or virtual networks empowers teachers and supports the generation of new STEM knowledge.





Alvesson, M. and Skoldberg, K. (2009). *Reflexive Methodology: New Vistas for Qualitative Research* (2<sup>nd</sup> ed.), Sage.

Argyris, C. and Schon, D. (1974) *Theory in practice: Increasing professional effectiveness*, San Francisco: Jossey Bass.

Brown, J.S., Collins, A. and Duguid, P. (1989). *Situated Cognition and the Culture of Learning*. Washington, DC: American Educational Research Association.

Charmaz, K. (2006). *Constructing Grounded Theory: A practical guide through qualitative analysis*, Sage, London.

Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. *Perspectives on socially shared cognition*, 13(1991), 127-149.  
<http://www.cs.cmu.edu/~illah/CLASSDOCS/Clark91.pdf> Accessed 3rd April 2015  
Accessed 3rd April 2015.

Dalkir, K., (2005). *Knowledge Management in Theory and Practice*, Burlington; Elsevier Butterworth-Heinemann.

Duguid, P. (2005). *The Art of Knowing: Social and Tacit Dimensions of Knowledge and the Limits of the Community of Practice*, The Information Society, Taylor & Francis, 109–118.

Dolan P, Leat D, Mazzoli Smith L, Mitra S, Todd L, Wall K. Self-Organised Learning Environments (SOLEs) in an English School: an example of transformative pedagogy?. *Online Educational Research Journal* 2013, 1-19.

Economic and Social Research Council (ESRC). (2014). *Choosing our futures: A roadmap for STEM education*. <http://www.esrc.ac.uk/research/major-investments/TISME.aspx> Accessed 2nd April 2015.

Finch, J. (1987). The vignette technique in survey research. *Sociology*, 21(1), pp. 105-114.

Finlay, L. and Gough, B. (2003). *Reflexivity: A Practical Guide for Researchers in Health and Social Sciences*, Blackwell.

Geertz, C. (1973). *Thick Description: Toward an Interpretation Theory of Culture in; The Interpretation of Cultures: Selected Essays*, New York, Basics Books Inc.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow, M. (1994). *The new production of knowledge: the dynamics of science and research in contemporary societies*. London: Sage.

Hargreaves, D.H., (1999). The Knowledge-creating School, *British Journal of Educational Studies*, 47:2, p122–44.

Hildreth, P., and Kimble, C., (2004) [Knowledge Networks: Innovation through Communities of Practice](#) London / Hershey: Idea Group Inc. Accessed 2nd April 2015.

Moore, M.G. (2013). Independent learning, MOOCs, and the open badges infrastructure. *American Journal of Distance Education*, 27(2), pp. 75-76.

Morgan, N. (2014). Secretary of State for Education speaks about science and maths at the launch of Your Life campaign.  
<https://www.gov.uk/government/speeches/nicky-morgan-speaks-at-launch-of-your-life-campaign>. Accessed 18th July 2015.

Nonaka, I., and Takeuchi, H., (1996). The Theory of Organizational Knowledge Creation", *International Journal of Technology Management*, Vol 11, no 7/8.

Saunders, M. (2006). *From organisms to boundaries: the uneven development of theory narratives in education, learning and work connections*. Routledge.

Wenger, E., McDermott, R., and Snyder, W. (2002). *Cultivating communities of practice: a guide to managing knowledge*, Cambridge, Mass, Harvard Business School Press.