Research report: July 2009

NESTA Making Innovation Flourish

The identification and measurement of innovative characteristics of young people

Development of the Youth Innovation Skills Measurement Tool

Professor Elizabeth Chell and Rosemary Athayde, Kingston University

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Foreword

The challenges of the future - globalisation, climate, technological and demographic change – require a different response from our education system. We need to equip future generations not only with strong basic skills and specialist technical knowledge, but with the attitudes and wider skills to generate radical new solutions and adapt to our rapidly changing world.

We need to provide future generation with the skills for innovation to a greater degree than ever before: the confidence and insight to generate a novel idea or new approach; the motivation, commitment and resilience to pursue that idea; the leadership, energy and dynamism to communicate their vision to others and drive it forward from concept to reality.

For these skills to have currency in education we need to be able to identify and measure them. We are delighted to have supported this pioneering work from Kingston University, which combines theoretical knowledge on measuring skills with practical understanding about how it can be done.

In partnership with Kingston University, we intend to take this work forward with the development of an online tool that will be freely available to young people, so that they can assess their capacity for innovation and appreciate how they can develop it further.

Helen Gresty
Executive Director Innovation Programmes, NESTA

July, 2009

NESTA is the National Endowment for Science, Technology and the Arts.

Our aim is to transform the UK's capacity for innovation. We invest in early-stage companies, inform innovation policy and encourage a culture that helps innovation to flourish.

Executive summary

The Youth Innovation Skills Measurement Tool is an instrument to support the development of the skills and attitudes which young people require if they are to become the innovators of tomorrow.

The Tool measures the skills needed for innovation
The Tool measures five generic skills that underpin innovative behaviour and form a set of attributes clearly linked to the innovation process:

- Creativity (imagination, connecting ideas, tackling and solving problems, curiosity);
- Self-efficacy (self belief, self assurance, self awareness, feelings of empowerment, social confidence);
- Energy (drive, enthusiasm, motivation, hard work, persistence and commitment);
- Risk-propensity (a combination of risk tolerance and the ability to take calculated risks); and
- Leadership (vision and the ability to mobilise commitment).

The skills were identified through a literature review and through testing the concepts with separate focus groups of young people and teachers from different disciplines in schools and colleges in Greater London and Hampshire.

The skills assessed by the Tool are also important for young people's employability and ability to make a wider social contribution. The five skills tested match closely those which employers say they most need in their new recruits, but which they too often find missing. Our current economic climate, where enterprises have to adapt to survive, has made these skills even more important, and they can also help social enterprises and public services to respond to the major social challenges of today.

Schools and colleges have opportunities to develop young people's innovation skills
The Tool is underpinned by social and heuristic learning theory[1] which indicates that with the right support and environment, nearly all young people have the potential to strengthen and develop these five core skills.

There is a great deal that schools and colleges can do across the curriculum and through extra-curricular activities to develop young people's innovative skills. Teaching style is influential as is an ethos and culture tolerant of experimentation, where students are encouraged to be adventurous in their thinking and approaches to learning.

Regardless of subject discipline, a problem-solving, curiosity-driven approach helps develop creativity. When students work together on projects, they are developing the teamwork skills needed in the workplace. Group project work can also develop leadership skills, personal self-efficacy[2] and energy.

Young people can find it hard to transfer ideas from one subject to another and make connections between them. But cross-disciplinary projects can be used to explore a subject and enable young people to be more creative and adventurous in their thinking, particularly where they are not formally assessed. These projects can allow them to see how far they are willing to take risks.

Sporting and extracurricular subjects are also excellent vehicles for promoting the development of leadership skills and personal self-confidence. Young people can also learn to take risks where they are occasionally allowed to get things wrong and encouraged to think through how to put things right. It is also important that they learn that there may

1. Heuristic learning theory involves trial and error: it is developed from practical experience.
2. Self-efficacy is the belief that one is capable of performing in a certain manner to attain certain goals.

be more than one right answer to the same question.

The Tool has widespread applicability
Within and outside formal education settings, the Tool has a number of potential uses.

1. **Young people's personal development**: The Tool can help young people gain insight into what skills they might want to strengthen and how they might go about strengthening them. This could form part of personal, learning and thinking skills (PLTS) activities, careers guidance, or other advisory sessions on subject choices or further education options. Such self-awareness and self-reflection are skills valued by employers.

2. **Evaluation of initiatives**: Innovation skills are generic and can be developed through science, arts and vocationally-oriented subjects, as well as through a wide range of extra-curricular activities. The Tool can be used as a benchmark to measure the impact of enterprise and innovation programmes and initiatives.

3. **Comparison between schools and teaching groups**: Our research indicates that the ethos and culture of schools can impact on young people's ability to develop the skills for innovation, as can different teaching approaches. The Tool can enable comparisons to be made between groups of young people in different institutions or subject groups to assess the effectiveness of different pedagogical styles and other features of school or college culture.

How the Tool was developed
The Tool was developed over 18 months in 2007-09 through three phases of testing and trialling with 1,358 young people aged 14-19 (724 male, 634 female) from a wide range of ethnic backgrounds in schools and sixth forms colleges in inner city, suburban, commuter-belt and semi-rural locations in Greater London and Hampshire.

The Tool is administered as a web-based questionnaire comprising 31 attitudinal statements together with six statements designed to elicit a young person's intention to pursue an innovative career-pathway as well as demographic questions. The attitudinal statements are measured using a seven-point Likert scale.[3]

The Tool has aroused wide interest
In developing the Tool, we have presented the findings to academic conferences and seminars where our colleagues' expertise and insights have helped develop our thinking. We have also responded to the interest shown by policymakers and practitioners in education and youth organisations in presentations and seminars in the UK and abroad.

This interest demonstrates that the Tool is addressing a need within education. Whereas examinations can test knowledge and intelligence, there are few objective and robust methods for assessing these core skills.

We are developing a self-report version of the measure
The measure is currently available online to a number of schools and colleges. Their use of it has enabled us to refine the measure and its sub-scales of Creativity, Self-efficacy, Energy, Risk-propensity and Leadership, and we are currently strengthening the measurement of Risk-propensity. Having established a valid and reliable measure, we plan to develop norms for cohorts of young people in different age groups and to test the Tool further with schools around the UK. We are also developing a 'self report' version of the Tool that will allow young people to measure their own skills. The new version will be ready in 2010.

3. The Likert technique presents a set of attitude statements. Subjects are asked to express degrees of agreement or disagreement with each degree given a numerical value from one to seven. A total numerical value can then be calculated from all the responses.

About the authors

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Professor Chell is currently a research consultant and professor affiliated to Kingston University's, Small Business Research Centre (SBRC). Throughout her career she has pursued an interest in social psychological aspects of behaviour and specialised in understanding entrepreneurial, small business and innovative behaviour. She has written extensively on this topic and her latest book entitled The Entrepreneurial Personality – a social construction 2nd ed. was published by Routledge/The Psychology Press in May 2008. Her next book (co-authored with Dr Mine Karatas-Ozkan) entitled Nascent Entrepreneurship and Learning is due to be published by Edward Elgar Publishing Ltd in 2010. She has also recently published work in social entrepreneurship.

Elizabeth is a member of editorial boards of several renowned journals in entrepreneurship, including ET&P, Entrepreneurship & Regional Development and the ISBJ. She is a Fellow of the Royal Society for the Arts, Manufactures and Commerce (RSA) and of the British Academy of Management. She is a member of the British Psychological Society. She may be contacted initially by email on: e.chell@kingston.ac.uk.

Rosemary Athayde MSc
Rosemary Athayde is a senior researcher at the Small Business Research Centre Kingston University, and her research interests are enterprise and entrepreneurship education. She has carried out evaluations of different types of enterprise programmes using a range of psychometric measures and techniques. Rosemary has developed an Attitudes to Enterprise (ATE) Test which measures enterprise potential in young people. The test has been used in the UK and Australia, and is currently being used by the North West University in South Africa to measure pupils' attitudes to enterprise in secondary schools. An undergraduate version of the ATE test was used to evaluate the Bright Futures Programme run by West Focus, for the Higher Education Entrepreneurship Group (HEEG). The undergraduate ATE test is also being used by Kettering University in Michigan U.S. to evaluate their entrepreneurship programme, and by the University of Zagreb in Croatia. In 2004 Rosemary gave a presentation on her work at the United Nations Economic Commission Working Party on Youth Entrepreneurship in Geneva, Switzerland. A paper on the early development of the test was published by Entrepreneurship Theory and Practice in March 2009.

Acknowledgements

We would like to acknowledge the invaluable support of schools and colleges for this project. This includes staff, not merely for organising their classes to participate in the online Tool, but also for giving of their time to talk to us about issues of innovation in secondary education. A very large number of students participated in the research and we are grateful to them. Particular thanks go to Andrew Greenman for his assistance in carrying out the literature review and contributing to the development of a series of case studies based on the qualitative background work.

Research of such a sustained nature requires the involvement of colleagues at some level; we would therefore like to thank Cynthia Jones, Emma Soane, Mark Hart, Sally Caird and Nick Wilson for initial discussions about the project; and Dan Bolton for his help in uploading the online Tool and looking after it, during the various periods when it was live. We also appreciate Arthur Seruga's office support. Thanks also to Sandra Morris for detailed discussions about the teaching profession in particular and generally for her valuable insights and unstinting support.

This, and the previous interim report, was subjected to rigorous scrutiny by a group of anonymous reviewers. Whilst we cannot thank them personally, we do appreciate their time and constructive comments. Finally we would like to thank the staff at NESTA for their help and guidance throughout this project; in particular we should mention the unstinting work of Theresa Crowley for nursing the project through its many stages, but thanks also to Richard Halkett, Katherine Mathieson, Gerard Darby and Maria Estevez for their valuable input

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Part 1: Innovation is the engine of society and the economy

Successive governments have expressed their desire to raise the UK's global economic performance, particularly in White Papers.[4] Innovation has emerged as the engine of national prosperity and social cohesion.[5] But for the UK to maintain international competitiveness and people's standard of living, productivity needs to improve, new industries need to be generated and people need to gain the skills that employers require. This demands fundamental structural shifts in society and the economy, with people more willing to accept change, embrace new ideas, and develop new skills and capabilities.

The UK needs innovative people to drive society and the economy forward

This means also that young people must develop the skills that enable them to unleash the imagination, energy and talent that are fundamental to innovation.[6] The Leitch Review of skills[7] and the 'Innovation Nation' White Paper both recognise the need for improved skills leading to improved management practices, company performance and innovation.

Great play is made of the role of creative skills in innovation – the ability to generate novel ideas, problem-solve or connect apparently disparate ideas. But other skills are also important to innovation – for example, subject specific skills and knowledge, leadership and management skills, and the ability to handle risk. In the absence of a definitive list of generic innovative skills, this report aims to identify those fundamental skills.

Innovation has traditionally been associated with the sciences and engineering. More recently, it has been shown to embrace other sectors including the creative industries and social enterprise. People – human capital – are recognised as clearly important for innovation and its many and varied outputs and processes,[8] whether incremental innovations in organisational processes and productivity or radical changes to industrial structures. Innovation involves the emergence of new firms, and new products and processes that require people with new specialist skills or the capacity to accept change and retrain.[9]

The definition of innovation that NESTA uses for its UK Innovation Index – change associated with the creation and adaptation of ideas that are new-to-world, new to nation/region, new-to-sector or new-to-organisation – captures both incremental and radical innovation and implies that innovation can occur within any sector. NESTA has contributed significantly to the debate about the nature of innovation by harnessing its resources to develop programmes that go beyond the narrow view of innovation associated with science to address the various current policy debates; including the need to develop the nation's future innovators.[10]

Hence, innovation is not limited to technology transfer, but is conceived more broadly as knowledge transfer, as novel ideas may occur in any discipline or walk of life. The production of novelty is what matters. Furthermore, manufacturing new products or implementing new processes requires a combination of industry specific knowledge and personal and interpersonal skills if they are to become more widely used. Most of these latter skills are generic and may be learnt.

4. See, for example, Department of Trade and Industry (1993) 'Realising our Potential: a strategy for science, engineering and technology.' Cm 2250. London: Her Majesty's Stationery Office; Department of Trade and Industry (1998) 'Our Competitive Future: Building the Knowledge Driven economy,' Cm 4176. London: Her Majesty's Stationery Office; Department for Business Enterprise and Regulatory Reform (BERR) (2008) 'Enterprise: Unlocking the UK's Talent.' London: HM Treasury.
5. Department of Trade and Industry (2002) 'Social Enterprise: A Strategy for Success.' London: Her Majesty's Stationery Office; see also Cabinet Office/Office of the Third Sector (2006) 'Social Enterprise Action Plan: Scaling new heights.' London: Cabinet Office/Office of the Third Sector; also, see, Department for Innovation, Universities and Skills (2008) 'Innovation Nation.' Cm 7345. London: DIUS.
6. Department for Innovation, Universities and Skills (2008), op.cit. pp.57-69.
7. Leitch Review of Skills (2006) 'Prosperity for all in a global economy: world class skills.' London: HM Treasury.
8. OECD (2008) 'Introduction to Innovation Strategy Measurement Brainstorm: Skills for Innovation.' 16th December, Paris: OECD.
9. Ibid. p.1.

Developing their innovation skills will help young people deal with a rapidly changing future

Each generation attempts to prepare its young for an unknown and uncertain future. Today's young people face even greater uncertainty as a result of global competitiveness which is driving rapid changes in industry, work and the quality of people's lives. Increasingly, employers require their young recruits to have appropriate attitudes and skills for this challenging environment.[11] This suggests the need to prepare young people throughout their education for a rapidly changing world.[12] Various initiatives have been taken by government in secondary and tertiary[13] education, whilst non-governmental bodies also provide opportunities for young people to develop appropriate skills and behaviours.[14] Attitudes and behaviours tend to be linked, and result in a particular way of working. An attitude that embraces innovation will thus be reflected in positive attitudes towards change, a willingness to embrace new ways of doing things and a way of working that is flexible and open to new ideas.

Social structure, context and personal situation shape attitudes and behaviours,[15] so it is important that there is a social structure that fosters the personal development of young people, their aspirations and those of society and the economy. Clearly, this social structure is broader than the education system, and includes their families and the wider community. The social structure is also dynamic and evolving. Within the school, it may be used as a means to organise teaching and informal learning better to suit the needs of individual young people.

Innovative people are much in demand. In new sectors such as computer gaming and digital media, young people adapt these technologies in ways not anticipated by manufacturers.[16] Hence, teenagers may exhibit innovative potential, even if they have not yet had the opportunity and motivation to exploit their innovative ideas.

Current policies provide opportunities to develop the innovative attitudes and behaviours of young people

Young people's lives are shaped first by their families and then by formal education and non-formal activities within and outside school. Attention is now being paid to how non-formal activities may be a source of learning and skills development. Such activities aim to broaden the young person's experience and provide opportunities for learning within the workplace and communities.[17]

In formal education, the focus has been on the national curriculum and raising standards of achievement at various critical points in the young person's development. Now, with the school leaving age being raised to eighteen, there is a shift in emphasis, reflecting a recognition that not all young people wish to follow an academic route; many have a practical inclination and a learning style to match. Hence, the development of Diplomas aimed at 14-19 year olds, where some theory is melded with the development of practical understanding and capability. This approach has also been enhanced by the introduction of personalised learning, where the pace at which young people can absorb information and develop their understanding is individualised, alongside an opportunity to undertake independent research that matches the young person's interests. Much of this builds on the White Paper 'Every Child Matters'[18] and helps young people to develop particular practical skills, such as seeking information, expanding their knowledge of a personal area of interest, and taking responsibility for personal learning.

10. NESTA has a young people's innovation programme and has also commissioned reports that focus on the need to develop the innovative potential of young people e.g. CIHE, NESTA and NCGE (2008) 'Developing Entrepreneurial Graduates – putting entrepreneurship at the centre of higher education.' London: NESTA; Rolfe, H. and Crowley, T. (2008) 'Work-related learning for an innovation nation.' London: NESTA.
11. Rolfe, H. and Crowley, T. (2008) op.cit.
12. Margo, J. and Dixon, M. with Pearce, N. and Reed, H. (2006) 'Freedom's orphans: Raising Youth in a changing world.' London: IPPR. Also, see NESTA (2007) 'Education for Innovation.' London: NESTA.
13. Science enterprise challenge, university challenge and the higher education innovation fund are just some national initiatives that have been in evidence and which were used to develop entrepreneurial skills and technology/knowledge transfer opportunities from universities. See also, CIHE, NESTA and NCGE (2008) op.cit.
14. For example, Young Enterprise and Make Your Mark are such. See also, The National Youth Agency (2007) 'Young People's Volunteering and Skills Development.' Leicester: The National Youth Agency.
15. Chell, E. (2008) 'The Entrepreneurial Personality – a social construction.' London: The Psychology Press/Routledge. This work presents the argument for the development of individuals through their active engagement with social context at different levels within society (see especially chapter 3). When people are enacting particular roles, society delineates what are appropriate behaviours and attitudes and the effective skills that lead to successful realisation of their chosen role. Such a skills set for the successful entrepreneur is identified in chapter 8. It also suggests that successful entrepreneurs are highly innovative.
16. Rolfe, H. and Crowley, T. (2008) op.cit. p.12.
17. Ibid.
18. DfES (2003) 'Every child matters.' Cm 5860. London: The Stationery Office.

Part 2: Innovation skills can be learned

Innovation is an activity. And as such it can be executed well or badly. Active skills are honed through practice. However, could it be that such behaviours are underpinned by personality traits? As this question has a long history, the social and management sciences have developed a range of theories and models of the characteristics of innovators. Two contrasting psychological approaches have different implications for how we foster innovation.

There has been a long debate about whether innovators born or made

Trait theorists assume personality to be relatively stable and that patterns of behaviour, aptitudes and abilities are developed early in life through the interaction of genetic make-up and experience. This would imply that innovators are born innovative and that the supply of innovators is limited. By contrast, social cognitive theorists place greater weight on social learning.[19] An individual's 'mind set' comprises knowledge, beliefs, attitudes and values shaped in response to social contexts and influenced by emotions and feelings. Together they direct the individual's behaviour.

The social cognitive approach assumes that behaviours, beliefs, attitudes, values and skills may be learnt. Moreover, behaviour tends to be oriented towards particular goals, tasks or outcomes. Whilst a final goal may be sub-conscious, people's beliefs and attitudes are influenced by social processes. For example, there are usually key people in a person's social circle who shape the rules for that social group: young people's parents, teachers and peers strongly influence their beliefs, attitudes and consequent behaviour. They are consciously or subconsciously influenced by social engagement in the home, school, church, youth club or neighbourhood. Just as attitudes can be learnt in this way, they can also be modified, a process known as social learning. Social learning[20] is based on experience and involves young people developing attitudes, beliefs and values consistent with a young person's behaviours and goals. Without such consistency, the person feels uncomfortable – a process known as cognitive dissonance.[21] So, for example, making young people mentors results in a different attitude – greater responsibility for their peers – and a belief that mentoring is helpful to young people. By valuing their new responsibility, they are likely to become more aware of their own behaviour and enhance their social skills, all through the experience of becoming a mentor.

These theories apply generally to people. But other social cognitive theories have been applied specifically to entrepreneurial and innovative behaviour. Ajzen's theory of planned behaviour assumes that intention is also a good predictor of future behaviour.[22] This theory also draws on the influence of cultural norms, social influence processes, attitudes towards perceived outcomes and perceived self-efficacy. In other words people must believe that they can achieve a particular goal before trying to accomplish it.

Innovation is driven by human endeavour – initially, the recognition and development of an idea judged to bring social and economic benefits. The process is clearly cognitive in that it draws on individuals' experience and ability to translate and transform their knowledge and ideas into something novel that will be valued by others.

19. Mischel, W. (1973) Towards a cognitive social learning reconceptualization of personality. 'Psychological Review.' 80, pp.252-283; Mischel, W. and Shoda, Y. (1995) A cognitive-affective system of personality: reconceptualising situations, dispositions, dynamics and invariance in personality structure. 'Psychological Review.' 102, pp.246-268. Also see, Chell, E. (2008) op.cit. Ch 6.
20. Bandura, A. (1986) 'The Social Foundations of Thought and Action.' Englewood-Cliffs, NJ: Prentice Hall.
21. Festinger, L. (1957) 'A Theory of Cognitive Dissonance.' Evanston, IL: Row Peterson & co. Cognitive dissonance theory has been criticised over the years but has nonetheless stood the test of time. The important point is the need for consistency between attitude and behaviour.
22. Ajzen, I. (1987) Attitudes, traits and actions: dispositional prediction of behaviour in social psychology.' 'Advances in Experimental Social Psychology.' 20, pp.1-63. Also see, for example, Krueger, N.F., Reilly, M.D. and Carsrud, A.L. (2000) Competing models of entrepreneurial intentions. 'Journal of Business Venturing.' 15, pp.411-432.
23. The dearth of personality research in innovation probably reflects the fact that innovation studies have focused on the firm as the unit of analysis not the individual. Research on the process and also the cross over to entrepreneurship research has highlighted this deficiency.
24. McClelland, D.C. (1961) 'The Achieving Society.' Princeton, NJ: Van Nostrand.
25. McClelland, D.C. (1987) Characteristics of successful entrepreneurs. 'Journal of Creative Behaviour.' 21, pp.219-233.
26. Utsch, A. and Rauch, A. (2000) Innovativeness and initiative as mediators between achievement orientation and venture performance. 'European Journal of Work and Organisational Psychology.' 9(1), pp.45-62.
27. Examples include: Mumford, M. and Gustafson, S. (1988) Creativity syndrome: Integration, Application and Innovation. 'Psychological Bulletin.' 103(1), pp.27-43; Tierney, P. and Farmer, S. (2002) Creative self-efficacy: its potential antecedents and relationship to creative performance. 'Academy of management Journal.' 45 (1) pp.1137-1148; Glynn, M (1996) Innovative genius: a framework for relating individual organisational intelligences to innovation. 'Academy of Management Journal.' 21 (4) pp.1081-1111.

Trait theory assumes that innovation starts with an individual who is predisposed to be innovative, underpinned by identifiable attributes. However, there is little research to support this hypothesis and much of what there is relates to entrepreneurship rather than innovation.[23] For example, David McClelland, whose seminal work identified achievement motivation as the driving force of entrepreneurship and economic success,[24] linked innovative behaviour to high achievement.[25] Building on this, Utsch and Rauch suggested that innovativeness and initiative were behaviours that mediated (or enhanced) motivation to achieve on business performance.[26]

Few studies identify and measure the characteristics of innovators

The attempts to identify the characteristics of innovators have been few and much of this literature focuses on creativity as a personality trait.[27] This presumes that creativity alone is sufficient for innovation with no regard for other individual characteristics. Kirton's measure of innovators and adaptors[28] has been developed and applied to adult employees working within large organisations. Whilst undoubtedly interesting work, it is based on a model of intrapreneurship[29] and may not be applied to our broader concept of innovation. Finally, it might be expected that measures of personality structure, such as the 'Big Five' might demonstrate a personality profile for a typical innovator.[30] It has been suggested that such an innovator would have imagination; inquisitiveness; high energy; a strong desire for autonomy; social rule independence;[31] and considerable self-confidence.[32] It has also been argued, however, that such remote measures cannot predict the achievement of innovative or entrepreneurial outcomes.[33]

In conclusion, the social cognitive approach is conceptually well advanced and may be readily applied to a process such as innovation. Moreover, this approach assumes that innovative behaviours may be learnt and such learning is generally based on experience and experimentation. Thus innovators may be developed through appropriate education, training and experience.

Social context and personal situation are crucial for developing innovative behaviours

The importance of social context and personal situation in shaping an individual's behaviour are well established.[34] For example, teaching and learning strategies for skills and knowledge development requires the teacher to consider: the appropriateness of particular structured tasks as part of the learning context (situation); effectiveness of exchanges with the student (social psychological dynamics of interaction); checking mutual understanding (effectiveness of person-situation interaction, where the teacher is part of the situation or context for the student); and opportunities for diagnostic feedback (further shaping student-teacher interaction). Other work in education has emphasised the need for teacher-learner engagement for skills development and effective learning.[35] However, in this report we emphasise not only formal contexts for learning, but also learning which takes places informally away from the classroom.

Thus, following Bandura,[36] this study assumes the importance of social learning. Social learning is based on experience and involves developing attitudes and values consistent with the behaviours being expressed. Attitudes and values have both a belief component and an emotional content, which drive the consequent behaviour. Positive role models and positive reinforcement of particular attitudes and values will tend to encourage the development of appropriate behaviours, whereas negative reinforcement will have the opposite effect. Where young people are concerned, authority figures such as parents and teachers, together with role models such as high profile individuals and peers, strongly influence attitudes and behaviours. Peers also provide a strong social context for informal learning of beliefs, attitudes, values and behaviours.

Learning also involves trial and error. This 'heuristic' mode of learning helps young people develop innovative behaviours by giving them the chance to develop novel thoughts, ideas and plans through to practical implementation. Bandura also places considerable emphasis on the development of self-efficacy through experience and social learning.[37]

28. Kirton has described an innovator as a person who challenges rules, dislikes routine work and takes control in unstructured situations – the latter appealing to highly creative persons who see the scope to present new configurations. Adaptors on the other hand are people who seek solutions to problems in tried and tested ways, seek greater efficiency and attempt to maximise continuity and stability. Kirton, M.J. (1976) Adaptors and Innovators: a description and measure. 'Journal of Applied Psychology.' 61, (1): pp.622-632; Kirton, M. J. (1987) Adaptors and innovators. Cognitive style and personality. In S.G. Isaksen (Ed.) 'Frontiers of Creativity Research', Buffalo: Bearly Ltd.; Buttner, H. and Gryskiewicz, N. (1993) 'Entrepreneurs' problem-solving styles: an empirical study of Kirton's Adaption-Innovation theory. 'Journal of Small Business Measurement.' 31, (1), pp.22-31; Miron, E., Erez, M. and Naveh, E. (2004) Do personal characteristics and cultural values that promote innovation, quality, and efficiency compete or complement each other? 'Journal of Organisational Behaviour.' 25, (1), pp.175-199.
29. Intrapreneurship is where individuals are expected to show entrepreneurial skills in a large organisation where they have few of the risks associated with entrepreneurship.
30. The 'Big Five' personality structure comprises: Neuroticism (anxiety, angry hostility, impulsiveness etc), Extraversion (warmth, gregariousness, assertiveness etc), Openness (fantasy, feelings, actions, ideas etc), Agreeableness (trust, straightforwardness, compliance etc), and Conscientiousness (competence, order, dutifulness etc); Costa, P.T. Jr. and McCrae, R.R. (1992) Four ways five factors are basic. 'Personality and Individual Differences.' (135), pp.653-665. See, also Chell, E. (2008) op.cit. pp.122-124.
31. Whilst Patterson et al do not explain what they mean by 'social rule independence', we interpret this concept to derive from self determination theory; the idea that a person prefers situations that feature low external regulation, allowing the individual maximum freedoms to specify their own course of action; to be driven by internal motives and reasons rather than externally perceived forces. The latter allows the individual to create their own rules and boundaries when deciding on a course of action.

Schools can provide opportunities to develop innovation skills

The national curriculum does not explicitly require the teaching of innovation. But NESTA and others have identified many opportunities in schools and colleges to develop innovative behaviours and attitudes both within the curriculum and through extracurricular work and informal learning.[38] This reinforces the importance of a flexible interpretation of the curriculum and teaching styles that enable young people to express themselves innovatively through assignments, class work, homework and projects. This process may be tempered, however, by external examination pressures and the requirement to focus on the content of a particular syllabus rather than exploring wider aspects of a subject. Schools and colleges also vary in type, performance and ethos. A tightly focused national curriculum interpreted in an academic way by the school or college may constrain experiential learning. Moreover, Ofsted inspection verdicts will impact on educational opportunities for the development of wider social skills and in particular innovative thinking and behaviour.

Furthermore, educational context should also take account of the various transitional points that young people negotiate during their school careers. These include crucial examinations that shape their career choices and future pathways; and critical transitional events, such as the move from middle school to sixth form college or to further education, university or work. How such critical junctures are negotiated will be greatly influenced by personal circumstances, including the school or college environment. Making decisions that involve choosing career pathways, for example, can be particularly stressful for students, as we found amongst Year 12 students at a high performing sixth form college in Hampshire. Such critical episodes[39] tend to heighten social learning and can lead to new knowledge, beliefs and attitudes. These periods of change and transition will be important periods in young people's lives for developing innovation skills.

Environments that offers few opportunities for personal development may stifle the capacity to innovate

An impoverished teaching and learning environment is unlikely to generate many opportunities for personal development.

Furthermore, low expectations and aspirations reduce self confidence and self-efficacy – crucial self beliefs that would otherwise positively reinforce innovative thinking and behaviour. Parental occupation appears to have an influence on young people's subsequent career choices and pathways. For example, children with a self employed or business-owning parent are more likely as adults to become self-employed or run businesses.[40] It is unclear whether this also holds true for the development of innovative behaviour, due to a lack of definitive research, although it would seem likely to be an influence.

Cultural diversity can foster innovation

The influence of cultural diversity on innovation is of interest in a multicultural society like the UK. The different ideas that may arise from ethnic diversity potentially provide a basis for the creation of new ideas, new tastes and new demands. Leadbeater[41] points to many examples of innovative behaviour amongst immigrants who have settled in the U.K. from the eighteenth century to the present day. But the context needs to be managed so that connections may be made, principally through shared activities and values. This suggests that where peoples from different ethnic backgrounds come together their different perspectives can stimulate new and potentially innovative ideas. Schools and colleges with diverse intakes have the potential therefore to create a stimulating environment for innovation by drawing on the different life experiences, cultural traditions and social challenges of different communities.

32. Patterson, F., Kerrin, M. and Gatto-Roissard, G. (2009) 'The Characteristics and Behaviours of Innovative People in Organisations.' London: NESTA.
33. Rauch, A. and Frese, M. (2007) Born to be an entrepreneur? Revisiting the personality approach to entrepreneurship. In: Baum, J.R., Frese, M. and Baron, R. (eds.) 'The Psychology of Entrepreneurship.' Mahwah, N.J.: Lawrence Erlbaum Associates. p.47. See also, Damon, W. and Lerner, R. M. (2008) 'Entrepreneurship across the Life Span: a developmental analysis and review of key findings.' Kansas City: The Ewing Marion Kauffman Foundation. p.21.
34. Funder, D. C. (2008) 'Persons, situations, and person-situation interactions.' In John, O.P., Robins, R.W., Pervin, L. A. (eds.). 'Handbook of Personality Theory and Research. 3rd ed.' New York: The Guildford Press. pp.568-580. For relevance to entrepreneurship and innovation research, see also, Chell, E (2008). 'The entrepreneurial personality – a few ghosts laid to rest?' In: Blackburn, R. and Brush C.G.(eds.) 'Small Business and Entrepreneurship.' London: Sage. vol.1, part 3, pp.246-258.
35. Higgins S. and Newman, M (2007) 'Learning skills and the development of learning capabilities.' EPPI Centre, Institute of Education, University of London. Futurelab (2007) 'Developing and accrediting skills and competencies.' Bristol: Futurelab; www.futurelab.org.uk/projects/qca/research
36. Ibid.
37. Bandura, A. (1994) 'Self-efficacy.' In: Ramachaudran, V.S. (ed.) 'Encyclopedia of Human Behavior', vol. 4, New York; Academic Press. pp.71-81.
38. Rolfe, H. and Crowley, T. (2008) op.cit.
39. Cope, J. and Watts, G. (2000) Learning by doing – an exploration of experience, critical incidents and reflection in entrepreneurial learning. 'International Journal of Entrepreneurial Behaviour and Research.' 6(3), pp.104-124. See, also, Chell E. (2003) Critical Incident Technique. In: Cassell, C. and Symon, G. (eds.)(2004) 'Essential Guide to Qualitative methods in Organisational Research.' London: Sage. Chapter 5, pp.45-60.
40. Goldthorpe, J., Llewellyn, C. & Payne, C. (1987). 'Social Mobility and the Class Structure in Modern Britain (2nd ed.)'. Oxford: Clarendon Press; Stanworth, J., Blyth, S., Granger, B & Stanworth, C. (1989) Who becomes an entrepreneur? 'International Small Business Journal', 8, 1, 11-22.

Part 3: We have identified the generic skills that underpin innovation

Research on innovators has moved away from a consideration of personality traits to an examination of the thoughts, judgments and other cognitive processes that each person brings to the development of an innovative idea through its various phases.[42] If we are to understand how young people may be encouraged to learn appropriate attitudes and skills for successful innovation, it is important to understand what will actually be demanded of them.

The skills for innovation overlap but differ from entrepreneurship

The skills required for innovation are often equated with the skills required for entrepreneurship. Entrepreneurship, however, is usually about starting businesses, whereas innovation is also about wider economic and social wellbeing. Definitions of innovation and entrepreneurship abound and it is important to be clear about underlying assumptions. We suggest that innovators are people who generate new ideas; entrepreneurs are generally people who take ideas (novel or not) to market; and, innovative entrepreneurs are entrepreneurs who have new ideas which they take to market.[43] Furthermore, innovative entrepreneurs may be distinguished from other entrepreneurs by their superior economic performance.[44]

The essence of the process is the identification and recognition of opportunities – some of which will of themselves be original, and many opportunities may require new thinking for their exploitation. For example, the Cat's Eye® road stud was a novel idea when it was invented; its inventor Percy Shaw not only conceived the idea, but also exploited it by developing it into a viable business – he was an innovative entrepreneur. Sir Tim Berners-Lee invented the World Wide Web but made no attempt personally to exploit it; instead he put it into the public domain and has since worked on ways in which it can be used – we may consider him to be an innovator. Sahar and Bobby Hashemi set up the Coffee Republic in the 1990s, a concept which they 'borrowed' from cafés in New York and exploited a then relatively new market for the now burgeoning coffee culture in the UK – we term them entrepreneurs. With numerous entrepreneurs, innovators and innovative entrepreneurs, the difficulty conceptually is being able clearly to distinguish between them.

Different skills predominate at different stages of the innovation process

The common denominator among innovators, entrepreneurs and innovative entrepreneurs is the initial process of conceptualising an idea that may go on to be exploited either by the innovator or by others. The idea may arise from the subject or sphere of knowledge in which innovators are expert. Alternatively, they may have generic experience or skills that they apply to the subject, thus enabling them to develop the concept further. This knowledge or experience is often combined with an intuitive sense of the market in the case of the innovative entrepreneur, or socio-economic awareness and empathetic understanding where a social innovator wants to develop a solution to a problem with social implications. This depth of knowledge or skill arguably confers a competitive advantage on the

41. Leadbeater, C. (2008) 'The Difference Dividend – Why immigration is vital to innovation.' London: NESTA.
42. Baum, J.R. and Locke, E.A. (2004) The relationship of entrepreneurial traits, skill and motivation to subsequent venture growth. 'Journal of Applied Psychology.' 89, pp.587-598; Gaglio, C.M. (2004) The role of mental simulation and counterfactual thinking in the opportunity identification process. 'Entrepreneurship Theory and Practice.' 28, pp.533-552; Park, J.S. (2005) Opportunity recognition and product innovation in entrepreneurial hi-tech start-ups: a new perspective and supporting case study. 'Technovation.' 25, pp.739-752.
43. See, for example, Chell, E. (2008) op.cit.; Harding, R. (2007) 'Understanding the innovative entrepreneur: what the literature doesn't tell us.' London, NESTA: Innovative Entrepreneurs Seminar, 21 September (unpublished paper); Bessant, J. and Tidd, J. (2007) 'Innovation and Entrepreneurship.' Chichester: Wiley.
44. Ibid.

individual, thus furthering his or her innovative endeavours.

Innovation, like entrepreneurship, is a cognitive process that involves the thoughts, associated feelings and ways of thinking of the innovator that are expressed in their innovative behaviour.[45] An idea may of itself be of little value, but the judgment that it is worth pursuing followed by critical evaluation of the idea add value and enable the innovator to decide whether an opportunity should be taken further. Such socio-cognitive skills are honed through experience; they are learnt behaviours[46] which means that training and education have a potentially important role to play.

Figure 1 shows the various phases of idea development that occur during the process of innovation. Whilst it may appear to be linear, the process may be reversed along the way, where it seems that no further progress may be made, potential has disappeared or where support needed to proceed is not forthcoming.

The process of generating ideas requires imagination as well as judgment that the idea represents an opportunity. This initial stage is likely to be the first step in a more complex process which demands a broader set of skills from individual innovators and their teams. The outcome of this process may involve a new business; equally, it may lead to licensing agreements, royalties or new processes within a company that increase its efficiency, effectiveness and competiveness.

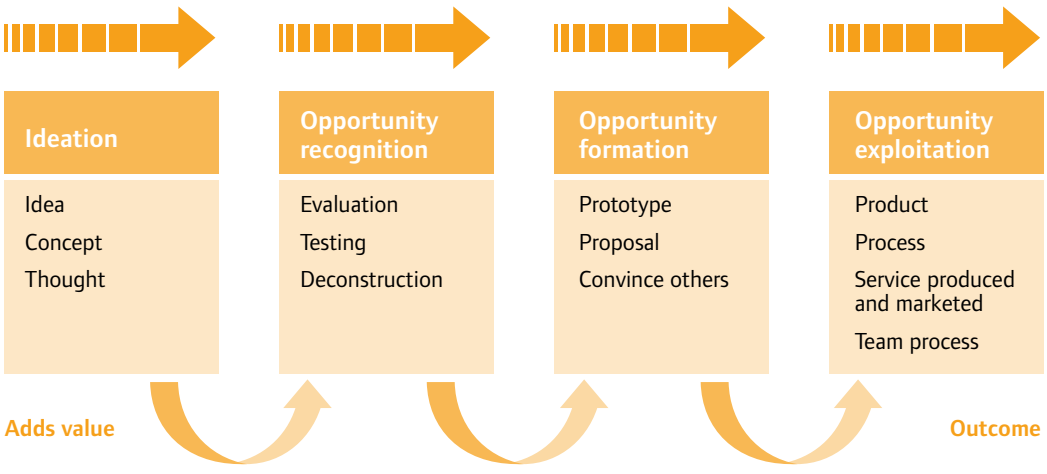
Once innovators have conceived an idea and decided it is worth pursuing, they are more likely to recognise opportunities for advancing it when they have confidence and self belief in their ability to achieve their objective.[47] Moreover, the process may be lengthy, and require leadership, energy, motivation and resilience to carry the project forward. The extent to which risks may be apparent and weighed may vary; nonetheless, being able to handle uncertainty and associated risk is crucial at this early stage. Moreover, innovation is a collaborative activity: whilst one individual may initiate the idea, few can go it alone. Innovators need to convince others that their ideas are of value and should be supported. This, too, requires leadership skills.

Creativity, self-efficacy, energy, risk-propensity and leadership are key generic innovation skills

The skills and attributes associated with the complete process of innovation from the generation of ideas to their exploitation are considerable, but the requirement for the potential innovator to get started is more modest. To become future innovators, young people need an initial set of skills and attributes that are clearly linked to the innovation process. For the purposes of the Tool, these were labelled: Creativity, Self-efficacy, Energy, Risk-propensity and Leadership. But what evidence is there for this choice of skills, especially given the plethora of other skills identified in the broader literature?

45. Mischel, W. and Shoda, Y. (1998) Reconciling processing dynamics and personality dispositions. 'Annual Review of Psychology.' vol. 49, pp.229-58; argue that the seat of personality comprises a 'cognitive-affective system' which disposes an individual in the context in which he or she finds him- or herself to act in particular ways. This creates motivational pathways and a 'behavioural signature' that typifies an individual.
46. Albert Bandura's seminal work on social learning theory and also self-efficacy is relevant here, especially as it has a welcome practical orientation. See e.g. Bandura, A. (1977) 'Social Learning Theory.' Englewood Cliffs, P.A.: Prentice Hall; Bandura, A. (1994) op.cit.
47. Park, J.S. (2005) 'Opportunity recognition and product innovation in entrepreneurial hi-tech start-ups: a new perspective and supporting case study.' 'Technovation.' 25, pp.739-752.

Figure 1: How ideas are developed into innovations



Our review of the literature and our earlier work showed that there has been a gradual convergence on the nature and type of skills and attributes required of effective innovators. The ability to generate an idea that is innovative is not only the first essential step in the process of innovation, but it also requires the skills of imagination and creativity. Imagination means the ability to envision the development of the idea into the future. Creativity subsumes imagination and adds an ability to connect ideas, to tackle and solve problems, and curiosity. There is a consensus that creativity is a necessary condition of innovation. Such work is consistent with our social cognitive approach and the importance of social context that may foster or inhibit innovation. The seminal work of Amabile, Sternberg and Csikszentmihalyi supports this view.[48]

Creativity alone is not sufficient to foster innovation. Self-efficacy – self belief, self assurance, self awareness and feelings of empowerment – is essential both to social learning (acquiring appropriate positive attitudes) and social confidence (believing in one's idea and wanting to take it forward).[49] Self-efficacy has gained momentum in the entrepreneurship literature as a crucial personal attribute of people who recognise and exploit opportunities. But it has also long been understood that people have always needed confidence to pursue their aspirations, to defend and promulgate innovative ideas, and to manage risks.

What is important in our work is to capture a mindset and attitudinal approach rather than a set of personality traits. Hence, energy, for example, includes drive and enthusiasm. This comprises three aspects: conation, indicating that the action is meaningful and goal-oriented; cognitive, involving thought and judgment; and affect, that is, encompassing feelings towards the end-goal.[50] Without energy, motivation and commitment, the individual may not take the innovation forward through what will be a testing time, requiring resilience and mental toughness. Thomas Edison put it well: "genius is one per cent inspiration and ninety-nine per cent perspiration." In other words, an inspired thought may occur in a flash, whilst its production and exploitation may take months or years.[51]

The innovation process has uncertain outcomes and it is in this sense that innovators (and entrepreneurs) are thought to be able to tolerate high levels of risk. However, how risk-propensity is conceptualised is problematic.[52] Whatever the potential innovator is proposing, the outcome is unknown and shrouded in uncertainty. Some people might shrink from such uncertainty, but the potential innovator should be able to weigh up the risks inherent in the proposal. This is known as calculative risk taking. To be fearful of uncertainty and inherent risks is to be risk averse; such people would tend to leave when things get tough, not seeing a venture through. At the other extreme, blind risk taking or gambling involves people riding the risks. They may sometimes get lucky when the risk pays off big time – but this only happens occasionally. By contrast, the calculative risk taker takes steps to manage the risks involved, identifying them and considering ways to minimise them. Such calculative risk taking helps reduce the chances of failing, and promotes the likelihood of achieving the desired goal.

One view is that innovators and entrepreneurs have a high risk-propensity; that is, they are risk tolerant. This implies that their risk-propensity directly influences innovation outcomes. They will positively see an opportunity where another observer may perceive a much higher level of risk. Alternatively, they may be much more calculating in their approach to risk. This view suggests that they are neither risk averse nor risk seeking, but take the middle course, which is a measured approach to risk taking. There is insufficient evidence to support one view over the other.[53]

Leadership is a generic skill thought to be associated with effective entrepreneurship. Modern notions of a leader are associated with vision, energy, dynamism, creativity, change and risk taking, and the ability to mobilise commitment and embrace transformational change and novelty.[54] In the context of an innovative process, such a leader would be able to communicate their vision effectively to others, convincing them of its quality and potential, mustering sound arguments to gain support and see off rival ideas. Such a skill, arguably, is critical throughout the innovation process.[55] The potential innovator will need the support of other people, including possible partners and investors. Gaining that support is about more than being able to make a pitch.

These basic innovator skills are also valuable life skills. People with these skills make good employees who can contribute to their organisation's innovation activities. As

48. Amabile, T. M. (1996) 'Creativity in Context.' Boulder, CO: Westview; Sternberg, R.J. (2003) 'Wisdom, Intelligence and Creativity Synthesized.' Cambridge: Cambridge University Press; Csikszentmihalyi, M. (1996) 'Creativity: Flow and the Psychology of Discovery and Invention.' New York: Harper Collins.
49. Ibid.
50. Robinson, P.B., Stimpson, D.V., Huefner, J.C. and Hunt, H.K. (1991) An attitude approach to the prediction of entrepreneurship. 'Entrepreneurship, Theory & Practice.' 16, 3, pp.13-31.
51. Chell, E. (2008) op.cit. p.265.
52. See discussion in Chell, E. et al (1991) 'The Entrepreneurial Personality concepts, cases and categories.' London: Routledge. pp.42-43; Rauch, A. and Frese, M. (2007) op.cit. pp.49-51.
53. The notion that entrepreneurs and innovators have a high risk-propensity compared to managers or the population generally has been based on economic theorising, e.g. that of Schumpeter whose theory of 'creative destruction' suggested radical innovations in conditions of high levels of uncertainty. However, the work of McClelland (1961) op.cit. suggested moderate risk taking was consonant with the notion of achievement motivation, that is, the ability to maximise achievement through judging the level of challenge one was prepared to take. Rauch, A. and Frese, M. (2008) op.cit suggest that there is some support for a direct linear relationship between risk-taking and innovation outcomes, but that this is small and positive. The curvilinear relationship put forward by McClelland, they suggest, requires further testing.
54. Burns, J.M. (1978) 'Leadership.' New York: Harper Row; Bass, B.M. (1998) 'Transformational Leadership: industrial, military and educational impact.' Mahwah, NJ: Lawrence Erlbaum Associates; see also, Chell, E. (2001) 'Entrepreneurship: Globalization, Innovation and Development.' London: Thomson Learning. Chapter 9.
55. Witt, U. (1998) Imagination and leadership – the neglected dimension of an evolutionary theory of the firm. 'Journal of Economic Behaviour and Organisation.' pp.35, 161-177.

citizens, these basic skills will enable them to work through everyday problems, as well as contributing to their local community.

The five skills we have described can be learnt, but what opportunities are there in the national curriculum for young people to develop a basic innovative skills' set?

Creativity can be developed throughout the curriculum

Sternberg's[56] discussion of different types of creativity is useful here. In science teaching, the idea of paradigm shifting creative discovery may be introduced to the young person as something that is not only exciting, but critically important to scientific and technological developments. This contrasts with the creative contributions of the arts, which may vary from solving a well-defined problem to producing a 'high-stakes' performance. In the field of psycho-economics, creative contributions may vary from the ability to 'defy the crowd' by 'buying low' and 'selling high' to redefining a problem. Alternatively, there are different types of creative thinking involving a focus on a single solution to a problem, or generating and considering many possibilities to solve it.

A national curriculum can be constraining by setting boundaries for 'appropriate responses' to a set question or topic, when young people need the scope to explore a subject. However, even within such constraints, young people may be taught problem-solving and subject-specific or universal approaches to creativity. But their age and stage of development must also be considered – some young people may feel totally at sea with an unstructured approach and need more guidance from the teacher.

Developing self-efficacy in young people requires a 'life span' approach that takes account of family, peer and school influences

Students may grow in their belief in their own capabilities through honing their skills and thereby mastering their experiences. Such self-efficacy may come through observing successful role models, encouragement that strengthens their self belief that would otherwise impact negatively on the individual's self-efficacy.[57] Schools can develop self-efficacy, where young people develop cognitive competencies, model themselves on their peers, make social comparisons with other students, derive motivation and drive, and are influenced by teachers' judgments of their work and behaviour.

Much can be done to structure classroom situations to help build students' beliefs in their ability to achieve set goals – for example teaching through experience, combined with allowing young people to make mistakes, whilst ensuring they understand why they are mistakes and encouraging them to consider alternatives.

A 'life span' view of the development of attitudes and behaviours in young people is helpful as it highlights the challenges that young people face as they grow and develop. These include their physical, sexual and emotional development, and transitions through the educational hurdles of national examinations or career decisions. If young people believe in themselves at these crucial transition points, they will feel capable of exercising control over their lives. For young people moving through testing stages in their development, reality may be strewn with frustrations and setbacks. By enabling them to develop a robust sense of self-efficacy and self worth, schools and colleges can help sustain young people's efforts to be successful.[58]

Energy and motivation flow from perceived self-efficacy and the pursuit of personal interests

School is where young people learn about different subjects and where particular aptitudes and interests give them a sense of mastery and the motivation to pursue particular areas of study. However, not all students are so self-aware which is where techniques such as personal learning plans can be valuable. Teaching staff would want to guide their students along pathways that result in positive learning, motivational and emotional experiences.

56. Sternberg, R.J. (2003) op.cit. pp.104-105.
57. Bandura, A. (1994) op.cit; Seligman, M. (2003). 'The optimistic child.' New York: The Free Press.
58. Bandura, A. (1994) op.cit.

The development of an understanding of risk in young people is not well researched and understood

McClelland focused on risk taking in respect to economic behaviour, which suggests that it is appropriate to consider that risk taking is highly context specific. The ability to handle risk in financial matters, for example, will not necessarily be carried over to contexts of personal safety or sexual behaviour. The usual definition of a risk taker is someone who pursues an idea when it appears (often to other people) to have little chance of success. However, economists have furnished us with a more stringent definition. Knight,[59] for example, argued that it is important to distinguish between risk taking in contexts where; (a) possible outcomes can be identified and the likelihood of either one of them occurring may be estimated; (b) conditions of uncertainty where possible outcomes may be identified, but the likelihood of any one of them occurring cannot be calculated; and (c) extreme uncertainty where the range of possible outcomes is unknowable and therefore calculating the likelihood of any single outcome is impossible. Schumpeter's innovator carried out 'new combinations' and as such could create significant change in an economy – a radical innovation. The assessment of risk and, in particular, people's propensity to deal with risk depends in part on their perception of risk as well as their attitude towards it. Experience may also play a part as it shapes a person's beliefs about the potential riskiness in the situation or opportunity. Bad experiences may make a person risk averse, whereas positive experiences should result in greater risk-propensity. How might this translate into economic risk taking behaviour by young people?

The educational context tends to influence pupils' attitude to risk avoidance because the formal education system, particularly where it is academically-oriented, puts pressure on teaching staff and students to produce excellent examination results. However, this does not represent all that goes on in schools. In particular, extracurricular activities – theme weeks, special interest days and sports days – present opportunities for staff and students alike to go beyond the prescriptions of a national curriculum, to explore and test ideas out and push their boundaries.

The principles of leadership behaviour are well understood

Importantly, leaders may be appointed in formal situations or may emerge in informal contexts.[60] Leaders may also differ in their focus; for example some are more task-driven, whilst others attend primarily to the social and emotional needs of their group. Young innovative leaders are likely to be self-appointed and motivated by particular tasks, though enjoyment may also be a factor. However, leadership roles demand effective interpersonal and negotiation skills to ensure that others are brought on board to lend their support to the innovative idea. An effective innovator would want to see off any rival challenges and so should be able to handle such situations adeptly.[61] In schools and colleges, there appear to be many situations – both formal and informal – for students to gain experience of taking a lead. Formally, these may include prefect systems, sports events where team leadership is essential and, more recently, mentoring systems of peer control and management. Developing the skills of effective leadership may also increase a student's self efficacy skills. Students may start out by participating in formal or informal groups without planning to take on a lead role. However, as they grow in confidence and feel they belong to the group, they will have a better idea of what role they may effectively assume. Assuming a role where there are expectations and demands, and the opportunity to build confidence and take responsibility, is an effective way of developing personality characteristics.[62] Giving a group challenging tasks to perform in school or college will not only help develop leadership skills, but also feelings of responsibility towards the group and completing tasks.

59. Knight, F.H. (1921) 'Risk, Uncertainty and Profit.' New York: Houghton Mifflin.
60. Burke, B.J. (1967) The development of task and socio-emotional role differentiation. 'Sociometry.' 30(4) pp.379-392.
61. Witt, U. (1998), op.cit.
62. Roberts, B.W., Wood, D. and Caspi, A. (2008) The development of personality traits in adulthood. In: John, O.P., Robins, R.W. and Pervin, L.A. (eds.) 'Handbook of Personality', Third Edition. New York: The Guildford Press. Chapter 14, pp.375-398.

Part 4: The skills for innovation can be measured

In seeking to embed new practices, those advocating education for innovation are frequently thwarted by the lack of a recognised system for identifying and measuring the innovative capacity of young people and the impact of specific initiatives. Devising such a measure would help young people to become more aware of their innovative potential and support them in developing their personal profile. Moreover, this awareness should relate to the educational and employment pathways that young people explore and arm them with a skills set that enables them to deal more effectively with increasingly complex socio-economic environments. From a policy perspective, this should help address the issue of long term innovative capacity building.

What the measure aims to do

The Youth Innovation Skills Measurement Tool aims to address a gap in educational assessment by offering a robust measure of young people's innovation skills. The research to develop the Tool aimed to (1) identify robustly the important components of innovative capability in young people; (2) demonstrate ways of revealing this capacity; (3) understand innovative behaviour within secondary schools and sixth form colleges; and (4), where appropriate, identify any individual school or college initiatives that would promote the development of innovative attitudes and behaviour.

The assumptions underpinning the measure are that young people's capacity to innovate can be developed and fostered

Any measurement tool should aid young people's self-awareness and reveal innovative pathways that young people choose to follow rather than attempt selectively to differentiate innovators from non-innovators. This approach contrasts, for example, with intelligence testing. Intelligence testing was initially based on an assumption that intelligence was one-dimensional and inherited; hence young people could be selectively differentiated on the basis of a test and streamed accordingly. The measurement of innovative behaviour makes no such assumptions; indeed, quite the opposite.

Innovative behaviour is multi-dimensional and these behaviours and attitudes are socially learnt; hence there is a developmental aspect to the acquisition of appropriate innovative behaviours and attitudes. Moreover, a case could be made for innovative behaviour arising from practical intelligence which makes experimental or heuristic learning in schools and society more important.[63] This has implications for the measurement of innovative behaviour in young people. For example, the basic attitudes and skills that are seen as necessary for the development of innovative behaviour may be directed at a range of possible innovation outcomes, including social and environmental innovation as well as technological innovation. At any single point in time a young person may be shown to have stronger or weaker intention of pursuing an innovation pathway. The new measure of innovative behaviour must

63. Indeed Sternberg's 'triarchic theory of intelligence' suggests; (a) a componential dimension where information processing and analytical skills are evident; (b) an experiential dimension that addresses novelty and automatisation that includes problem-solving and creative ability, and also the ability to acquire skills and perform them without conscious effort (such as reading); (c) a contextual dimension that addresses real-world issues which result in practical abilities and is often referred to as practical intelligence; Sternberg, R.J. (2003) op.cit.

therefore encompass innovation in all its forms and potential outcomes.

There are few measures of innovation and none designed for young people

One of the best known measures of the capacity to innovate is Kirton's innovation-adaptation (KIA) measure.[64] This was developed with adults employed in large companies and was designed to identify those with entrepreneurial attitudes from other employees who adapted their behaviour to conform with organisational requirements. The KIA has been used in schools,[65] but its objective and scope are too limited for our objectives. Furthermore, statements constructed for experienced adults may not be particularly meaningful to young people.[66]

Some measures have been developed on attitudes to entrepreneurship. Attitude theory is the basis of the 'Entrepreneurial Attitude Orientation' measure, which is aimed at employed adults. This comprises four sub-scales: Achievement, Self-esteem, Personal control and Innovation.[67] This measure showed some promising results. Attitudinal measures have also been developed in the field of Enterprise. The measure of General Enterprise Tendency, for example, measures risk taking, creative tendency, achievement motivation, autonomy and internal locus of control.[68] The author points out that 'enterprising behaviour' is much more general than that of entrepreneurship and as such may not offer occupationally specific information.[69]

More recently, work is being done to develop an attitude scale of enterprise potential in young people still at school.[70] But there remains a clear lack of any means to measure innovative attitudes and skills in young people.

A measure should be predictive of future outcomes

The principles and procedures to be adhered to when developing a new measure guide the work reported in the ensuing sections. Briefly, it is essential that a scale measures the dimension it purports to measure; in other words it is valid.[71] Moreover, it should also be reliable, that is, each scale is internally consistent.[72] This means that each statement on the scale correlates with the rest: the higher the correlation, the higher the internal consistency (or reliability) of the scale. The level of reliability is signified by the results of statistical procedure known as a coefficient, termed Cronbach's alpha. This coefficient should normally reach a recommended threshold of 0.7. Further, the structure of the measure should reflect the original theoretical model, which in this case has five dimensions.

Structural validity testing, using Principal Component Analysis on the five individual subscales, showed that each subscale was uni-dimensional and that statements loaded on one component only. These procedures are a prerequisite for estimating whether the measure relates to the characteristic it is intended to measure. Two methods are used: criterion and external validity. To establish the former, we differentiated a sample of respondents that had scored highly on the criterion – stated intentions to become an innovator – from other respondents with low or no such intentions, and used a statistical procedure to establish whether they were more or less likely to score highly on the measure. Hence the measure can distinguish between students with stronger or weaker intentions of pursuing an innovation pathway.

The type of innovator that the young person may aspire to become is in this case the criterion or dependent variable. Thus, a high score on the dimensions of Creativity, Self-efficacy, Energy, Risk-propensity and Leadership should indicate an intention to become a future innovator. The dependent variables include social, cultural or corporate innovator, inventor or entrepreneur (definitions are given in Appendix 1). We established external validity by identifying a group of young people within the sample who had taken some steps towards developing their innovative ideas. Once again, those young people (whom we termed 'nascent innovators') should have scored significantly higher on the measure of innovative behaviour. In the ensuing sections we set out the results of this work with young people in schools and sixth form colleges in Greater London and Hampshire.

64. Kirton, M. (1976) Adaptors and innovators: a description and measure. 'Journal of Applied Psychology.' 61, pp.622-629.
65. Selby, E.C., Treffinger, D., Isaksen, S.G. and Powers, S.V. (1993) Use of the Kirton Adaption-Innovation Inventory with Middle school Students. 'Journal of Creative Behaviour.' 27(4), pp.223-235.
66. Ibid. p.232.
67. Robinson P.B., Stimpson, D.V., Huefner, J.C. and Hunt, H.K. (1991) An attitude approach to the prediction of entrepreneurship. 'Entrepreneurship Theory and Practice.' 15, pp.13-31.
68. Caird, S. (1991) Testing Enterprising Tendency in Occupational Groups. 'British Journal of Management.' 2, pp.177-186.
69. Ibid. p.182.
70. Athayde, R. and Hart, M. (2008) An Empirical Investigation of the Impact of Enterprise Education in Schools.' 3rd European Conference in Entrepreneurship and Innovation.' The University of Winchester 15-16 September 2008; Athayde, R. (2009; forthcoming) Measuring enterprise potential in young people. 'Entrepreneurship Theory and Practice.'
71. Chandler, G.N. and Lyon, D.W. (2001) Issues of Research and Design Construct Measurement in Entrepreneurship Research: The Past Decade. 'Entrepreneurship Theory and Practice.' 25, pp.101-113; Comrey, A.L. (1988) Factor-analytic methods of scale development in personality and clinical psychology. 'Journal of Consulting and Clinical Psychology.' 56 (5)5, pp.754-761.
72. Cronbach, L.J. (1951) Coefficient alpha and the internal structure of tests. 'Psychometrika.' 16 pp.297-334; Cronbach, L.J. (1990) 'Essentials of Psychological testing', Fifth Edition. New York: HarperCollins. (pp 193-195)

Part 5: The Tool has been piloted and tested

The Tool was piloted and tested in schools and sixth form colleges. The scope of the study did not permit access to all types of school, so we limited this to specialist arts, science and technology schools, academies and sixth form colleges (the latter to reach 17-19 year-olds). We limited the age range to 14-19 years because we wanted to ensure the Tool statements were meaningful to the young person. We also varied the context of the school or college from inner city to rural, sourcing these schools in Greater London and Hampshire.

There were three phases of fieldwork: Phase 1 Pilot Study; Phase 2 Main Study Part 1; Phase 3 Main Study Part 2. The fieldwork comprised students completing an online version of the Tool and focus groups with several staff from a range of disciplines and separate focus groups with a small number of students (usually about seven from a mix of year groups). In addition to the analysis of the questionnaire data, we prepared twelve case studies after each wave of data collection.

The pilot study indicated some encouraging results

In November 2007, we started to pilot the first version of the measure. Four types of school (including one sixth form college) participated, located in Greater London and Hampshire. This gave us a variety of types of school and location and maximised the chance of capturing 14-19 year olds. This format was repeated in the subsequent testing phases. This pilot study was crucial in that it enabled us to carry out separate focus groups with students and staff at each venue to discuss each dimension of innovative behaviour and how it might be expressed both within the school or college context and through extracurricular or informal activities. We were also able to glean evidence of potential constraints on the expression of innovative behaviour. The transcribed discussions enabled a list of potential statements to be compiled which were subsequently critically scrutinised by the team and reduced to 88 statements (inclusive of dependent variables). The second part of the questionnaire included questions seeking demographic information (such as gender, ethnic background and age) of the respondent and information about parental occupation.

The online questionnaire was uploaded from the Kingston University site and the link given to the participating schools and college. A school with specialist arts status, an academy and one sixth form college participated in the pilot, yielding 239 completed questionnaires. The data were initially analysed for the reliability of each dimension of the Tool. Leadership, Creativity and Energy yielded acceptable results. The results for Self-efficacy and Risk-propensity fell below the normal threshold for reliability (Appendix 2 gives technical details).[73]

The Tool was scrutinised and some statements were reworded, others discarded and new statements introduced. The resulting measure was shortened to include 58 statements, inclusive of measures of the dependent variables. The wording of the dependent variables was tightened to avoid statements of aspiration rather than intention. A question was introduced into part 2, the demographics section, to assess external validity of the measure of innovative behaviour. This question sought evidence of possible steps taken by

73. Also see Kingston University (2008) 'The Identification and Measurement of Innovative Characteristics of Young People: Interim report'. www.nesta.org.uk

those students who had a stronger intention of pursuing an innovation pathway. This was the only optional question.

A further adjustment in part 2 saw the removal of one question seeking information about what the parents or guardians did for a living, whilst retaining a shorter question seeking information about the type of work (e.g. self employed, part-time, full-time, unemployed etc.). Finally, we also sought feedback from the schools to improve the design and identify any difficulties students were experiencing with particular questions.

Main Study Part 1 improved the reliability of the measure

The second version of the online Youth Innovation Skills Measurement Tool was piloted in five schools, including three sixth form colleges and a secondary school specialising in technology in Hampshire and a London academy. The online Tool was administered to 308 pupils during the summer term in 2008. There were 145 male participants and 163 female, including 111 sixth formers (17-19 years), 141 Year 10 (14-15 years) and 56 Year 11 (15-16 years). After conducting Principal Components Analysis (PCA),[74] the reliability of each of the dimensions of Creativity, Energy, Leadership, and Self-efficacy was shown to be excellent. However, the sub-scale Risk-propensity fell below the accepted level of reliability. The validity of the measure was also demonstrated in so far as those students who scored highly on the measure of innovative behaviour also showed a stronger propensity to pursue an intended innovation pathway (see Appendix 1 for criteria). Further technical information is contained in Appendix 3.

As a result of the data analysis, we made a number of changes to the Youth Innovation Skills Measurement Tool instrument. This included removal of a number of weak statements that did not strengthen the validity of the dimension or sub-scale. Other statements were thought to be poorly worded and were rephrased and some additional items were developed. Part 1 of the online Tool was thus reduced to 42 statements, plus six that were measures of intention to innovate.

Main Study Part 2 resulted in a reliable measure of innovative behaviour

For reliability and validity testing, the third version of the Youth Innovation Skills Measurement Tool was administered to 811 pupils in seven institutions. Two institutions in Hampshire participated: one sixth form college and one secondary school specialising in performing and visual arts. In London, five institutions took part: two academies: two sixth form colleges; and one secondary school specialising in music and English language. (Appendix 4 gives the characteristics of the sample and further technical information.)

Of the 42 statements in this version of the measure, 31 were retained after purification and the reliability of these 31 to measure innovative behaviour was assessed. All the sub-scales reached the required threshold of 0.7 apart from the Risk-propensity scale, which achieved an alpha of 0.583. The Creativity scale had the highest alpha at 0.790.

Students who had expressed strong intentions to pursue an innovation-oriented pathway beyond school or college scored significantly higher on the measure of innovative behaviour. This demonstrated that the measure was able to identify students that at that point in time showed a stronger intention to pursue an innovation pathway.[75] The results are shown in Appendix 4, Table 10.

Those students that had taken some steps toward developing their innovative idea scored more highly on our measure of innovative behaviour and were thus demonstrably pursuing more strongly an innovation pathway. These results may be found in Appendix 4, Table 12.

There were some statistically significant differences between schools and demographic groups

We interrogated the data further in order to establish whether gender, age, ethnicity, type of school attended or parental business ownership might be associated with higher scores on the measure. The findings (see Appendix 5, Table 14) indicate that Age, Gender and Parental experience of self-employment were not associated with students' scores. However, ethnic background and the school/college did yield statistically significant results. Two high performing sixth form colleges

74. This is a statistical technique which enables us to identify the underlying structure of the measure; the aim is to identify the strongest components of each dimension and thus arrive at dimensions that comprise a single structure (or component).

75. It should be noted that this statistical manipulation is used for purposes of establishing the robustness of the measure. Ultimately, the measure of innovative behaviour will assume that all students have some innovative potential and that the measure will help students become aware of their personal (spiky) profile, which they may subsequently improve upon through suitable extracurricular or other activities, some of which may indeed be delivered through formal education channels.

(one based in London, one in Hampshire) scored above average on the measure and, of the ethnic groups; Black and Asian students did likewise. White students scored below average and yielded the lowest result of all the ethnic groups.

Of the seven institutions participating in the Main Study Part 2 (autumn, 2008), one London sixth form college came top and the other bottom, whilst the Hampshire based sixth form college was placed fourth. This seems to demonstrate that type of school is not the key factor affecting innovative behavioural expression of students. School ethos and teaching style are important and this is independent of the type of institution.

There is clearly a need to carry out more research to explain the findings related to ethnic background. One possibility is that the wider experience of life fostered by ethnic minority students' exposure to a wider range of cultural influences may encourage the development of innovative attitudes and skills.[76]

76. Leadbeater, C. (2008) op.cit.

Social background may also be important. The lowest scoring institution on the Tool was located in one of the most deprived boroughs in England, where 75 per cent of students lived in areas of high social and educational deprivation. This also suggests that with a larger sample of institutions it may be possible to show the greater and subtle interaction of such background factors.

Further discussion concerning the types of school and college and their performances on the measure is below.

Part 6: Our case studies helped us understand how schools' and students' characteristics influence the development of innovation skills

The number of case studies carried out in this study is relatively small – twelve in total, covering only two parts of the country (Greater London and Hampshire) and so no definitive conclusions should be drawn. However, in-depth discussion with students and staff revealed some valuable insights, which are reported below.

We achieved variety by choosing different types of school or college – three specialist arts schools, two with specialist status in science and technology, three sixth form colleges and four academies (all located in London). Five schools/colleges were located in Hampshire and the remainder in Greater London. They were in contrasting locations, including semi-rural and commuter belt locations in Hampshire and central and suburban locations in Greater London which ranged in their catchment areas from poor to prosperous, middle class neighbourhoods. They also had different ethnic mixes, with greater diversity in the London schools.

In each of the twelve institutions, we set up separate focus groups with 6-8 students aged between 14 and 19 and with up to five staff from a range of disciplinary backgrounds. To manage the information and focus on the important questions, we identified a set of propositions including:

- Young people in schools or colleges that are orientated towards high academic achievement will exhibit weaker levels of innovative behaviour expression/interest.
- The examinations context will suppress innovative behavioural expression.
- Teaching style (and attitude) will affect innovative behavioural expression.
- Engagement in extracurricular activities that provide a challenge will positively affect innovative behavioural expression.
- Opportunities created by the school for innovative behaviour will influence its extent among students.
- Students' age, gender and ethnicity will affect their innovative behaviour.

These propositions are hypotheses to be explored. They are not listed in any particular order, although we may draw tentative conclusions as to what appear to be the more important influences of innovative behavioural expression.

Both vocational and academic subjects offer opportunities to develop innovation skills

The participating schools and colleges provided a range of vocational, academic or mixed orientations, with the aim of matching the abilities and interests of their students. The more academically gifted students were no more likely to develop innovative capability than those who were less academic. Indeed, the tension between absorbing knowledge and the development of skills and attitudes might arguably detract from a proper focus on what would be needed to underpin innovative capability. However, even this claim could not be sustained once the complexity of subject specialism was taken into account. Vocationally-oriented subjects, such as the performing arts, music and media studies, leaned towards activity and experimental modes of learning and offered opportunities

for innovation. In science, a body of knowledge is needed before a student can be innovative. Even here, however, an appropriate teaching style and a focus on technology and the application of knowledge enabled mixed ability students to grasp some of the fundamentals of applying principles coupled with imagination to the subject matter.

However, not all was plain sailing; there was some evidence from a couple of the weaker performing London-based schools of challenges facing teachers where their classes had a wide ability range, with many socially deprived students and a large number whose first language was not English. In such settings, teachers and students felt that vocational subjects provided more opportunities to develop 'soft' skills rather than the literacy, numeracy and analytical skills associated with traditional 'A' Levels. It would appear that vocational subjects provide a way to engage students who are not motivated by the academic route. From a teaching and learning perspective, this suggests that vocational subjects may offer such students better opportunities for attainment, and incidentally, (as this was not the educational objective), better opportunities to develop innovation skills than the academic 'A' Level route. For example, one student in a semi-rural school, which typically had a wide range of ability in classes, had been disaffected by academic subjects. However, when he took up a Higher National Diploma in catering he became more engaged with the subject, but also more responsible as a role model and mentor to younger students.

77. DiDA (Diploma in Digital Applications) aims to transform 'screenagers' from 'passive consumers to active producers of high quality digital content.' (http://dida.edexcel.org.uk/home/aboutdida/). There are four qualifications in the 'DiDA suite', each of which is the equivalent to one GCSE. The course encourages independent working, time management and reflective learning. Students self-manage an 'eportfolio' and are encouraged to engage in prototyping, testing and presentation within online environments. The course requires tools (hard- and software) and teachers with an ability to assess digital content authoring and management over a variety of digital media (video, still images, sound).

Opportunities for sixth formers at a college in the heart of Hampshire

This College has an Ofsted rating of Outstanding and is a Beacon College. It has a strong 'A' Level pass rate of 98 per cent; yet also offers forty vocational courses, the International Baccalaureate and seventy enrichment options. On the vocational side, it offers apprenticeships through the NVQ and BTEC routes. One core value of the College is that 'the future should be embraced through creativity and innovation'. But was this revealed in practice? We talked to six students for about an hour to explore their innovative behaviour. One student mentioned his 22 year old brother, who had founded an e-business and now ran a web design company. But all students identified opportunities to develop innovative behaviours, either through formal education, extracurricular activities or informal, out-of-college pursuit of their chosen, special subject. For example, Photography and Media Studies gave the students the space to express themselves creatively; schemes run by the Royal Navy and the Army Cadet bands provided opportunities to get involved in design ('design a way of carrying a spare wheel on a 24 hour motorbike race') and pursue interests in Music. One student was so keen on music that he played in five Jazz bands – Jazz involving a great deal of improvisation – and a local Jazz Orchestra, though he was having to cut back to concentrate more on his studies. Importantly, students were encouraged to take greater responsibility for their own learning, which was linked to the experience of pursuing subjects in which they were personally interested – either as future careers or hobbies. The fact that the College ran its own Record Label and Radio Station encouraged such experiential learning and the pursuit of subjects and hobbies in which students were intrinsically interested and were prepared to invest time and energy. This was illustrated by one Music Technology student whose ambition was to set up his own recording studio. He was already taking steps towards this, by setting up a studio in his bedroom. This case demonstrated how the learning environment of the College was leveraged by drawing together key infrastructure investments: ICT, College Radio and Record Label; strong links with external organisations; teachers who encouraged students towards innovative behaviour (musical composition and intensive technology use). Other instances included Catering and Sports Coaching, where the learning environment acted as a bridge by providing access to facilities, external organisations and subjects that both encouraged individual students' personal interests and enhanced the College's reputation.

The Diploma in Digital Applications (DiDA),[77] as well as design technology and media classes played to the strengths of many students. So too did BTEC courses in Art and Design, Music, Employability Skills and Construction in several of the London based schools. Plans were also in place to offer students new Diplomas in Construction, Engineering and Creative and Media. These practical options are perceived to provide a wide range of opportunities for students to engage in innovative behaviour, as are enterprise education and opportunities to develop business plans.

The sixth form colleges were, arguably, doing rather more, at least consciously and explicitly, to develop appropriate skills and attitudes in their students, regardless of whether they were embarked on a vocational or academically oriented career pathway.

Each type of school provided a range of opportunities to develop innovation skills and attitudes both formally and informally. The development of leadership skills is a good example, where both extracurricular opportunities exist, as well as opportunities through sport, school management (as prefects, mentors or on school councils) and participation with responsibilities. These opportunities occurred across the age range.

In general, while the academic focus may have detracted from the formation of innovative skills and attitudes during periods of intense examination pressure, there were many opportunities through extracurricular and non-formal learning to acquire innovation skills. A vocational focus, however, allows the application of knowledge and more clearly lends itself to the acquisition of innovative skills and attitudes. That said, it would be invidious to suggest without more fine grained analysis by subject that vocationally oriented schools and colleges offer more opportunities; there are different ways in which such skills may be acquired including through the encouragement of independent learning that was evident in some of the top performing schools and colleges.

Examinations can leave little time for creativity and innovation

School life has a cycle during which there are pressure points on young people and staff to perform particularly well which coincide with national examinations. The imposition of external criteria of excellence and the publication of league tables arguably raises standards of performance overall, though

A sixth form college that prides itself on being innovative

Students enter college at a critical point in their personal development. This college manages the transition through its innovative tutorial programme that helps support the students' skills development in emotional intelligence and personal learning strategies; and in gaining work experience, choosing the right university and seeking employment and training opportunities.

Teachers are encouraged to develop their individual teaching and learning style by engaging in their own action research project, in which a teacher explores how an aspect of his or her teaching style might be addressed to improve student achievement.

Innovative initiatives did not stop there; the thinking behind the 'extended essay' was also innovative, at least in the sense that it challenged accepted wisdom that marking a piece of work was an indispensible condition of learning. Here the mature view of 'exploring a subject' through curiosity and intrinsic interest was encouraged and feedback given through constructive comments rather than a grade or mark. The essay would address a topic of personal interest that touched on more than one subject, strongly suggesting that students should transfer knowledge and information across subjects and thus developing an important creative skill of 'making connections'. It was at such junctures that innovative thinking might occur. This voluntary exercise meant that students who 'bought into it' received a good grounding in research skills that would be required in university and beyond.

performance measures may also narrow schools' and colleges' attention to the requisite syllabi and national curriculum. During examination periods, staff and students all felt the pressure. Staff felt that there was little time to encourage much creativity or exploration of a subject outside the confines of the syllabus. Some schools and colleges did what they felt they could to balance the impact of this; for example, there were theme days and enrichment weeks, where the scope was relaxed to allow greater immersion in a subject or event. One sixth form college explained that it offered students the opportunity to write an extended essay in which formative development rather than grading and marking was emphasised. This gives students a chance to explore a topic more fully.

'A' Level students, on the other hand, tend not to receive any such tangible benefits from enrichment activities; although the recent introduction of the extended essay or project to the A Level syllabus will expand opportunities. There may be a need for greater recognition of the importance of extra-curricular activities carried out by students following 'A' Level courses to encourage them to participate in creative and innovative activities. Examination design also constrains the opportunities for innovative behaviour in some subjects like Science, which is modular and involves a heavy examinations diet.

In sum, the examinations system does have an impact on innovative behaviour, but most schools and colleges attempted at least to mitigate the effects in the intervening years in a variety of ways.

Teaching style can encourage young people to develop innovation skills

We were impressed by the attention staff paid to teaching style. In some schools there was a wide range of ability, which placed considerable demands on teachers to maintain interest and convey information in an interesting way. They used a variety of methods to impart information; no longer relying solely on PowerPoint for illustration or to maintain concentration.

One comprehensive school considered it a success when a less able student demonstrated his engagement in a topic and produced some results. For example, in Design and Technology, carrying out practical tasks with an end in sight is one way of engaging disaffected students. The lesson was to build a trebuchet (medieval catapult). The upshot was that one student, who was usually difficult to engage in class, built a four foot high trebuchet which fired split tennis balls filled with flour to a distance of fifty feet. Moreover, at home he built a smaller version, which he used to catapult dog biscuits (to the delight of his pet, which would run and catch them). His interest and imagination were clearly captured.

Teachers were conscious of the impact of praise on students' aspirations and performance. A culture of praise was evident in one successful academy. Subject teaching was underpinned by a system of goal-setting, reward and praise. Throughout the school, pupils were set targets for expected attainment and more challenging targets to which they were encouraged to aspire. A system of rewards comprised online feedback, including teachers sending emails to students to highlight good work, as well as ad-hoc rewards such as colourful or smiley face stickers, verbal praise and class applause for presentations. This system of goal-setting and rewards was perceived to be an essential component of building a safe environment in which pupils could take risks, be creative and increase self-confidence. One Hampshire comprehensive teacher noted the impact of praising a student whose performance did not exactly warrant it: the student appeared to rise to this new level of performance, appreciating the confidence expressed in her.

However, teaching staff were also aware of parental attitudes and were careful about taking any risks with student performance. Grades were not only important to the school and the student; most parents expected good grades from their child.

Challenging extracurricular activities encourage young people to develop the skills for innovation

The range of extracurricular activities open to students was impressive in all types of school across the age range. Specialist status was used to lift the whole school's achievement through the provision of many extra-curricular learning opportunities. A strong focus on vocational skills, through the introduction of a wide range of vocational courses and qualifications, often fed into extra-curricular activities. Catering was a good example where formal teaching was supported by catering for an out of school

hours event. Other opportunities included drama productions, concerts, talent-shows, fashion shows and design and technology and art exhibitions. Involvement in drama and fashion productions also drew in students from other courses such as hair and beauty. Young people generally responded well to extracurricular opportunities and also pursued their hobbies and interests beyond the confines of the school or college.

Offering wide opportunities for innovative behaviour may encourage its development more

Innovative behavior, attitudes and skills are learnt socially and experientially. Therefore we would expect that the more opportunities offered by schools and colleges, the more they would be able to develop young people's innovative behaviour. With our small sample, it is impossible to be scientifically precise about this; even though we can show differences in innovative performance between institutions as measured by the Youth Innovation Skills Measurement Tool. However, we collected many examples of opportunities that were actively supported and encouraged by the schools and colleges, such as the Duke of Edinburgh awards, St John's Ambulance, Army cadets, girl guides, Young Enterprise, Enterprise Day, funded jazz bands, garage rock bands, an operatic music society and overseas trips. One school got particularly involved in the local community. Another entered students for the Jack Petchy Foundation awards, which recognise leadership qualities. Some schools made use of the after-school club 'Make Space,' a £4 million national programme launched in 2002 by national charity 4Children, with the support of Nestlé UK, which is part of a national network of youth clubs.[78]

A science specialist school had developed a Virtual Learning Environment, which fostered the personal development of students, building a sense of self-efficacy and independent learning, energy and creativity. The academies have new facilities including ICT, dance, design and arts studios, theatre and video conferencing. One technology-specialist academy used such facilities in its community programme, providing ICT training for parents and carers as well as a family learning programme for parents and children. Such opportunities to engage in hands-on subjects such as Art, Design and Technology, and ICT, were perceived to be more motivating by students in this academy, as well as in arts specialist schools.

Employer Engagement sessions run by Entrepreneurs in Action (EIA) are another example of opportunities made available to young people.[79] EIA provides business challenges for secondary schools in Croydon. The aim is to give students experience of the business world and to help the Year 8 students make more informed choices in Year 9 when they will have the option of selecting one of the new 14-19 Diplomas, specialising in either Engineering or Creative and Media Studies.

Teaching and other aspects of educational practice are important

Even this small sample shows clearly that while schools differed on the measure, the type of school does not in itself impact on the expression of innovative behaviour, although vocationally-oriented subjects may lend themselves more to innovative practices. Educational practices are however important and every school and college can influence the development of these fundamental innovative attitudes and skills.

Some attitudes and skills are nurtured far more than others. It is clear from discussion with both staff and students that there are opportunities to develop leadership skills across the age range. Issues to do with the development of self confidence and efficacy are beginning to be addressed, either where there is an obvious need, for example in young people from disadvantaged communities, or in sixth formers looking forward to the transition to tertiary education, training or employment. Efforts are made by staff to motivate their students, whilst students are themselves well aware of what energises them; however, there appears to be a large gap in understanding of risk and uncertainty – there is no provision for educating young people in this fundamental aspect of life and specifically innovation.

At a school in semi-rural Hampshire, a teacher managed the issue of risk for the students in design and technology by telling them, 'if things don't work out you move on.' Demonstrations at the bench by the teacher do not always work. Realising this, the children are effectively given permission to 'have a go' and to experiment and discover what works and what doesn't for themselves without fear of criticism. The students could then be

78. http://www.makespace.org.uk/home. Make Space provides contemporary extra-curricular facilities for 11-19 year olds. It is open after school and during most school holidays and aims to provide a safe and accessible environment for young people. Based around a chill-out space where young people can relax and meet their friends in comfortable surroundings, it has a quiet space where young people can access computers and the Internet, and read or study. It also offers activities with a range of sporting, arts and other opportunities, which provide alternative opportunities to motivate students.

79. http://www.theeia.co.uk/eng/partners/ CEO Derek Browne left a career in the City to start his own business, Entrepreneurs in Action, aimed at teaching students the value of entrepreneurship. He went on to win the Queen's Award for Enterprise Promotion in 2006 and to act as coach and business mentor for Jamie Oliver's four graduates on the Channel 4 'Jamie's Chef' show.

taught how to improve on their ideas. However in other instances, risk did not appear to be well understood by students; and was largely confined to physical safety. Both boys and girls appeared to like the excitement and thrills and spills afforded by some games and sports; but the management of money did not appear to worry them. For a group of 16-19 year olds, it was only in facing the uncertainty of achieving their grades or making choices that would affect their future that they began to understand risk as being about making decisions when facing an uncertain future.

In one Hampshire comprehensive, a teacher described children in her charge (aged 14-15 years) as having a fear of failure. It is very difficult to disentangle whether such fear arises from the pressure of examinations, teachers and parents, or whether there is a more general protective ethos that leaves young people lacking in the resilience to cope with pressure. In a London academy, many teachers explained the first priority was creating a learning environment in which students felt it was permissible to take risks and fail. This was described as a means of breaking a 'vicious cycle' of low confidence, low risk taking and low achievement. 'Just to try at all' was a huge risk, since it required challenging traditionally low levels of aspiration and educational attainment. Moreover, parents' low tolerance of risk was identified as one of the constraints to participation in activities, such as school trips. There are many examples, where the demographic characteristics of a school's catchment area influence such attitudes. It is perhaps not surprising that students then develop a risk averse attitude. However, where confidence can be built up, a more robust attitude toward risk may be achieved.

Development transitions can influence innovative behaviour

Young people go through a number of transitions during the 14-19 year period, including puberty, physical growth and maturation. Boys and girls develop at different rates and in different ways and, whilst these biological, emotional and cognitive developmental differences were not discussed by students, some staff did draw attention to those that could have a bearing on innovative behavioural expression among younger students. At one London academy, gender differences, reflecting the national trend of greater female attainment, had led to increased confidence generally among girls, but also the need to respond to boys' differing needs. In one academy and in a Hampshire based sixth form college, there was emphasis given to making the transition into the new institutional environment, and explicitly to inducting students.

Further practical and policy issues that have emerged from the case studies are discussed in the concluding section.

Part 7: The development of the Tool has practical and policy implications

Innovation skills can now be measured

Our work to develop the Youth Innovation Skills Measurement Tool has demonstrated that the generic skills that underpin innovative behaviour in young people can be measured through a web-based questionnaire.

Schools and colleges could do more to develop young people's innovation skills

These skills can be developed by nearly all young people regardless of where they sit on the spectrum of academic ability. In developing the Tool we have sought therefore to understand how schools, colleges and youth organisations can help young people to develop these skills. We identified a wide range of opportunities that could be supported and encouraged by policymakers and educators both within and outside the curriculum.

Innovative potential and its dimensions that we have described are not taught discretely in secondary schools. But students are often learning the innovative characteristics of creativity, self-efficacy (self confidence), emotional intelligence (especially where this impacts on the students' motivation), and leadership, often through extracurricular subjects and activities. Within the curriculum, science, arts, humanities and vocational subjects can all stimulate young people's thinking and enable them to practise innovation skills. Outside the curriculum, schools and colleges that provide a wide range of opportunities appealing to the different interests of young people are most likely to stimulate their innovative potential. It is important, however, that examinations and school performance tables do not crowd out opportunities to enrich young people's education and prepare them better for the world of work.

Young people would benefit from more opportunities to develop their risk-propensity

Through focus groups with staff and students in twelve schools and colleges we also found that risk-propensity was the least well understood of our concepts and was little taught.

One of our strong recommendations is that **risk-propensity should be taught**, with a particular focus on economic risk so that today's students understand how they may improve society through their innovative efforts and how society and the economy is shaped through appropriate and ethical risk management.

To develop their understanding of risk, **young people should be given permission occasionally to get things wrong**. But they should also be encouraged to think through how to put things right, and introduced to the idea that there may be than one right answer to the same question.

Young people should be taken out of their own 'comfort zone' occasionally to explore different ideas and different ways of doing things (perhaps with other young people in the class with whom they do not usually associate).

Young people have difficulty in transferring ideas from one subject to another and making

connections. Projects that are cross-disciplinary should not necessarily be marked, but used as a means of exploring a subject; this would enable young people to be more creative, more adventurous in their thinking and to explore how far they are willing to take risks. Further, competitive sports and the strategic thinking needed to win can develop young people's understanding of risk and leadership, and their self-confidence.

These could help young people begin to understand the nature of risk-taking. However, that willingness to take risks could be enhanced by developing young people's self awareness of their own attitude towards risk and by discussing the nature of economic risk in extracurricular classes or formal enterprise education lessons. Such lessons could touch on financial risk, money management, employment, careers and whether it is better to pursue vocational or academic pathways.

The Tool has a wide range of potential uses

The Tool is of obvious value to educationalists, including secondary and further education teachers, and organisations that work with young people. It should be of interest to parents and young people themselves. From a policy perspective, it should appeal to national and local government.

The Tool can be used as a personal development measure for young people

The vast majority of young people have the potential to develop the five innovative characteristics, but they need opportunities, encouragement and support to do so. The Tool therefore should be used as a personal development tool, rather than a test, that will enable young people to identify ways in which they can improve their skills. Innovative skills may be applied socially, environmentally and economically: with such breadth, young people should discover where their personal interests lie. This means crucially that they should receive appropriate, relevant and personally meaningful feedback, with high expectations and an absence of labelling. Moreover, the social and heuristic learning behind the Tool assumes that through carefully tailored support, individuals can improve their achievement.

The Tool can be used diagnostically to help young people see what skills they might want to strengthen and how to strengthen them. This makes it an enabling device in a wider programme of personal development which could form part of personal, learning and thinking skills (PLTS) activities, careers guidance or other tutorial and advice sessions on subject and education choices. Such self-awareness is in itself a skill valued by employers as it encourages self-reflection and a focus on self-development that can help to improve workplace performance.

The Tool assumes standard psychometric properties of reliability and validity that enable different individuals to consider their performance against the average performances of cohorts of young people. Such cohorts may be defined by their age or some other suitable criterion. For example, eighteen year old potential innovators can not only look at their 'spiky profile' on the measure of the five innovative skills, but compare their performance against the average for their age group. Doing this on a personal basis rather than as a part of the formal curriculum enables young people to become more self-aware and take responsibility for the further development of their skill profile. It is a choice open to everyone; it may also be included in extracurricular activities and supported by the personal tutorial system. Alternatively, it may be adopted by a youth organisation, especially one keen to promote the development of skills. Such avenues would give young people the opportunity to talk through just how they might go about strengthening one of more of their skills.

The Tool can help evaluation educational initiatives and teaching approaches

There are additional policy uses for the measure. These include:

- assessing the impact of initiatives intended to develop innovative or enterprise capability in schools and colleges;
- assessing whether extracurricular activities develop innovative behaviours;
- comparing the scores of young people who have undertaken different innovation initiatives;

- using its conceptual basis as an educational tool;
- facilitating career guidance for students; and
- demonstrating change in young people's skills over time.

Our research to develop the Tool indicates that the ethos and culture of schools and different teaching approaches can help young people to develop the skills for innovation. The Tool can enable comparisons to be made between groups of young people in different institutions or subject groups to assess the effectiveness of different pedagogical styles and other features of school or college culture.

We are developing the Tool further

Work is underway to make the Tool easier to use, by creating a version that will generate a personal report for young people. The new version will also develop age-related norms and strengthen the measurement of risk-propensity. Further testing is being carried out with schools around the UK. The new version will be ready in 2010.

In the longer term, we are interested in developing further research to follow a cohort of students through the various educational and employment transitions and to test the effectiveness of the measure in predicting actual innovation outcomes by those young people who consistently score highly on the measure. We are also interested in looking more closely at the impact of the culture, teaching and learning style of different educational institutions on the development of innovative behaviour. We wish to determine whether the nature of particular courses influences the development of innovative attitudes and skills. Thus, a further piece of research might focus on the new Diplomas and their impact on the development of innovative behaviour in young people.

Statistical appendices

Appendix 1: Dependent variables[80]

The choice of dependent variables is tied up with intention; intention being a strong predictor of future behaviour (Bird, 1988).[81] The dependent variables selected may be described as 'states of being' and the possible socio-economic roles with which the young person could identify (Table 1).

Table 1: Types of future innovator and associated dependent variable

Type of innovator	Statement of future intention to be innovative
Inventor/innovator	I would like to invent something that is new to the world
Cultural Innovator	I would like to design or create something new, such as music, software, dance, TV or fashion
Corporate innovator	I intend to get a job in a large company and apply my skills to develop new products or services
Innovative entrepreneur	My ambition is to set up a successful company that offers something completely new
Social innovator	I would like to do something no one has ever thought of before that would bring about positive changes to society or the environment
Economic entrepreneur	When I leave school/college, I intend to spot opportunities to make a lot of money

80. Key sources of authority used are: Nunnally, J.C. (1978) 'Psychometric Theory.' New York: McGraw-Hill Publishing; Chandler, G. N. and Lyon, D.W. (2001) Issues of Research and Design Construct Measurement in Entrepreneurship Research: The Past Decade. 'Entrepreneurship Theory & Practice.' vol. 25, pp.101-113; Comrey, A.L. (1988) Factor-analytic methods of scale development in personality and clinical psychology. 'Journal of Consulting and Clinical Psychology.' 56, 5, pp.754-761; Cronbach, L.J. (1951) op.cit.; Cronbach, L.J. (1990) 'Essentials of Psychological testing', Fifth Edition. New York: HarperCollins; Devellis, R.F. (2003) 'Scale Development: Theory and Applications.' Sage: London; Hair ,J.F., Jr., Anderson, R. E., Taltham, R. L. and Black, W.C. (1998) 'Multivariate Data Analysis', International Edition, Fifth Edition. Princeton: New Jersey: Prentice-Hall.

81. Bird, B. (1988) Implementing Entrepreneurial Ideas: The Case for Intention. 'Academy of Management Review.' 13, 3, pp.442-453.

Appendix 2: Reliability of the sub-scales from the Pilot Study (N= 239)

The first version of the online Youth Innovation Skills Measurement Tool was piloted in three schools, two in Hampshire and one in London, yielding a total sample size of 239 pupils during February/March 2008. In Hampshire, one sixth form college and one 11-16 secondary school took part. In London, one of the new academies, with a sixth form, also participated in the pilot study. There were 150 male participants and 89 female, including sixth formers, Year 10 (14-15 year olds) and Year 11 (15-16 year olds).

Testing the reliability of the Youth Innovation Skills Measurement Tool

Reliability is the internal consistency of a scale, and the extent to which each item correlates with the rest and how well it correlates, with the total item pool in the sub-scale. This produces a coefficient, known as the Cronbach alpha. The coefficient threshold of reliability should reach 0.7. The procedure to develop the Tool involved an iterative process of calculating Cronbach alphas and carrying out principal component analyses for each scale to achieve a valid and reliable measure. Cronbach's alphas were computed for each subscale (Table 2).

This coefficient should normally reach a recommended threshold of 0.7 (Nunnally, 1978; Churchill, 1979).[82] The scales were purified by repeatedly refocusing on the relevance of individual statements related to the original theoretical constructs and on the contribution to the alpha score of each statement. The resulting purified scales were then tested for reliability once more. The results show that internal consistency scores of Self-efficacy and Risk-propensity still fall below the 0.7 threshold. As the Self-efficacy scale was close to the 0.7 threshold this was retained for the criterion validity tests, but the Risk-propensity scale at 0.551 was considered to be too unreliable for use in further testing. Instead this scale would be re-designed for the next version of the Tool.

82. Cronbach, L. J (1951) op.cit.; Churchill, G.A. (1979) A paradigm for developing better measures of marketing constructs. 'Journal of Marketing Research.' 16, 1, pp. 64-73; Nunnally, J.C. and Bernstein I.H. (1994) 'Psychometric Theory.' New York: McGraw-Hill Publishing. (p265)

Table 2: Reliability of the sub-scales from the pilot study data

Construct	Number of items	Cronbach coefficient alpha
Leadership	12	0.792
Creativity	10	0.765
Energy	8	0.745
Self-efficacy	10	0.670
Risk-propensity	6	0.551

Criterion validity testing of the Youth Innovation Skills Measurement Tool

A test of criterion validity was performed on the pilot data. A dependent variable was developed, which was a proxy for pupils' future intentions towards innovation. Respondents were asked to indicate how much they agreed or disagreed (on a scale of 1-7) with a series of statements about pursuing five different innovative pathways: an inventor, a cultural innovator, a corporate innovator, an innovative entrepreneur, and a social innovator.

For the purposes of validity testing, respondents were categorised into one of two groups. If respondents scored 7 (i.e. strongly agree) on any of the dependent variable statements (which measure future intentions towards an innovative career pathway), they were categorised as having a stronger intention to pursue an innovation pathway. If respondents did not score 7 on any of these statements, then for the purposes of the test development analysis only they were categorised as having weaker intention of pursuing an innovation pathway.[83]

To explore differences between those students who have expressed a stronger innovative intention and those students that have expressed a weaker intention on the five dimensions, a t-test was calculated using average scores achieved on the Youth Innovation Skills Measurement Tool for each group. Average scores were calculated by adding scores of all statements in each reliable sub-scale (Leadership, Creativity, Energy, and Self-efficacy). The sub-scale measuring Risk-propensity was not reliable and was therefore omitted from this stage of the analysis.

A total 'innovation' score was then calculated by adding sub-scale scores for each respondent. The average Innovation scores for the stronger intention and weaker intention groups were then compared using a T-test. There were 128 respondents with stronger intentions to become social innovators, inventors, cultural innovators, corporate innovators, or innovative entrepreneurs; and 111 pupils with weaker aspirations. Table 3 shows the results for the T-test comparison of mean Youth Innovation Skills Measurement Tool scores.

The average score for the stronger group on all four sub-scales and on the total Innovation score (Youth Innovation Skills Measurement Tool score) was significantly greater (at the 1 per cent level of significance) than the average scores for the weaker group.[84] These findings show that the Tool can successfully distinguish between these two groups, thus demonstrating the robustness of the measure.

Note on statistical significance

Statistical tests, such as the t-test, are designed to show whether an observed result can have occurred by chance. The result of the test is expressed as a statistic, which is assessed against different levels of probability. It is usual to accept a level of probability of 0.05 – that is, there is only a 5 per cent probability that the result occurred by chance. This means that the finding is statistically significant at the 5 per cent level or, p (probability) = 0.05. Statistical significance may also occur at higher levels as in the above example.

83. It should be noted that this is a statistical manipulation, which is designed to establish the validity of the scales and the measure overall. Once the validity has been established, the measure will be used by students for personal development purposes. The scales represent generic innovation skills; thus by participating in the Youth Innovation Skills Measurement Tool, the student will gain an understanding of their own innovation skills profile at a particular point in time. The tool may be used to show the development of these skills over time especially after experience of a targeted educational initiative.
84. A detailed explanation of the pilot study can be found in Kingston (2008) op.cit.

Table 3: Mean scores for the stronger and weaker innovation pathway with probabilities of significance using T-test analysis

Group	Number	Mean Innovation score*	Significance (2-tailed)
Stronger innovation pathway	128	196.47	0.000**
Weaker innovation pathway	111	174.94	
Total	**239**		

*Maximum score = 280 **significant at 0.001 level

Appendix 3: Reliability and validity testing Main Study Part 1 (MS1) (July 2008)

The second version of the Tool consisted of 58 statements related to Creativity, Self-efficacy, Energy, Risk-propensity and Leadership, and included 5 dependent variables. The aim of the statistical procedures was to reduce this number to achieve the tightest, most valid and reliable scale possible.

Testing the reliability of the Youth Innovation Skills Measurement Tool

The initial set of 53 statements was reduced to 29 during this iterative process. Table 4 shows the Cronbach alpha scores for each sub-scale and the final number of statements in each. Four of the scales met the 0.7 threshold: Leadership, Creativity, Energy and Self-efficacy, while the Risk-propensity scale did not meet this requirement.

Structural validity

As well as meeting reliability thresholds, newly developed scales must also be one-dimensional; all items in each scale should load on only one component. This is to ensure the structure of the scales reflects the original conceptual design of the model. With several components, the scale is multidimensional.

A principal component analysis (PCA) was carried out on each of the five original sub-scales to explore the underlying structure of each. The results showed that Self-efficacy, Risk-propensity and Leadership had three components each while Energy and Creativity both had two. The structure of these components informed the development of the Tool. The statements in each component were reviewed and retained based on their contribution to the conceptual design of each sub-scale, as well as the results of reliability and validity tests. The final structure

Table 4: Cronbach's alpha scores for sub-scales (N=308)

Construct	Number of items	Cronbach coefficient alpha
Leadership	6	0.783
Creativity	5	0.818
Energy	7	0.793
Self-efficacy	7	0.738
Risk-propensity	4	0.584

of each sub-scale as shown in Table 4 was one-dimensional. So, all the statements in each purified scale loaded onto only one component, thus meeting one of the main requirements for scale development.

Criterion validity testing

A test of criterion validity was carried out using data collected from this second version of the Youth Innovation Skills Measurement Tool. A dependent variable was developed as a proxy for pupils' future innovative intentions. The method was the same as used in the Pilot Study: respondents were asked to indicate how much they agreed or disagreed (on a scale of 1-7) with a series of statements about pursuing five different innovative career pathways: inventor, cultural innovator, corporate innovator, innovative entrepreneur, and social innovator. Groups of respondents who scored 7 on at least one of these statements were categorised as 'stronger innovation pathway', and respondents who did not score 7 on any of the statements were categorised as 'weaker innovation pathway' at that point in time.

To explore differences between the higher and weaker scoring groups, a t-test was calculated using average scores achieved on the Tool for each group. The stronger innovation pathway group comprised 176 pupils while the group with weaker intentions to pursue an innovation pathway, comprised 132 pupils. Average scores were calculated by first adding scores of all statements in each sub-scale. A total 'innovation' score was then calculated by adding sub-scale scores for each respondent. The average Innovation scores for the stronger innovation pathway group and the weaker innovation pathway group were then compared using a T-test. Table 5 shows the results of the T-test analysis.

The mean score for the stronger innovation pathway group on the total Innovation score (SIS score) was significantly greater (at the 1 per cent level of significance) than the mean score for the weaker group. These findings show that the Tool can successfully distinguish between pupils with stronger and weaker innovative intentions from those who do not have these intentions. However this statistical manipulation has been used to demonstrate the robustness of the measure. Ultimately the measure will be used to indicate the level of each respondent's skills on each of the five dimensions and will have the potential to demonstrate change in the profile over time. Hence it could be used for personal development.

Table 5: Mean scores for a stronger and weaker innovation pathways groups with probabilities of significance using T-test analysis

Group	Number	Mean Innovation score*	Significance (2-tailed)
Stronger innovation pathway	176	148.02308	0.000**
Weaker innovation pathway	132	128.29	0.000**
Total			

*Maximum score = 203 **significant at 0.001 level

Appendix 4: Reliability and validity testing of Main Study Part 2 (MS2) (October-December 2008)

The third version of the Tool consisted of 42 statements related to Creativity, Self-efficacy, Energy, Risk-propensity and Leadership. The aim of the statistical procedures was to achieve the most parsimonious, valid and reliable scale possible.

Characteristics of the sample

The characteristics of the sample are shown in Table 6. There were 429 (52.9 per cent) male and 382 (47.1 per cent) female participants. There were 438 (54 per cent) pupils aged 14-15, 345 (42.5 per cent) pupils were aged 16-17, and the final group aged 18-19 was a small sample of 28 (3.5 per cent). There were six broad ethnic groups which included: Mixed; Asian; Black; Chinese; White and Other. The largest groups were 'White' with 438 (54.0 per cent) pupils, 'Black with 163 (20.1 per cent) pupils and 'Asian' with 108 (13.3 per cent) pupils. Over one third of pupils (38.5 per cent) had a parent who has owned a business at some time. Nearly one quarter of pupils have a parent, who currently runs a business (23.4 per cent).

Testing the reliability of the Youth Innovation Skills Measurement Tool

Cronbach's coefficient alpha was used to measure reliability and an initial alpha was calculated for each of the five sub-scales. A principal component analysis (PCA) was also carried out for each sub-scale to establish the underlying structure and to ensure each sub- scale was one-dimensional. Scales should be one-dimensional. The scales were purified by constantly refocusing on the relevance of individual statements to the original theoretical constructs and on the contribution to the alpha score and the underlying structure made by each statement.

The following table shows the final results of the reliability testing, with details of the alpha score for each construct and the number of items included in the final sub-scale. This purified version of the Tool consists of 31 statements.

All the sub-scales reached the required threshold of 0.7 apart from the Risk-propensity scale which achieved an alpha of 0.583. The Creativity scale had the highest alpha at 0.790.

The results of the PCAs for each scale are shown in Table 8. All scales are one-dimensional and the factor loadings for each individual statement are shown.

Criterion validity testing of Youth Innovation Skills Measurement Tool

Following reliability testing an initial test of criterion validity was performed on this third version of the Youth Innovation Skills Measurement Tool. Several dependent variables were used which were a proxy for pupils' future intentions towards an innovation career pathway. Respondents were asked to indicate how much they agreed or disagreed (on a scale of 1-7) with a series of statements about

Table 6: Sample characteristics

Characteristics	Category	n	Percentage
School/College	Academy, London MS2.1	184	22.7
	Sixth form college, London MS2.2	57	7.0
	Sixth form college, Hants MS2.3	172	21.2
	School, London MS2.4	106	13.1
	Sixth form college, London MS2.5	45	5.5
	School, Hants MS2.6	114	14.1
	Academy, London MS2.7	133	16.4
	Total	**811**	**100.0**
Gender	Male	429	52.9
	Female	382	47.1
	Total	**811**	**100.0**
Age	14-15	438	54
	16-17	345	42.5
	18-19	28	3.5
	Total	**811**	**100.0**
Ethnic background	Mixed	69	8.5
	Asian	108	13.3
	Black	163	20.1
	Chinese	16	2.0
	White	438	54.0
	Other	17	2.1
	Total	**811**	**100.0**
Has a parent who has owned a business	Yes	312	38.5
	No	499	61.5
	Total	**811**	**100.0**
Parent currently owns a business	Yes	190	23.4
	No	621	76.6
	Total	**811**	**100.0**

Table 7: Cronbach's alpha scores for sub-scales (N=811)

Construct	Number of items	Cronbach coefficient alpha
Leadership	6	0.768
Creativity	6	0.790
Energy	7	0.755
Self-efficacy	8	0.702
Risk-propensity	4	0.583

Table 8: Principal Component Analysis (Varimax rotation) (N=811)

Scale	Statements	Factor loadings
Creativity	I would like my lessons to involve lots of different creative activities.	.840
	I prefer lessons that involve different activities rather than just sitting at my desk.	.792
	I feel proud when I've designed something myself and made it.	.729
	I like doing things that are very practical.	.688
	I have chosen subjects at school/college that give me the freedom to express my own ideas.	.564
	The subjects I have chosen at school/college require my imagination.	.554
Leadership	I really like being leader of a group.	.833
	Project work gives me the chance to take a leading role in the group.	.699
	When working in a group I do my best to persuade the others to take up my ideas.	.687
	I am often chosen to be the team leader or captain of my team.	.688
	I like organising other people.	.665
	My friends follow my suggestions when they can't make up their minds.	.516
Energy	It's energising when you are given rewards for good work (e.g. a school day trip)	.700
	I feel really motivated when I produce something that no one else has.	.686
	I feel really enthusiastic about my chosen subjects.	.657
	It's energising and rewarding to help other people.	.642
	I really push myself to achieve good grades.	.616
	When I'm doing something I like to feel it has a purpose or goal.	.589
	I have lots of energy for work and play.	.564
Self-efficacy	I like to pursue my interests outside school/college where I feel more in control.	.656
	I want my future work to be based around a set of challenges that I would find interesting.	.636
	Once I start something I like to finish it.	.622
	I would join a club/interest group independently of my friends if it was something I really wanted to do.	.578
	I'm not easily swayed by other people's opinions, but do what I think is best.	.549
	Students should have a say in how a school/college is run.	.541
	My spending money is important because it gives me a sense of my independence.	.540
	I've been brought up to think for myself.	.435
Risk-propensity	When I make choices I want to be as sure as possible what the future consequences will be for me.	.785
	I want my work to provide me with opportunities to show that I can overcome problems.	.685
	I would not take a risk on an activity that might spoil my chances of getting good grades at school/college.	.649
	Fearing that I might fail my exams is a powerful motivator at school/college.	.509

Table 9: Future Intentions in respect innovative behaviour

Question number	Statement of future intentions towards an innovation pathway
27	I would like to invent something that is new to the world.
38	My ambition is to set up a new company that offers something completely new.
42	I intend to get a job in a large company and apply my skills to develop new products or services.
16	I intend to design or create something new such as in music, software, buildings, dance, film, TV, or fashion.
12	I'd like to do something no one has ever thought of before that would bring about positive changes to society, the environment, or politics

For the purposes of validity testing the dependent variables were operationalised as follows

If respondents scored 7 (i.e. strongly agree) on any of the dependent variables statements they were then categorised as Group 1. If respondents did not score 7 on any of these items then they were categorised as Group 2. To explore differences between those who scored 7 on each question and those who did not a simple t-test was calculated using average scores achieved on the Youth Innovation Skills Measurement Tool for each group.

Average scores were calculated by first summing scores of all statements in each sub-scale (Creativity, Self-efficacy, Energy, Risk-propensity and Leadership). A total 'innovation' score was then calculated by summing sub-scale scores for each respondent. The average Innovation scores for each group were then compared using a T-test. Table 10 displays the results for each question and the levels of significance.

Table 10: Mean scores for Groups 1 and 2 with probabilities of significance using T-test analysis

Question number	Groups (n)	Mean Innovation score*	Significance (2-tailed)
12	1 (154)	179.88	0.000**
	2 (657)	161.11	
16	1 (161)	173.90	0.000**
	2 (650)	162.39	
27	1 (147)	176.36	0.000**
	2 (664)	161.97	
38	1 (100)	180.37	0.000**
	2 (711)	162.47	
42	1 (130)	180.63	0.000**
	2 (681)	161.63	

*Maximum score = 217 **significant at 0.001

External validity testing of the Youth Innovation Skills Measurement Tool

A further test of validity was carried out using groups of young people who indicated that they had taken some steps towards starting up their own business and could be described as nascent innovators. Table 11 shows the questions young people were asked to establish their status as nascent innovators.

Table 12 shows the results for each question and the levels of significance.

If the dependent variables used are taken as a reasonably accurate measure of pupils' future innovative intentions, this analysis has gone some way towards establishing the validity of the Tool. The implications of these findings are that the Tool can successfully distinguish pupils with stronger intentions to pursue an innovative career from those who expressed weaker intentions.

Table 11: Nascent innovators

Questions to identify nascent innovators	Question number
Sought support from family or friends.	1
Worked on your ideas in your bedroom or other personal space.	3
Working to a plan.	5

Table 12: Mean scores for Groups 1 and 2 with probabilities of significance using T-test analysis

Question number	Groups (n)	Mean Innovation score*	Significance (2-tailed)
1	1 (316)	168.99	0.001**
	2 (119)	161.66	
3	1 (263)	170.04	0.001**
	2 (159)	162.72	
5	1 (219)	170.46	0.002*
	2 (183)	163.80	

*Maximum score = 217 **significant at 0.050 level

Appendix 5: Differentiating on the measure on the basis of key demographic characteristics

Table 13: Students' characteristics

Characteristics (n=811)	Category	n	Percentage
School/College	Academy, London MS2.1	184	22.7
	Sixth form college, London MS2.2	57	7.0
	Sixth form college, Hants MS2.3	172	21.2
	School, London MS2.4	106	13.1
	Sixth form college, London MS2.5	45	5.5
	School, Hants MS2.6	114	14.1
	Academy, London MS2.7	133	16.4
	Total	**811**	**100.0**
Gender	Male	429	52.9
	Female	382	47.1
	Total	**811**	**100.0**
Age	14-15	438	54
	16-17	345	42.5
	18-19	28	3.5
	Total	**811**	**100.0**
Ethnic background	Mixed	69	8.5
	Asian	108	13.3
	Black	163	20.1
	Chinese	16	2.0
	White	438	54.0
	Other	17	2.1
	Total	**811**	**100.0**
	Mean Innovation score[85]	163.73[86]	(Max possible score=217)
	Mean Self-efficacy score	44.37	(Max. possible score=56)
	Mean Energy score	38.89	(Max. possible score= 49)
	Mean Creativity score	32.05	(Max. possible score=42)
	Mean Leadership score	27.47	(Max. possible score=42)
	Mean Risk-propensity score	20.93	(Max. possible score=28)

85. These scores are based on the third version of the Youth Innovation Skills Measurement Tool, which comprises 31 reliable items. Hence total score = 7x31 = 217. Sub scale scores are calculated according to the number of reliable items e.g. SE 8 items x 7 = maximum possible score of 56.
86. This score and the risk score should be interpreted with caution as the Risk-propensity sub-scale of 4 items did not meet the reliability criterion.

Table 14: MANOVA results for Innovation scores (n=811)

N.B. Total Innovation scores are shown in italics.[87]

Age	Ethnic background[88]	School	Gender	Parent currently self-employed	Parent has been self-employed
Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
0.560	0.001**	0.000***	0.264	0.426	0.991
14-15 *167.96*	**Mixed** *162.93*	**1** 160.03	**Male** *164.28*	**Yes** *163.31*	**Yes** *164.59*
16-17 *162.18*	**Black** *167.94*	**2** 170.88	**Female** *164.01*	**No** *164.99*	**No** *163.70*
18-19 *162.30*	**Asian** *164.53*	**3** 165.54			
	White *161.18*	**4** 165.59			
		5 154.99			
		6 163.60			
		7 168.40			

** Significant at 0.05 level *** Significant at 0.001 level

	School/college		Code
1	London academy		MS2.1
2	London sixth form college		MS2.2
3	Hants sixth form college		MS2.3
4	London secondary specialist in music and English language		MS2.4
5	London sixth form college		MS2.5
6	Hants secondary specialist arts		MS2.6
7	London academy		MS2.7

87. Caution needs to be used when interpreting these scores as they include the 'risk' scale which did not meet the reliability criterion.
88. The 'Chinese' and 'other' categories have been omitted due to small sample size.

There were two significant results: ethnic background and school attended. Age, gender, or having a self-employed parent, were not related to mean scores.

Black pupils scored significantly higher on the Youth Innovation Skills Measurement Tool than other ethnic groups. White pupils had the lowest mean score (See Table 14).

A London sixth form college and one of the London academies scored significantly higher than any of the other schools. The lowest mean Youth Innovation Skills Measurement Tool score was found at one of the London sixth form colleges.

Table 15 of mean scores between the ethnic groups shows that differences in mean Leadership scores are significant. Differences in mean scores on the Energy sub-scale and the Risk-propensity sub-scale are approaching significance.

White pupils scored lower on the Leadership scale than pupils in other ethnic groups. Black and Mixed race pupils scored the highest.

Table 15: Mean scores of dimensions by ethnic group

N.B. Levels of significance shown in brackets.

	Creativity (0.487)	Leadership (0.006)**	Energy (0.053)*	Self-efficacy (0.186)	Risk-propensity[89] (0.067)*
Mixed	31.92	28.27	38.20	44.17	20.36
Asian	31.78	27.99	39.65	43.67	21.43
Black	32.83	28.37	39.66	45.46	21.61
White	31.93	26.09	38.00	44.67	20.47

**Significant at 0.05 level *approaching significance

Table 16: Mean scores of dimensions by School

N.B. Levels of significance shown in brackets.

School	Creativity (0.000)***	Leadership (0.002)**	Energy (0.023)**	Self-efficacy (0.004)**	Risk-propensity[90] (0.051)*
1	31.78	25.90	37.80	44.03	20.50
2	34.61	27.75	40.50	46.93	21.07
3	30.85	28.59	39.93	45.15	20.99
4	33.13	28.08	38.80	44.04	21.51
5	29.11	26.11	37.49	42.08	20.17
6	32.76	29.11	37.65	43.39	20.66
7	32.56	28.20	39.94	45.82	21.86

*** Significant at 0.001 level, ** significant at 0.05 level, *approaching significance

89. Risk scores should be interpreted with caution as this scale did not meet the reliability criterion.
90. Risk scores should be interpreted with caution as this scale did not meet the reliability criterion.

Differences in mean scores between schools were significant for four sub-scales: Creativity, Leadership, Energy and Self-efficacy (Table 16). The differences in mean scores on the Risk-propensity scale were approaching significance.

Mean scores for Creativity, Energy and Self-efficacy were significantly higher for pupils at the London sixth form college (MS2.2) than at any of the other institutions.

Mean scores for Self-efficacy and Energy were also high at one of the London academies (MS2.7) and the Hampshire SFC (MS2.3).

Another of the London sixth form colleges (MS2.5) had the lowest mean scores for Creativity, Energy and Self-efficacy.

Mean scores for Leadership were significantly higher at the Hampshire specialist technology school (MS2.6) than at any of the other institutions. The lowest mean Leadership score was found at one of the London academies (MS2.1).

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Published: July 2009
ID&M/24

ISBN 978-1-84875-042-5