The Cambridge approach to 21st Century skills: definitions, development and dilemmas for assessment
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The overall aim of this session is to provide opportunities to share and discuss evidence-based thinking on 21st Century skills. Two key questions facing assessment professionals globally are those of: (i) what 21st Century skills are, and (ii) how learners can best show evidence of them. Building on international literature reviews of this diverse array of skills and knowledge, we outline the six major pedagogical approaches to their development in learners that Cambridge Assessment supports. Although the pedagogical approaches are not mutually exclusive, each has different implications for assessment. We outline how Cambridge Assessment uses a variety of research-driven assessment techniques to measure 21st Century skills.

We also discuss some of the key challenges faced by assessors internationally. These include the question of how contributions to collaborative tasks can best be assessed, and the tension between reporting complex skill sets in a sufficiently detailed and meaningful way whilst also providing results that can be utilised efficiently by end-users of the assessments.

Keywords: 21st Century skills; pedagogy; assessment

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Introduction

Since for many people life in the 21st Century has become international, multicultural and inter-connected, new skills are needed to succeed in education and in the workplace. In this paper conceptualisations of so-called 21st Century skills are collated and explored. The question of how the development of such skills in young people can best be supported is considered in depth. Approaches include: continuing with long-standing teaching methods; developing curricula that cover 21st Century skills explicitly; adopting a skills-centred pedagogy in schools and colleges; and nurturing skills through extra-curricular activities, through independent research projects, and in the workplace. Recent examples of these approaches, drawn from the UK and internationally, are described. Consideration is also given to the value of summative assessment of 21st Century skills, and to the feasibility of such assessment for test developers.

 "Today, because of rapid economic and social change, schools have to prepare students for jobs that have not yet been created, technologies that have not yet been invented and problems that we don't yet know will arise." Andreas Schleicher, OECD Education Directorate, 2010.

The understanding and skills needed to compete in today's global economy are arguably quite different to those upon which 19th and 20th Century education systems have traditionally focussed. Life has become much more international, multicultural and inter-connected. Seismic advances have occurred in ICT and in access to it. These have enabled the economies of developed countries to shift from a basis of material goods and services to one of information and knowledge (Lisbon Council, 2007; Cisco, Intel and Microsoft, 2008). Whereas the possession of detailed facts and figures was once a passport to a professional job or a university place, there is now much more emphasis on what people can do with the knowledge they can access (Silva, 2009) and on interpersonal skills. In the UK and elsewhere, aspirations towards a more meritocratic society (e.g. Aim Higher, 2011) coupled with these economic and social changes have contributed to intense competition for places at top universities and for jobs, leading applicants to seek new ways to distinguish themselves. Simultaneously, however, some employers and university tutors complain that new recruits arrive ill-equipped, having been spoon-fed material at school or college (Tickle, 2011). It is unsurprising that references to so-called '21st Century skills' have peppered many debates over what and how today's students should learn, in order to become productive citizens.

What are 21st Century skills?
There is no single widely-accepted definition of '21st Century skills'. Arguably, this is to be expected, given the diversity of agendas held by different educationalists, policy makers, employers, teaching unions, and higher education institutions. According to Silva (2009), there are hundreds of descriptors of the skills set, including life skills, workforce skills, interpersonal skills, applied skills, and non-cognitive skills.

One of the largest research ventures currently underway is *Assessment and Teaching of 21st Century Skills (ATC21S)*. The stated purpose of this international collaboration among academics, governments and three major technology companies is to empower students with the right skills to succeed in the 21st Century workplace (ATC21S, 2013). An initial objective of the ATC21S project was to develop clear, operational definitions of 21st Century skills. Researchers began by conducting what is probably the most thorough recent review of the

literature in this field. They analysed the definitions developed and used by eleven major organisations, including the Partnership for 21st Century skills (2013) in the United States and the Lisbon Council (2007) of the European Union.

The ATC21S researchers concluded that 21st Century skills can be grouped into four broad categories: (i) ways of thinking; (ii) ways of working; (iii) tools for working; and (iv) skills for living in the world (Binkley, Erstad, Herman, Raizen, Ripley and Rumble, 2010). Within these categories, they identified ten skills as encapsulating all others and accommodating all approaches. In particular, problem-solving, and ICT operations and concepts, are listed by all organisations (Table 1). Communication, collaboration, and information literacy (the ability to mine new information and interact constructively with it) are also listed frequently.

Table 1: Definitions of 21st Century skills

ATC21S		21st C skills reviewed by ATC21S			
21st C skill category	21st century skills	Partnership for 21st C skills (2013)	Lisbon Council (2007)	ISTE NETS (2013)	ETS iSkill (2013)
Ways of thinking	creativity & innovation	creativity & innovation		creativity & innovation	creativity & innovation
	critical thinking problem solving decision making	critical thinking problem solving decision making	problem solving	critical thinking problem solving decision making	critical thinking problem solving
	learning to learn metacognition				
Ways of working	communication	communication		communication	communication
	collaboration	collaboration	collaboration		collaboration
Tools for working	information literacy	information literacy media literacy	information literacy	information literacy	information literacy
ICT literacy	ICT operation and concepts	ICT operation and concepts	ICT operation and concepts	ICT operation and concepts	ICT operation and concepts
Living in the world	citizenship				
	life and career	e.g. initiative flexibility leadership	flexibility adaptability		initiative self direction
	personal and social responsibility				

In addition to the ATC21S 21st Century skills others were discussed at an education conference hosted by Cambridge Assessment[1]. A Senior Tutor at the University of Cambridge stressed the need for top university applicants to possess 'mental fluency' in their subject of interest; for example, this might be mathematical fluency, fluency in writing, or fluency in scientific thought (Partington, 2011). A closely-related skill is articulacy, an aspect of communication.

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[1] *What kind of education enables us to cope with an interconnected world?* A Cambridge Assessment event held at 1 Great George Street, Westminster, London, SW1, on 15/03/11.

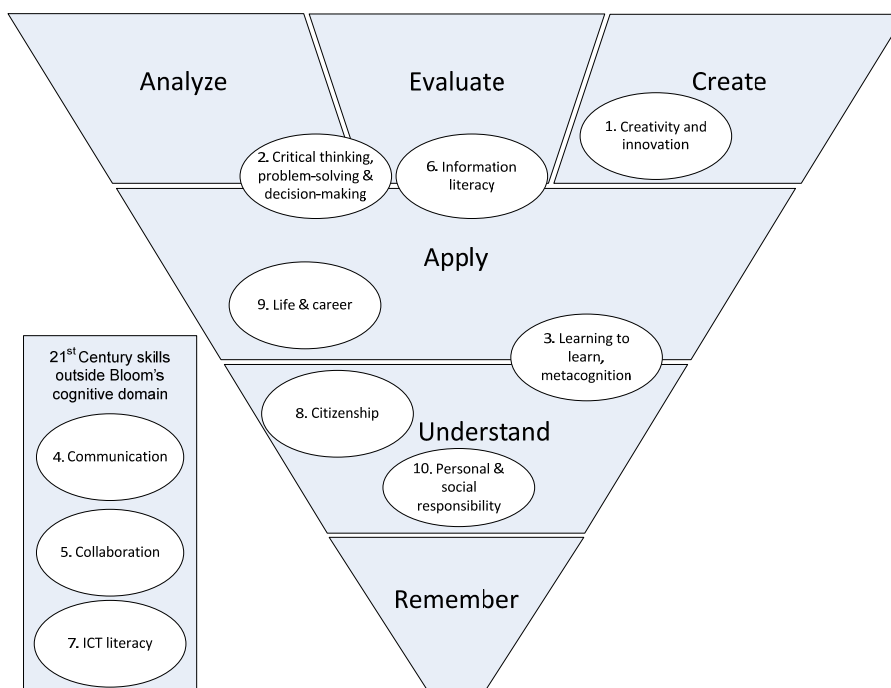## Approaches to developing 21st Century skills
The question of how best to support the development of 21st Century skills in young people is posed frequently. Several diverse solutions have been mooted, which are now discussed in turn.

Subject-based assessments
One view is that the skills now termed '21st Century' skills have long been recognised by educationalists and are nothing new. Whilst a focus on their importance by the media might be novel, it is a consequence of deficits in current education systems, and the skills themselves are ubiquitous. According to Silva (2009), creative, critical and analytical thinking skills have been valued by many philosophers and educators, from Socrates 2400 years ago, to John Dewey in the twentieth century. Puntis (2011) has argued that traditional academic subjects such as mathematics and the sciences can also be reconceptualised in terms of the 21st Century skills they engender - a position shared by the Advisory Committee on Mathematics Education (2011).

Consider the cognitive domain of Bloom *et al.*'s (1956) taxonomy of educational objectives, which comprises six levels: knowledge, comprehension, application, analysis, synthesis/creation, and evaluation. A relatively recent revision of the cognitive domain (Anderson and Krathwohl, 2001) presents the three lowest levels as ordered hierarchically, but the three higher levels as parallel. Figure 1 shows how many of the 21st Century skills identified by ATC21S (Table 1) can be captured by the taxonomy. The exceptions are communication, collaboration, and ICT literacy. While the latter skill could not have existed widely in 1956, communication and collaboration skills certainly did, but were conceptualised more implicitly, as necessary components of the successful usage of other cognitive abilities.

Figure 1: Approximate mapping of 21st Century skills (ATC21S conceptualisation) onto Anderson and Krathwohl's (2001) revised hierarchy of Bloom's cognitive domain

Although the positioning of 21st Century skills in Figure 1 is only approximate, it suggests that they tend to be higher order thinking skills. Arguably, the focus of present day educationalists has drifted up the hierarchy, since many routine tasks are now performed by computers and other machinery. This drift can be perceived as being part of a wider phenomenon of downwards pressure within the educational system, with higher education approaches to pedagogy and curriculum being implemented in secondary schools, and primary education approaches being applied in early years settings.

Skills-centred courses
An alternative view on the optimal development of 21st Century skills is that curricula should be developed to cover them explicitly. Over the past decade, critical thinking, for example, has become a subject in its own right for many sixth-form students in England. According to the website of a major English awarding body offering AS and A level courses in critical thinking: "Critical thinking is a skills-based rather than content-based A Level. It develops the ability to interpret, analyse and evaluate ideas and arguments and can support thinking skills in all subject areas, from arts and humanities to sciences." (OCR, 2013).

The popularity of critical thinking courses has soared over the past decade. While in 2001, just 2000 students sat AS level examinations in critical thinking, by 2009 that figure had risen to 22000 students (Black, 2010). Critical thinking is by no means the only 21st Century skill to be taught as a separate subject. There has been considerable debate in schools and advisory services in England about whether ICT literacy (knowledge, skills and processes) should be developed through teaching ICT as a separate subject or through integrating ICT across the school curriculum (Webb, 2002). In her exploration of the positioning of ICT in the curriculum, Webb (2002) identifies three discrete approaches: (i) learning ICT as a subject; (ii) using ICT as a tool for learning (for example, using word processing software to redraft an essay or running a simulation to test a scientific prediction); and (iii) learning through ICT (situations in which the ICT facility becomes the whole learning environment by providing learning materials and acting as the tutor and assessor).

The relatively new subject Global Perspectives is another skills-based subject in which students acquire skills in, for example, research, presentation, collaboration and analysis while considering different perspectives of global issues. Global Perspectives courses have been developed specifically to engender cross-disciplinary study and acquisition of 21st Century Skills. The assessment of collaboration in the IGCSE Global Perspectives course is considered later in this paper.

Competency-based pedagogy
To encourage the development of multiple 21st Century skills, the Royal Society for the encouragement of Arts, Manufactures and Commerce (RSA) has devised a pedagogical framework called *Opening Minds*. The framework has been created to promote 'innovative and integrated ways of thinking about education and the curriculum' (RSA, 2013). It entails five key competences: citizenship, learning to learn, managing information, relating to people, and managing situations. Teachers use the competences to develop curricula to suit their own schools, and can use whatever content they like. The idea is that they teach *through* the competences, which become the lesson objectives. According to the RSA's *Opening Minds* website, "A competence based approach enables students not just to acquire subject knowledge but to understand, use and apply it within the context of their wider learning and life. It also offers students a more holistic and coherent way of learning which allows them to make connections and apply knowledge across different subject areas." (RSA, 2013)

Extra-curricular activities
Another perspective is that 21ˢᵗ Century skills can be nurtured successfully outside lessons. This longstanding position has been described by Haensly, Lupkowski and Edlind (1985): "Many students seek, and seem to thrive on, activities outside of the traditional classroom setting. Such activities are variously termed the co-curriculum or the extra-curriculum, apparently depending on whether they are specific extensions of academic coursework, or are peripheral to it. Thus, students may extend and enrich previously learned academic skills through competitions (e.g. interscholastic debates) and by applying them to the real world simulations (e.g. writing skills in school publications). In the co/extracurricular setting they may also develop and practice artistic, musical, and psychomotor talents; leadership skills, and future career and occupational skills. Interpersonal and social strategies – proficiencies not considered basic elements of the academic curriculum – may especially be constructed through participation in the extracurriculum." Haensly, Lupkowski and Edlind (1985, p. 110-111)

Workplace skills development
The extent to which 21st Century skills could and should be developed in the workplace in addition to, or instead of, in schools and colleges, is a controversial issue. Apprenticeships, internships, and work experience placements provide young people with rich opportunities to develop the generic and transferable skills desired by members of the Confederation of British Industry.

Reporting on the German dual apprenticeship system, which entails alternation between training in vocational schools and training in firms, researchers (Tremblay and Le Bot, 2003) have commented: "Workplace apprenticeship is the fundamental principle of vocational training in Germany and is thought to combine the most favourable conditions for developing skills." Whilst in Germany, companies provide apprenticeships for social and moral reasons and assume the costs of practical training. Such obligations are arguably felt less strongly by many companies elsewhere. In some sectors within the UK, such as journalism, fashion, and politics, unpaid internships are common. The UK deputy prime minister recently commented (BBC, 2011) that "Skills include the capacity to take on the responsibilities involved in completing tasks, the ability to communicate and work in a team, the ability to think in terms of systems, and the ability of learning to learn."

Independent research projects
In order to improve equity, some schemes and activities have been designed to be flexible enough to function both within and beyond the curriculum. The British Science Association's (2013) Crest awards offer a modern example of how 21ˢᵗ Century skills are being nurtured in this way. The scheme operates at three levels spanning secondary education (11 to 19 years), and awards are given for project work in science, technology, engineering and mathematics (STEM subjects), produced either individually or in teams.

The Crest awards in STEM subjects resemble several more formal educational routes entailing independent project work, which lead to accredited qualifications. These routes include Project Qualifications, which have been developed for students in all subjects at three levels: Foundation (Level 1), Higher (Level 2), and Extended (Level 3). Project Qualifications are administered by several different awarding bodies in England and Wales. At Level 3 (16-19 years) Extended Project Qualifications (EPQs) are usually taken alongside A levels. Students explore a particular interest which may be unrelated to anything else they are studying. They undertake purposeful, cross-curricular study both inside and outside the

classroom. This leads to the composition of a 5000-word dissertation or to a shorter report of 1000 to 3500 words accompanying a project artifact (such as a piece of furniture or a musical performance).

Assessing 21st Century skills

The above approaches to developing 21st Century skills are diverse, each presenting different challenges for those wanting to assess the skills cultivated. Although these challenges (discussed subsequently) may be considerable, there is nonetheless a strong desire for assessment from some quarters. ATC21S, for example, places a strong emphasis on the importance of assessing 21st Century skills. At its launch, the project's director commented: "Reforming assessment is essential to enabling any systemic change in education. And change on a global scale is required to equip students of today with the skills they need to succeed in the workforce of tomorrow….. We all need now to work together to advance assessment practice." (McGaw, 2008) This comment conveys the implicit message that assessing a construct summatively adds meaning and extrinsic value to it for a greater number of people. If a 21st Century skill can be quantified, then measurements of it (that is, assessments and qualifications) can be utilised in application processes for jobs and university places, thereby making them more meritocratic. A further argument in favour of assessment is that it can drive curriculum and pedagogical developments through the washback effect, and for newly defined skill sets, these are often sorely needed.

A common difficulty with the assessment of 21st Century skills is that some skills may be too subjective and enigmatic to be measured objectively. Since creativity, for example, can involve every sense (sight, hearing, touch, smell and taste) and is almost infinite, it defies precise definition. Whilst it may be possible to assess the quality of products of creative (and additional) processes, the skill itself may not be readily assessable. Similarly, Unwin (2010) considers collaboration and initiative-taking to be highly contextual capabilities; they therefore elude comparable quantification.

So – how are 21st Century skills to be assessed? Multiple choice questions, usually associated with questions testing recall and simple application of knowledge, can be used to test higher order skills. Cambridge Assessment's Admissions Testing Service administers a range of assessments for entry to HE, including the BMAT, and various other subject-specific tests, for example, in history, classics, modern languages, maths, physics, English literature. One of its tests is the Thinking Skills Assessment (TSA), a multiple choice test giving 1 mark per question. It has been used by the University of Cambridge as part of its admissions process since 2001 and is also used by Oxford and University College London. In Cambridge, the TSA is used alongside A Levels and a structured interview, as part of the admissions process to particular colleges to study such courses as Natural Sciences, Engineering, Computer Science and Economics. It was found to be a successful predictor of degree outcomes and its use has expanded through the university. Thus it is possible to use a simple assessment type with excellent reliability to assess complex skills with validity. However, writing appropriate item types that differentiate appropriately is an exceptionally difficult and skilled job, requiring significant training and a great deal of experience. This is not an assessment method for wide scale testing of 21st century skills across many students.

The Cambridge International Examinations (Cambridge) (2014) IGCSE Global Perspectives syllabus aims to develop active global citizens who can actively engage with other cultures and have a range of affective skills. Students engage in an individual research project and group work, in which the 21st Century skill of collaboration is assessed. The current

assessment methodology has 5% of the marks for collaboration, awarded by the teacher and moderated by Cambridge. The assessment criteria are generic and the mark scheme is based on levels. The rationale for this assessment methodology is in recognition that the greatest validity in the assessment will be achieved by teacher assessment; the teacher's mark is checked by Cambridge and scaled as necessary, thus providing reassurance on the reliability of the assessment. But the number of marks awarded to this important 21st Century skill, which takes up a good proportion of the students' time on the course, is low. This is partly because generic assessment criteria cannot legitimately be used with a highly granular mark range, and partly because teachers are not trained to identify and assess different types of collaboration styles such as those identified by Belbin (2014).

A better way to assess collaboration might be to sub-divide the skill into different areas for assessment. ATC21S (2014) distinguish two main skill types that make up collaboration; social process skills and cognitive problem-solving skills. The former comprise aspects such as the degree of participation and ability to take perspectives, which may provide a more defined framework for assessment. Intuitively it seems likely that most students will demonstrate a spiky profile of these skills, which raises another issue – should assessments be reported separately so users of qualifications acquire a more defined and useful profile of the student?

Two dilemmas can therefore be seen to be associated with the assessment of 21st Century skills. The first is striking the right balance between validity and reliability, and the second is the granularity of reporting. Technology can be helpful in addressing these issues. At Cambridge an e-learning platform for Global Perspectives schools has been developed which has forum/group facilities. Learners can collaborate within and across teaching groups, wherever in the world that teaching group may be. Students were found to be enthusiastic and participative in this group work, and collaborated to great effect. We can monitor collaboration activities to describe the 'learner journey', those steps taken by the learner to acquire skills and use them, and will use this information to construct a more accurate assessment tool for skills such as collaboration.

Conclusions
In this paper, multiple conceptualisations of 21st Century skills have been outlined. The diversity of usage of the term has been highlighted, as well as the common ground among major organisations. The inter-disciplinary skills most commonly regarded as essential for the 21st Century are problem-solving, ICT operations and concepts, communication, collaboration, and information literacy.

The paper also contains an exploration of the key approaches to developing 21st Century skills currently in use. While some educationalists wish to continue with long-standing teaching methods, others favour the construction and adoption of new pedagogies, curricula and extra-curricular activities, which incur both risks and benefits. Several of the approaches discussed can be used in combination with one another. Assessment is a major consideration for many stakeholders, and opinions are divided over its value and feasibility. A skill such as collaboration can be subdivided into the component skills that together make up collaboration, which may provide a more secure assessment methodology. Assessment of the learner journey is also a key aspect of assessing 21st Century skills and this can best be achieved through technology. For many teachers, incorporating 21st Century skills into the education system entails a fundamental re-orientation in pedagogical approach which is likely to be supported by emerging communities of teaching and assessment practice.

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