

Preface

This book is the second volume in a series dealing with the identification, development, measurement and teaching of 21st century skills. The first volume was an edited collection of white papers that established a conceptual basis for the Assessment and Teaching of 21st Century Skills project. This volume explores the methodologies that underpin the work of a large team of people from six countries in developing and implementing the ideas of the project. The third volume will be a collection of research papers reporting on empirical studies into the reliability, validity and applications of the 21st century skills assessment.

The purpose of this volume is to make transparent the procedures and methodologies, the thinking and strategies, the data and analyses of ATC21S so that readers can understand the application of the theory that went into the project. We also hope that other researchers and measurement specialists will be encouraged to take up any opportunities or challenges raised by our methodology and find ways to improve the process, the products and deliverables. But most of all we hope that these researchers and specialists find ways to help teachers improve student learning in these important 21st century skills.

The idea of formative assessment has been central to the ATC21S project since its inception. The aim has been to inform teaching and ensure that teachers have both the information and the resources to enable them to build and develop 21st century skills among the students they teach. Formative assessment is about informing the teacher. We have used the phrase *informative assessment* at times in order to ensure that the data that are generated in our assessments can be used by teachers to identify student readiness to learn. More importantly, we hope that teachers using the data will change their own practices in ways that accelerate the growth and development of their students. This makes the project different from most other large scale projects which focus on 21st century skills.

The ATC21S project (www.atc21s.org) took as its first aim the definition of 21st century skills, characterising them as skills that are essential for navigating education and the workplace in the current century. A primary characteristic of these skills is that they involve a need for, manipulation of and use of information. The perspective taken by the project was that the identified skills did not need to be new.

Rather, it was argued, 21st century skills are those that must be brought to bear in today's worlds of education and employment in order for individuals to function effectively as students, workers and citizens. Given the recent rapid global changes in technology, certain of these 21st century skills will be new, while others may be traditional skills that need some adaptation for their implementation. Binkley et al. (2012) described recent changes in the knowledge economy under four headings: Ways of Thinking, Ways of Working, Tools for Working, and Living in the World. Collaborative problem solving operates at the intersection of critical thinking, problem solving, communication and collaboration in the framework of the ATC21S project (Griffin et al. 2012). The second area of development, Learning through Digital Networks (LDN-ICT) is introduced in Chap. 3 and will be extensively operationalised in a later volume.

Notwithstanding the process-orientation of these themes, the substance upon which processes are enacted is acknowledged and emphasised in ATC21S through recognition of the need for discipline-based knowledge and understanding. Processes are best learned in application: although the need for skills such as critical thinking and problem solving is often recognised, teaching those skills is often divorced from content. Educational programs need to integrate the development of skills within the learning of content. We use the word “development” deliberately, because we are describing a process that students progress through in a developmental manner via stages of increasing competence. A challenge for the identification, description, assessment and teaching of 21st century skills exists in bringing about acceptance of the concept of new literacies which might inform learning and teaching. In the same way that language literacy and numbers literacy are accepted as requirements for learning and teaching in language and numeracy, ICT skills and problem solving approaches can be viewed as forms of literacy. In the ATC21S project, the development of assessment tasks has rested on the idea that while the skills may be generic, their utility is demonstrated through students developing and using them in their curricular studies.

In the project, 21st century skills were defined as activities where groups execute a number of steps in order to transform a current state into a desired goal state, or to move through cognitive states from analysis of information to hypothesis testing. In defining collaborative problem solving, Hesse, Care, Buder, Sassenberg and Griffin (2015, this volume) describe both social and cognitive components. To solve a problem, it may be that a variety of content knowledge, different strategies, different resources, or different skills are required, and that not all of these are possessed by one individual. When a task has this level of complexity, identification of the problem or of the goal itself may present challenges, both in the way a group of individuals approaches the task and in the choice of processes used by the individuals to solve it. In 2015, the OECD has elected to use interactions between humans and computers (human to computer-agent, or H2A) as a means of educational measurement, whereas Griffin and Care (2015) in the ATC21S project have elected to use interactions between humans (human to human, or H2H) within a technology medium. The effectiveness of these approaches and their validity remains to be resolved. The discussion in this volume does not enter into the debate

about the medium of presentation of the assessment tasks. This volume is about the methodology of the ATC21S project. Further discussion on the medium of task presentation and the roles of agents or scripts in a collaborative environment will be included in Volume 3.

This book and its research project are set in the context of recognition that education is changing. Education needs to prepare students to deal with rapid changes in employment and learning styles. Teachers need to prepare students for jobs that have not yet been created. In the future there will be technologies that have not yet been invented; there will be ways of living and thinking and learning that have not yet emerged. Students will need to leave school and universities with skills, attitudes and values more commensurate with a digital information age. Education is now about the preparation of students for new ways of thinking: ways that involve creativity, critical analysis, problem solving and decision making. Students need to be prepared for new ways of working that will call upon their communication and collaboration skills. They will need to have a familiarity with new tools that include the capacity to recognise and exploit the potential of new technologies. In addition they will need to learn to live in this multifaceted new world as active and responsible global citizens.

The employment that these students are likely to enter will increasingly require critical and expert thinking skills and complex forms of communication. It is for most countries a formidable economic problem to prepare graduates for this new kind of workforce. Those wishing to be highly rewarded in the workforce of the future will need to be expert at interacting with people to acquire information, to understand what that information means, and to persuade others of its implications for action. This is not to say that the foundation skills of numeracy and literacy are becoming irrelevant. New forms of numeracy and new forms of literacy will emerge, but the capacity of an individual to work with numerical data, to access and interpret and use information from a number of sources, will always remain important. Problem solving skills in a technology-rich environment will become increasingly important. So, too, will the capacity to communicate, collaborate and create. As the globalised world becomes more complex and integrated across national boundaries, individuals will need to be able to cross those boundaries to collaborate on shared information and emerging knowledge. The more complex the world becomes, the more individuals will need these skills. The more content can be searched and accessed, the more important the filters and explainers will become – they will need to be able to build problem solutions by identifying components and linking them together in ways that make sense to them and to other people. It is also the case that in the 21st century the idea of fixed employment for 30 or 40 years has disappeared. In the 21st century, students leaving school or university can expect to have 10–15 different jobs in their work life. In order to successfully enter this new workforce, these people will need to have a new breadth and depth of understanding and a capacity to learn and re-learn. They will not be masters of one particular field, but will have the capacity to learn and adapt across many fields in their work life.

For all these reasons, the importance of the ATC21S project cannot be overstated. This book will, we hope, help academics, policymakers and teachers, as

well as parents and industrialists, in adapting their workforce, their graduates, their friends and their associates to work and live more successfully in the new digital world.

The book contains 15 chapters in five parts. Part I deals with the overview of the project. It contains Chap. 1 which provides an overview of the methodology and the nature of the project. The chapter details the method of the project, focusing on the development and calibration of the collaborative problem solving tasks. The method is important because in this project we have undertaken to be transparent in order to enable others to take what we have done and improve on it.

Part II deals with the conceptual nature of the project and the measures it derived. It contains Chaps. 2 and 3. In this part we define the conceptual basis of the 21st century skills that were chosen for development in this project. Chapter 2 presents the conceptual framework for collaborative problem solving and Chap. 3 describes the learning through digital networks construct both conceptually and through some empirical data.

Part III deals with the technical aspects of the development of the assessment tasks for collaborative problem solving. It contains a series of chapters that describe the delivery and interpretive mechanisms employed in the project. This includes the platform that needed to be developed to enable collaborative work to be undertaken on the Internet. This platform is explained in Chap. 5. One of the innovative aspects of the project was the automatic coding and interpreting of log stream data. This is explained and illustrated in Chap. 6. The data from this coding and analysis enabled more sophisticated work with item response modelling to be applied to the data. How this was applied to each of the tasks is explained and documented in Chap. 7.

Part IV deals with fieldwork aspects of the task development process. The chapters in this part discuss the work implemented in the six participating countries. Chapter 8 focuses on the work undertaken in Australia; Chap. 9 on the processes in Singapore; Chap. 10 on Finland; Chap. 11 on USA; Chap. 12 on Costa Rica; and Chap. 13 on the Netherlands. Each takes a slightly different approach and together they illustrate how the same core processes vary across countries according to their different needs and imperatives.

Part V addresses the implications of the project for educational issues that arise in the classroom and at the system level. In Chap. 14 suggestions are made about how the work of the project can be used in the classroom. In Chap. 15 the authors describe procedures that may help jurisdictions and education systems to take this project to scale.

The book is written for a number of audiences. Firstly, measurement people: we hope that our presentation of the measurement procedures introduced and followed in this project will enable others to improve, refine and critique the procedures and the analysis that we have used. Our procedures follow closely the chapter by Wilson et al. in Volume 1. The scoring procedures described in Chap. 6 comprise a very complicated process. It is our wish that others will find a way to simplify this process. The authors of this volume who are members of the University of Melbourne team will also be working in the near future to provide templates and simplified coding and scoring procedures. We hope it will be possible to include these in Volume 3.

A second audience for whom this volume is written comprises policymakers, education ministers, permanent secretaries, classroom teachers and postgraduate students. Finally, the book is about documenting procedures and data. It is about transparency. The debates that have emerged since this project began – debates about the way in which 21st century skills, such as collaborative problem solving, can be presented to students in an assessment format – have not been entered into in this volume. The authors of this volume are unanimous in their view that collaborative work involves people-to-people interaction and that people interacting with a computer does not amount to collaboration.

There are several innovative characteristics of this project and this volume sets out to detail each of them.

1. Most research on teamwork has focused on the outcomes of entire groups. Individual assessments are normally conducted externally, in isolation from the collaborative task. Through this approach it has not been possible to estimate individual group members' skills as demonstrated during the task: there has been a lack of opportunity or process to analyse interactions during the collaborations. The current volume addresses this problem by showing how the collaborative efforts of individuals can be measured.
2. The role of education technology in 21st century assessment enables computers to provide detailed time-stamped data capturing the activities of collaborators. The resulting activity logs provide log stream and chat stream data for modelling and evaluating student activity.
3. The study brings together a focus on assessment in ways that are unusual and seldom implemented. It follows that the ATC21S project has pioneered the H2H approach.
4. The study focuses on the development of problem solving within an inductive-deductive paradigm. The volume explores how this hierarchy is supported within a collaborative context and what implications it has for teaching hypothetico-deductive reasoning skills in two diverse curriculum areas.
5. A great deal of the work reported in this volume has been both pragmatic and conceptual. Discussions regarding the effects of mixed ability collaborations, role allocation and the call for empirical investigations of these issues have given this project an important base. We hope that its challenges will be taken up and that the cutting edge of 21st century assessment will be pushed even further into the future.

References

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Methods and Approach

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