Chapter 14
Linking Developmental Progressions to Teaching

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Abstract This chapter presents an approach to teaching 21st century skills on the basis of results from the assessment tasks described in Chaps. 3 and 4. Teachers' understanding of the skills being assessed and described in the developmental progressions is essential if they are to implement learning and teaching activities in their classrooms across the curriculum. In this chapter the interpretation of three report formats for the formative assessment of 21st century skills is explained in the context of a developmental learning framework. A teaching approach is outlined and examples of teaching and learning sequences are presented. The activities and tasks in the examples are adapted for students at different stages on the progressions, and suggestions are given for targeting teaching and learning to the stages of students on a combination of progressions.

A Developmental Approach to Assessment and Learning

In this section, the basis of a developmental learning approach to using assessment for teaching 21st century skills is outlined. The aim of the approach is to move a student's learning forward along a path or progression of increasingly complex knowledge and capabilities. The focus is on recognition of a student's readiness to learn and the process of building upon the current stage of learning. By contrast, a deficit approach to assessment and teaching focuses on discovering the things that a student cannot do, and teaching is then designed to address those deficits. A developmental approach to learning assumes that there is a typical pathway that describes and maps the progress of a student through stages of increasing knowledge, skills and understanding. In the context of the ATC21S™ Project[1] assessment materials, developmental assessment and learning is based on

[1] The acronym ATC21S™ has been globally trademarked. For purposes of simplicity the acronym is presented throughout the chapter as ATC21S.

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P. Griffin, E. Care (eds.), *Assessment and Teaching of 21st Century Skills*, Educational Assessment in an Information Age,
DOI 10.1007/978-94-017-9395-7_14

aspects of the theory and application of three academics: Lev Vygotsky, Robert Glaser, and Georg Rasch (Griffin 2007).

Lev Vygotsky (1978) proposed the concept of the zone of proximal development (ZPD), which can be thought of as an ideal space in which people learn most effectively. People learn effectively within their ZPD because they have enough prior knowledge to scaffold their learning of more complex skills or information, but not so much as to lead to disengagement because they are being taught concepts or material that are too simple. Vygotsky is also well known for his theory that social interaction plays a fundamental role in children's cognitive development.

The ZPD is defined as the zone between a student's actual developmental stage and the level that is beyond their current capacity when working independently, but not when supported by a more able or knowledgeable person (Vygotsky 1978). Between these two levels is the zone in which the student can succeed on a learning task or activity with the help of an adult or more capable peer. Vygotsky explained that students vary in their actual developmental stage, involving skills they demonstrate independently, as well as in their zone of proximal development – the distance between the actual developmental stage and the potential developmental stage with adult or mentor guidance. In his words:

> The zone of proximal development defines those functions that have not yet matured but are in the process of maturation … These functions could be termed the 'buds' or 'flowers' of development rather than the 'fruits' of development. The actual developmental level characterises mental development retrospectively, while the zone of proximal development characterises mental development prospectively.
>
> Vygotsky 1978, p. 86

One way to apply Vygotsky's insight is to acknowledge that teaching and learning should be informed by students' emerging skills, and seek to strengthen or extend these, rather than focusing on skills and abilities that are already established.

Robert Glaser was a researcher who studied aptitude, testing in education, the use of technology in education, and tailoring instruction to individuals. He introduced the term 'criterion-referenced interpretation' to help us understand assessment data in terms of the skills that the students demonstrate (Glaser 1963). Criterion-referenced interpretation of assessment data describes the performance of an individual as a skill, or set of skills, rather than simply as a number, percentage, or comparison with other students who have completed the same assessment. Student proficiency is mapped to a skill or behaviour criterion (or set of criteria) to give meaning to the set of capabilities a student can demonstrate (Griffin 2007).

Georg Rasch, a Danish mathematician, made an important contribution to psychometrics that has been applied to the measurement of knowledge, abilities, and attitudes. Using latent trait theory (i.e., constructing measures of variables that are not directly observable) and mathematical modelling, Rasch (1960/1980) was able to formally measure the location of student ability and test item difficulty together on a single scale. In the simple Rasch model, the probability of a correct response on a yes/no test question is a function of the student's position on the scale relative to the difficulty of the item. Both the difficulty of test items and the ability of students can be estimated from assessment data using specialised computer programs.

Scale	Students		Test items	Progression levels
6	High ability	x	Difficult items	
5		x		Level 6
		x		
4		x		
		x	11 14 17	
3		xxx	15	
		xxx		
2		xxxx	5 8	Level 5
		xxxxx	2 23 10	
1		xxxx	1 24	
		xxxxxx	13 26	
0		xxxxxxxx	9 12	Level 4
		xxxxxxxx	21	
-1		xxxxxxx	3	
		xxxxxx	7 15 16	Level 3
-2		xxxxxx	19	
		xxxx	2 4 27 28 30	Level 2
-3		xxxx		
		xxx	6 22	
-4		xx		
		xx	20	
-5		x		Level 1
	Low ability		Easy items	
-6		x	18	

Fig. 14.1 Map of the distribution of task difficulty, student abilities, and derived levels of proficiency interpreted from clusters of items of similar difficulty

Where a student's ability and the difficult of a test item are aligned in the estimation, the probability of the student answering that item correctly is 50 %. This modelling can then be used to support the interpretation and empirical validation of levels of increasing competence along a developmental progression (Griffin 2007).

To explain this in a little more detail, the output of a Rasch modelling analysis can be shown as a variable map, an example of which is presented in Fig. 14.1.

The *X*s on the left of the scale represent the position of students on an ability continuum ranging from low to high ability. The numbers on the right of the scale indicate the position of test items along a continuum from low to high difficulty.

Combining the insights of Vygotsky (1978), Glaser (1963) and Rasch (1960/1980), a student's assessment score can be interpreted in terms of performance criteria that are grouped into a stage of competence (Griffin 2007). This information can be used to determine a point of intervention where learning can be scaffolded for a student or group of students. The challenge for educators is to

identify students' emerging skills, the skills located within their ZPD, and provide the right level of support at the right time (Griffin). The implications for teaching and learning practice are that test scores are no longer simply an end-point – a piece of summative information from the past that describes the skills or information students have retained – nor a means of comparing students with each other. Instead, test scores can be interpreted in terms of the skills a student is beginning to develop to provide the starting point for planning instruction (Griffin). So, as can be seen in the example shown in Fig. 14.1, sets of skills with similar levels of difficulty can be grouped into levels along a progression and interpreted in terms of their commonalities. In other words, we can ask ourselves 'What do the skills that cluster at this broad level of difficulty have in common?' Or 'How do the skills at this level along the developmental progression differ from those that are more (or less) difficult?' These questions can help us to understand and interpret what we mean when we talk about the development or unfolding of skills and understanding in a particular area of learning.

Using Developmental Frameworks to Describe and Understand Learning

Many developmental frameworks are general in nature and can be applied to a range of situations. One example familiar to many teachers is Bloom's Taxonomy (Anderson et al. 2001), which provides a classification framework with six stages of increasing competence as shown in Table 14.1.

As an example of the application of Bloom's taxonomy to a practical skill, students who have learned about tagging in social media, twitter or other online contexts may demonstrate increasing stages of competence as shown in Table 14.2.

Students at the lowest stage who create and use tags to follow comments on a topic and post their own comments (Stage 3) are ready to learn to organise tags effectively (Stage 4) and need to be given tasks to help them understand and practise organising tags for a variety of purposes. Students who are able to organise tags

Table 14.1 Summary of the cognitive dimension of Anderson and Krathwohl's revision of Bloom's taxonomy (Anderson et al. 2001)

1 Remembering	Retrieving relevant knowledge from long-term memory.
2 Understanding	Determining the meaning of instructional messages, including oral, written and graphic communication.
3 Applying	Carrying out or using a procedure in a given situation.
4 Analysing	Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.
5 Evaluating	Making judgments based on criteria and standards.
6 Creating	Putting elements together to form a novel, coherent whole or make an original product.

Table 14.2 Example of an application of Bloom's taxonomy

Stage	Example behaviour to demonstrate knowledge of tagging in social media or other online contexts
3 Applying	Creates and uses tags to follow or post comments on a particular topic
4 Analysing	Able to organise tags for a given purpose
5 Evaluating	Comments on the usefulness of tags and optimises effectiveness for a purpose

effectively (Stage 4) are ready to learn to evaluate tags in terms of their purpose and suggest improvements and adjustments (Stage 5). This may involve exploring different perspectives, and looking at ways to organise information and communicate it with awareness of a range of possible perspectives.

In contrast to classification taxonomies, which are commonly drawn from theory, empirical progressions are derived through an analysis of assessment data from large numbers of students. Statistical methods are used to determine the order of acquisition of skills, knowledge or attitudes based on a sample of students, as illustrated in Fig. 14.1 above. Empirical progressions represent a typical pathway for students' development and can therefore be a useful reference for teachers to set goals for their students and to plan tasks designed to engage and challenge them.

Using empirical data and theoretical frameworks, the ATC21S project produced progressions of learning for students. Summary versions of the progressions that describe students' collaborative problem solving skills (Hesse et al. 2015) are presented in Tables 14.3 and 14.4. Drawing from the work of Wilson and Scalise (2015), Tables 14.5, 14.6, 14.7, and 14.8 describe hypothesised progressions of skills linked to learning through digital networks and Table 14.9 shows an overarching progression for these as a skill associated with Information and Communication Technology skill development. This is referred to in this volume as LDN-ICT. In each progression, stages of competence can be identified by a sequence of letters or numbers, or short descriptions that summarise the overall theme for each stage. Examples of each of the progressions and labels are shown below.

Using a Developmental Model to Plan Teaching

Assessment data interpreted within a developmental framework can be used to understand how students progress from one level of competence to the next (Griffin 2007). In this section we will be introducing the assessment reports that can be derived from the ATC21S tasks. These reports can be used by teachers to plan for instruction and to organise their classes, and also by students to review their progress on each of the progressions shown above.

Table 14.3 A progression of cognitive skills for collaborative problem solving

Skill level	Cognitive skills for collaborative problem solving
F	**Refined strategic application**: Students' sequential investigations and systematic behaviour require fewer attempts for success and are completed in an optimal amount of time. The student works with their partner to identify and use only relevant and useful resources. The student has a good understanding of the problem and can reconstruct and/or reorganise the problem in an attempt to find alternative solution paths.
E	**Efficient working**: Students' actions appear to be well thought out, planned and purposeful, identifying the necessary sequence of sub-tasks. They identify cause and effect, base their goals on prior knowledge and use suitable strategies to gain a correct path solution for both simple and complex tasks. The students can modify and adapt their original hypotheses, in light of new information, testing alternative hypotheses and adapting additional or alternative ways of thinking.
D	**Strategic planning and executing**: Students can identify connections and patterns between multiple pieces of information. They are able to simplify the problem, narrow their goal focus and increase co-working by planning strategies with their partner. The students adopt strategic sequential trials and increasingly display systematic exploration. They can successfully complete sub-tasks and simpler tasks.
C	**Sharing and connecting information**: Students recognise the need for more information, realising that they may not have all the required resources, and allocate their own resources to their partner. They attempt to gather as much information as possible and begin connecting pieces of information.
B	**Establishing information**: Students identify possible cause and effect of actions, demonstrate an initial understanding of the task concept and begin testing hypotheses and rules. They limit analysis of the problem, using only resources and information to hand. Student goal setting is limited to generation of broad goals.
A	**Exploration**: Students explore the problem space but exploration is limited to following instructions, adopting a singular approach, and focusing on isolated pieces of information. Trial and error appears random and there is little evidence of understanding the consequences of actions, resulting in a lack of progress through the task.

Report Formats

Reports can be generated on completion of the ATC21S assessment tasks, to place students at levels or stages on progressions of skill and understanding. One of these reports is a *learning readiness report*. An example is provided in Fig. 14.2. This report shows a series of learning stage descriptions in a particular domain – e.g. cognitive skill for collaborative problem solving (Hesse et al. 2015) – arranged from the lowest stage at the bottom to the highest stage at the top. This can be linked to the progression of skills described in Table 14.3.

The learning readiness report summarises the capabilities that a particular student is currently developing in a given domain, and those that the student might be expected to develop next, and thus can be used to identify an appropriate focus for student learning and teaching intervention. It can be used by students as feedback

Table 14.4 A progression of social skills for collaborative problem solving

Skill level	Social skills for collaborative problem solving
F	**Cooperation and shared goals**: Students work collaboratively through the problem solving process and assume group responsibility for the success of the task. Feedback from partners is incorporated and used to identify solution paths or modify incorrect paths. The students can evaluate their own and their partners' performance and understanding of the task. The students may tailor their communication and manage conflicts with partners successfully, resolving differences before proceeding on a possible solution path.
E	**Appreciated and valued partnership**: Students actively participate in scaffolded and unscaffolded environments. The students initiate and promote interaction with their partners and acknowledge and respond to contributions from their partners. Despite efforts, differences in understanding may not be fully resolved. The students are able to comment on their partners' performance during the task.
D	**Mutual commitment**: Students persevere to solve the task as shown by repeated attempts and/or use of multiple strategies. They share resources and information with their partners and modify communication where necessary to improve mutual and common understanding. Students have an awareness of their partner's performance on the task and can comment on their own performance.
C	**Awareness of partnership**: Students become aware of their partner's role in the collaborative problem solving process and recognise the need to engage with their partner. They discuss the task with their partner and make contributions to their partner's understanding. The students report to their partner regarding their own activities on the task.
B	**Supported working**: Students actively participate in the task when it is scaffolded but work largely independently. Communication between partners occurs but is limited to significant events and information necessary to commence the task.
A	**Limited interaction**: Students commence the task independently with limited interaction from partner, mainly prompted by instructions. They may acknowledge communication cues by their partner but have not started to work collaboratively. Most communication occurs at the beginning of tasks and only in those tasks where the instructions are clear.

Table 14.5 An hypothesised progression of LDN-ICT skills as a consumer in networks

Skill level	LDN-ICT literacy: consumer in networks
High	**Discriminating consumer**: Students are able to seek expert knowledge through networks and judge the credibility of sources/people. They filter, organise, manage, evaluate and reorganise information into an integrated and coherent knowledge framework. They select optimal tools for tasks and tailor searches and interactions to their own and their audience's circumstances.
Medium	**Conscious consumer**: Students construct targeted searches, select appropriate tools and strategies, compile information systematically and are aware that credibility of sources is an issue.
Low	**Emerging consumer**: Students perform basic tasks in a network environment, searching for information using common search engines. They have some knowledge of social media tools.

Table 14.6 An hypothesised progression of LDN-ICT skills as a producer in networks

Skill level	LDN-ICT: producer in networks
High	**Creative producer**: Students produce attractive digital products, selecting from multiple technological options and tools to best suit the purpose. They are able to assemble digital products creatively through a process of assembling distributed contributions. Students make use of their understanding of skills in a team to make best use of available expertise.
Medium	**Functional producer**: Students establish networks and communities and organise communication within these networks using appropriate tools and styles. They plan and develop creative and expressive websites, blogs or games, with an awareness of security and ethical and legal issues. Their work is based on established models.
Low	**Emerging producer**: Students produce simple representations of information from templates. They are able to use a computer interface to post an artefact and start an identity.

Table 14.7 An hypothesised progression of LDN-ICT skills in building social capital in an online environment

Skill level	LDN-ICT: developer of social capital
Very high	**Visionary connector**: Students take a cohesive leadership role in building a social enterprise. They reflect on experience in social capital development.
High	**Proficient connector**: Students initiate opportunities for developing social capital through networks. They encourage multiple perspectives and support diversity in networks.
Medium	**Functional connector**: Students are aware of multiple perspectives in online social networks. They contribute to building social capital through a network, and encourage participation and commitment from others.
Low	**Emerging connector**: Students are aware of online social networks, and participate as observers or passive members, or engage actively at a basic level in social enterprises.

Table 14.8 An hypothesised progression of LDN-ICT skills in building intellectual capital in an online environment

Skill level	LDN-ICT: developer of intellectual capital
Very high	**Visionary builder**: Students question existing social media architectures and develop new architectures. They engage in dialogue at the interfaces between social and knowledge building architectures.
High	**Proficient builder**: Students understand and make use of various architectures in social media (tagging, polling, modelling, role playing) to link to knowledge and expertise. They choose optimal tools to locate and access information. They interrogate data for meaning and distinguish between relevant and extraneous information. Students create, share and reframe mental models to build collective knowledge.
Medium	**Functional builder**: Students are aware of multiple perspectives in knowledge organisation. They are able to organise tags thoughtfully. Students understand the mechanics of collecting and assembling data to create a shared representation. They know when to draw on collective intelligence.
Low	**Emerging builder**: Students are able to make tags or post a question online, and have some knowledge of survey tools.

Table 14.9 An hypothesised overarching progression of LDN-ICT skills

Skill level	Overarching LDN-ICT developmental progression
E	Students can successfully navigate the web and efficiently select relevant resources and materials and apply these appropriately to tasks. The students can reflect on their overall performance on tasks. They take an active role in leading their team to successful completion of tasks.
D	Students can distinguish and sort between relevant and irrelevant statements relating to content. They can provide explanations for a change in answer based on partner feedback. They are also able to reflect on their own and their partner's performance. They can create their own materials and incorporate them into existing interfaces.
C	Students generate new ideas relating to content using available tools. They are able to upload appropriate images, audio and word documents correctly. Students can produce an accurate pie chart by analysing data online and in a graph. They can generalise from website content to generate hypotheses and questions relating to content. They can suggest appropriate website addresses with relevant, preferred content.
B	Students can sort information by relevance and select the relevant web link for the current task. They can forage/gather and analyse appropriate information from websites to enable them to answer questions. Students can answer questions on the content of tasks and provide an explanation for a previous answer or action. They can create simple representations of their ideas using available tools.
A	Students are able to use available simple tools, such as drawing tools and icons, to drop and drag and create pictures/landscapes They can copy text from one location and paste into another. They can amend existing content on a page and generate new basic content using available tools. Students can access the resources available to them to search for pieces of information including available web links, although not always those relevant to the current task. They can engage with available help-podcasts when requiring further instructions. The students can follow simple instructions as well as activate content on a page.

on their current skills and understanding in that domain, and to provide information on how to improve their knowledge and performance. It can be used by teachers to support their plans for future learning experiences for students.

The black bar on the report shows the student's stage of learning readiness on the progression. The associated description of the stage outlines the skills that the student is currently ready to learn. The student's estimated stage on the report is not an achievement level but, rather, a point of intervention that teachers can use to make decisions about the best possible learning program for the student and to set goals and intentions for teaching and learning.

The position of the black bar within a stage indicates whether the student is just beginning to develop the skills, consolidating the skills, or moving towards mastery and ready to start a new stage of learning. As students move to the upper half of a stage, it can be helpful to look ahead to the next stage on the progression and to reflect on the sorts of skills and capabilities the student is working towards. With the additional support of scaffolding or modelling, teachers and students can use this information as a way of setting more challenging targets for learning.

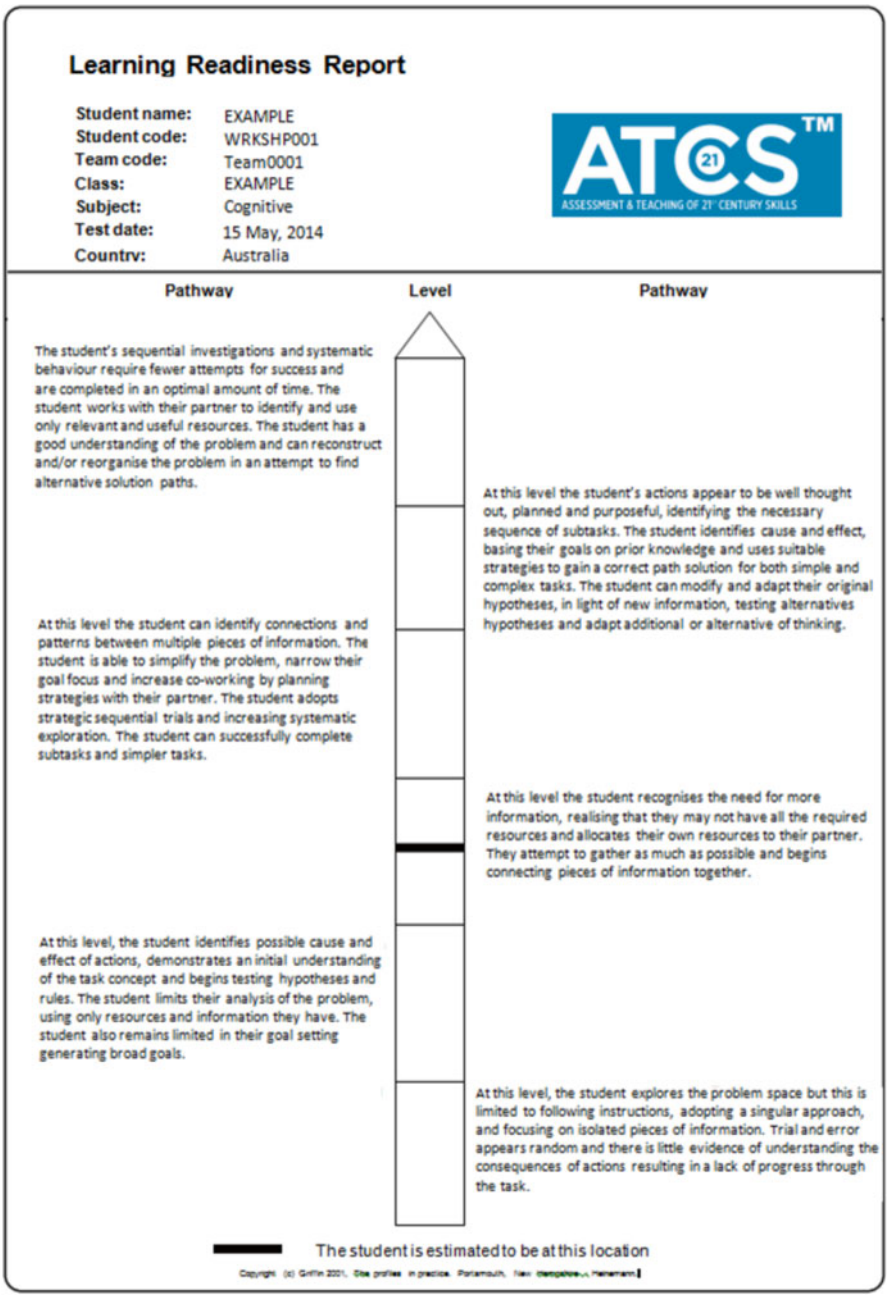


Fig. 14.2 Example of a learning readiness report

Another report that can be generated from the ATC21S tasks is the *student profile report*, which maps an individual student's stage of learning across a number of learning domains (i.e., cognitive and social skills in collaborative problem-solving, and ICT literacy skills). This report, an example of which is shown in Fig. 14.3, is designed to support consideration of a student's individual pattern of strengths and abilities.

There is no expectation that a student will be at the same stage across all learning domains simultaneously; nor is there an expectation that he or she will move through different stages at the same general rate of progress. Indeed, it is quite common for a student to be working at a high overall stage in the social aspects of collaborative problem solving while working at a lower stage in the cognitive aspects. In contrast, some students may have particular strengths in the cognitive aspects of problem solving but struggle to develop the social aspects needed to be a skilful collaborative problem solver.

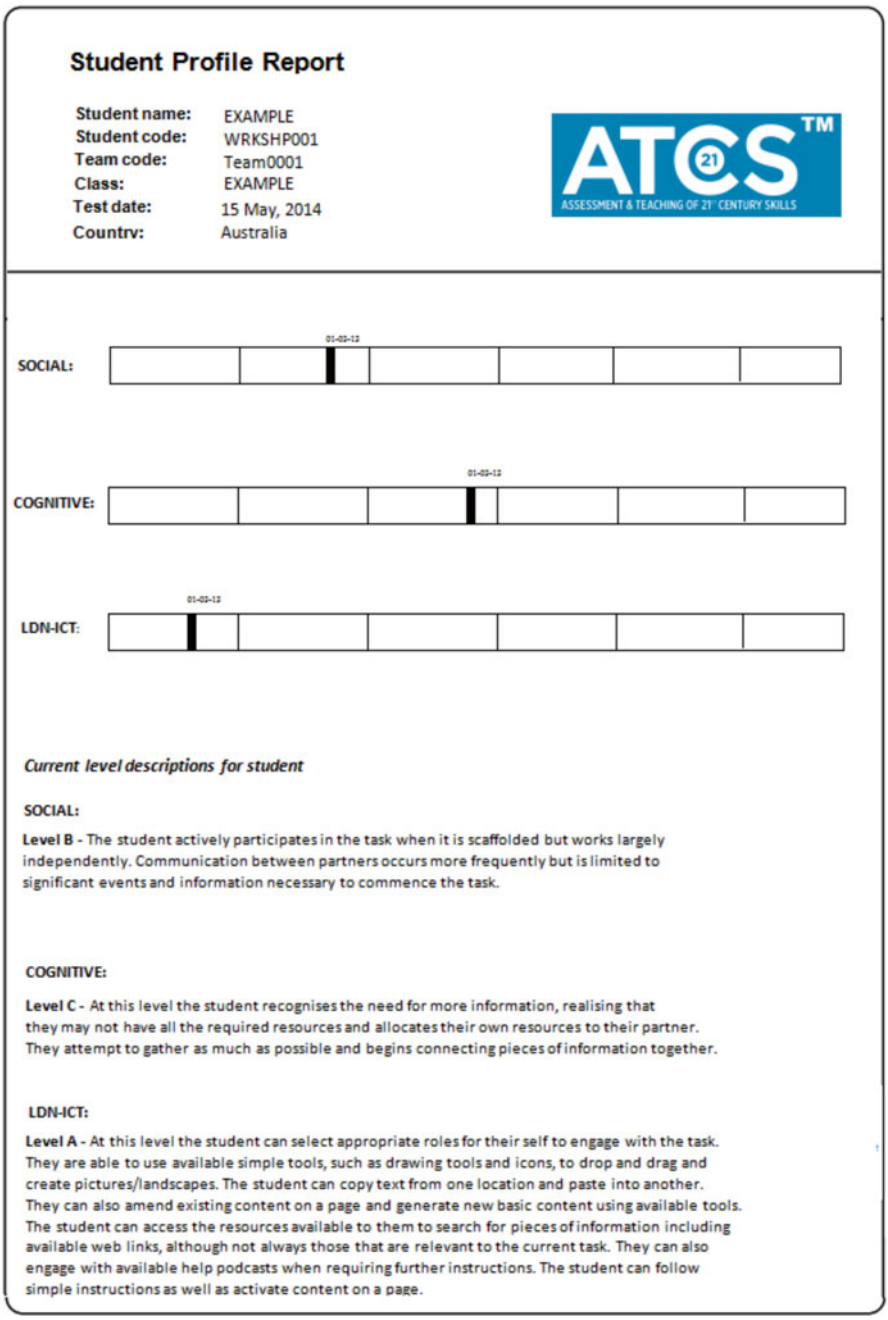
Reviewing Student Progress

Students and teachers can work together or independently to review progress and set targets for future learning. The learning readiness report can be used to confirm understanding of what a student can do with confidence and what they are ready to start learning with scaffolding, modelling, or the support of a more capable other. The profile report can promote understanding of a student's particular pattern of strengths and abilities.

Teachers can use this information combined with other evidence from work samples, classroom observation and other assessments to develop a rich understanding of students' knowledge and skills. This allows teachers to formulate a set of learning intentions that will engage and challenge each student. Through an understanding of students' learning preferences and interests, teaching can be adapted to promote student progress.

In determining learning intentions for students working at the same generalised stage of skill and understanding, it is important to consider both long term and short term goals and plans. Learning intentions should be clear and achievable so students understand what they need to do or demonstrate in order to make progress. Developmental learning progressions are very useful in this process, as they describe the skills and abilities at both the students' current stage and the next stage. Once student learning intentions have been agreed, the next step is to use this information to plan appropriate learning activities. Over time, teachers can build up a bank of successful strategies and learning experiences for students at each developmental stage. Some ideas and examples suggested by teachers are provided in the next section.

As part of the process of planning and reflection, teachers and students may make notes about the evidence of learning that they expect to be able to observe. This will allow for effective review of the goals that are set as well as the teaching



Student Profile Report

Student name:	EXAMPLE
Student code:	WRKSHP001
Team code:	Team0001
Class:	EXAMPLE
Test date:	15 May, 2014
Country:	Australia

ATC21S™ ASSESSMENT & TEACHING OF 21ST CENTURY SKILLS

Current level descriptions for student

SOCIAL:

Level B - The student actively participates in the task when it is scaffolded but works largely independently. Communication between partners occurs more frequently but is limited to significant events and information necessary to commence the task.

COGNITIVE:

Level C - At this level the student recognises the need for more information, realising that they may not have all the required resources and allocates their own resources to their partner. They attempt to gather as much as possible and begins connecting pieces of information together.

LDN-ICT:

Level A - At this level the student can select appropriate roles for their self to engage with the task. They are able to use available simple tools, such as drawing tools and icons, to drop and drag and create pictures/landscapes. The student can copy text from one location and paste into another. They can also amend existing content on a page and generate new basic content using available tools. The student can access the resources available to them to search for pieces of information including available web links, although not always those that are relevant to the current task. They can also engage with available help podcasts when requiring further instructions. The student can follow simple instructions as well as activate content on a page.

Fig. 14.3 Example of a student profile report

strategies. By specifying what to expect in students' classroom behaviour, teachers are able to identify the point at which students have moved to a new stage of understanding and are ready to take on new challenges in their learning.

Generalising Intervention and Differentiating Instruction: Class Reports

Teachers can also refer to a report that plots the current learning readiness of all students in a class and use this to make decisions about ways to organise small-group learning experiences or to foster mentoring by pairing less able students with more able students. Often the same or similar learning intentions can be used for groups or clusters of students who are working at the same generalised stage of proficiency. In many classrooms, teachers can expect to have students working at two, three, four, or even five stages of learning readiness. One way to visually determine groups of students operating at the same stage is to use a *class report*. An example is provided in Fig. 14.4.

The class report can thus be used to help teachers differentiate instruction to best meet the learning needs of students who are working at different stages of understanding or proficiency. Some suggestions for the practice of differentiated instruction are provided in detail below.

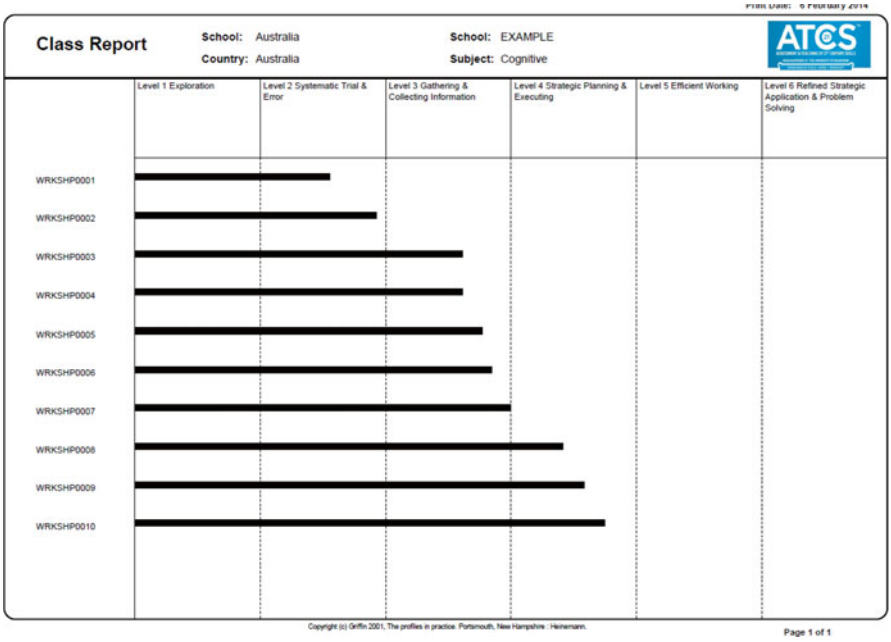


Fig. 14.4 Class report showing students at different stages of skill and understanding

Teaching 21st Century Skills

By definition, 21st century learning tasks can be open-ended, involve unbounded sets of information, and may involve on-going redefinitions of the goal of the task. It is important that students develop skills to establish and adapt goals according to available information, seek out relevant and valid information for the task, and continually monitor their own progress. The teacher's role is to set highly motivating tasks with achievable goals and to provide sufficient structure and scaffolding based on a thorough understanding of the students' interests and needs. The students also set goals and targets for their own learning, and move forward with a clear understanding of the usefulness and application of the new skills and understanding they are developing.

Another approach that fits well with the teaching of 21st century skills is tailored and differentiated instruction. Tomlinson and McTighe (2006) noted that teachers in differentiated classrooms draw upon strategies such as small-group instruction, materials presented at a variety of reading levels, personalised rubrics, learning contracts, a variety of product and task options with common learning goals, and independent studies. Small-group instruction may be particularly helpful in targeting learning tasks, allowing students to shape their own learning goals and to seek out and select materials and information of relevance to the task. The task of teachers is to provide the most effective structure through the establishment of smaller groups based on similar abilities or to provide opportunities for peer mentoring.

Teaching and Learning in Mixed Ability Classrooms

This section provides an example of the way teachers can use student assessment data as a foundation for planning a targeted and differentiated teaching sequence. The assumption is that the example teaching sequence provided here is suitable for delivery across multiple lessons and within a mixed ability class of students. In other words, it is expected that students in the same classroom may be working at any of four, or possibly more, stages of knowledge and understanding in the cognitive and social aspects of collaborative problem solving or the development of social and intellectual capital. Table 14.10 represents this for a hypothetical classroom in which students are spread across four stages of proficiency in each of the cognitive and social aspects of collaborative problem solving.

A teacher may target learning experiences similarly for a group of students to improve their performance on the cognitive aspects of collaborative problem solving, but one or two in the group may benefit from different support or conditions to build their capacity to work with others on the task. The example of a teaching and learning sequence presented below suggests ways that a teacher in a class might differentiate instruction for students working at different stages of cognitive skill while also being mindful of the students' different stages of social skill and understanding. In other words, teachers may need to think about their students' competence across two skill areas simultaneously.

Table 14.10 Illustration of the spread of students across cognitive and social aspects of CPS in a hypothetical class of 20 students

Learning stage	Cognitive stage A	Cognitive stage B	Cognitive stage C	Cognitive stage D
Social stage A	XX	X	–	–
Social stage B	XX	XX	X	X
Social stage C	X	XXX	XX	X
Social stage D	X	X	X	X

Note: Each student in this illustrative table is represented by an X

Application to Teaching and Learning Practice

Taking the empirical information that has been generated through the ATC21S project on the skills identified as crucial for students to learn, it is important to demonstrate in a practical way the feasibility of using this information for the purpose of teaching and learning. If the skills can be assessed but are not teachable, the value of the assessments is questionable to say the least. The remainder of this chapter describes a preliminary process to explore the feasibility of using ATC21S assessments to promote growth in students' skills along empirically derived developmental progressions such as those set out in the progression tables (i.e., Tables 14.3, 14.4, 14.5, 14.6, 14.7, 14.8, and 14.9 above).

This section describes ideas and examples for teaching ATC21S skills that were generated by teachers, ICT coordinators and curriculum specialists working with some of the ATC21S developmental progressions as their guides. The brief provided to these teachers, coordinators and specialists was to design teaching and learning sequences that could be implemented by teachers to best promote learning for students at each stage on the progressions. Two examples are described below, showing how a common theme can be used to design a task that can be differentiated for each stage on the progression.

Example: Collaborative Problem Solving – Cognitive Skills

Teaching and Learning Intention

In this section, a teaching and learning sequence is presented with the purpose of building students' capacity to take a structured approach to planning. This includes:

- identifying information they require but have not been given;
- searching for and collecting information they need;
- organising information they are given together with information they collect;
- following a process to generate ideas, present and discuss them, and finally to decide on a single idea to follow through;
- testing ideas for feasibility relating to a given set of constraints; and
- presenting a plan in sufficient detail to be implemented by another group.

Theme: Planning an excursion. Students are given the task of working in groups to discuss and agree on a plan for an excursion with given time and budget constraints. Student groups present their plans to the class, after which the class can vote and, if practical, decide to go on the most popular excursion. The class should evaluate the plans against other criteria, such as feasibility, clarity and creativity. If the task is not suitable for the school or class context, other ideas for themes can be used and developed in a similar way. Some examples are: planning a school event or a celebration and preparing a presentation on a particular topic.

In the case of an excursion, the plan should include:

- mode of transport;
- itinerary, including schedule of times;
- schedule of costs;
- parent permission forms;
- email to school principal requesting permission; and
- booking requests (e.g. email) for any attractions/museums, and so on, to be visited.

The goal of the activity can be adapted to address a particular topic to be covered in a curriculum or subject area. Some examples are given in Table 14.11.

Differentiation for Each Stage on the Cognitive Skill Progression

To differentiate teaching for students at different stages of skill or understanding, teachers may refer to their general location on a progression such as the one illustrated in Table 14.3 (Hesse et al. 2015). To briefly recap, that progression describes

Table 14.11 Examples of tasks embedded in curriculum subject areas

Subject area	Goal of the excursion
Science Grade 4	Investigation of an ecosystem of a given type, or containing given elements. Students could be expected to create a model of the ecosystem showing all the interactions, and to give examples of evidence of the interaction.
Art Grade 7	Exploration of different styles of painting. Students could be directed to find two typical examples of paintings in each of a given set of styles and explain why they represent the given style. Students could write a description of each painting and include background information on the artist. Some examples of styles that could be explored are:
	Cubist
	Impressionist
	Modernist
	Expressionist
History Grade 8/9	Compilation of biographical information on a particular historical figure with local relevance to the city or country. The biography could be presented in the form of a play, documentary or book.

stages of increasing competence as students move from an exploratory or trial and error approach (Stage A) to an approach based on establishing information (Stage B) to approaches that demonstrate capacity to share and connect information (Stage C) to strategically planned and executed approaches (Stage D) then those based on efficient working (Stage E) and refined strategic application (Stage F). This can be used to develop expectations about the next step for students who are working at different points along a learning continuum.

In the practical example described above, students who are just beginning to develop some initial planning skills will be learning to discuss ways of planning within a group to direct their activity in completing the task. They will be able to think of ideas and test them out through discussion or experimentation, but they require some guidance on taking a more directed approach to understanding the resources they are given or are able to gather.

As students improve their understanding and proficiency, they will begin to select their own methods and tools to structure their planning process. They need to be supported in developing an ability to organise information from different sources, which may not coincide, and to reorganise information in the light of additional or altered information.

For students who have well-developed planning skills, the activity should promote a deeper understanding of generating creative ideas by combining contributions from all members of the group, and understanding the different strengths and abilities within a group. Students should be supported to develop increasing levels of sophistication in targeting communication online and face-to-face in order to:

- search for information;
- encourage contributions from all group members; and
- challenge group members.

The section below presents detailed ideas and targeted strategies for working with students at different stages of proficiency.

For students working at Stage A on the cognitive skills progression, who typically use an exploratory, trial and error approach:

- Present this activity as a closed task by naming a destination with two feasible modes of transport by which it can be reached. Provide instructions in verbal, written and/or pictorial form. Scaffold students' searching and planning by providing two or three websites, a map and a few relevant and irrelevant public transport timetables. Work collaboratively with the group to investigate the resources at their disposal and, if required, to establish some initial rules for deciding which resources are likely to be useful.
- Leave time at the end of the session for students to describe the process they went through, to name one thing they contributed, and one thing each other member of the group contributed.
- Provide a rubric for students to evaluate, against specific criteria, the excursions proposed by the class. This could be done after the students have an opportunity to vote for the idea they like the most, to contrast these two methods of evaluation.

For students working at Stage B on the cognitive skills progression, who are typically identifying possible cause and effect relationships and beginning to test hypotheses and rules:

- Build in an explicit planning stage for students to identify and list the information they need.
- Scaffold the search for modes of transport by explicitly teaching internet searching skills, including ways to restrict searches and evaluate the usefulness of different sources of information.
- Provide a structure for negotiations to select a single idea for an excursion. This could take the form of a set of guiding questions. Each student could present one or two ideas to be typed up in a single document. Direct the students to use a colour coding system to indicate the stage of negotiation of the ideas, for example:
  - Green for proposed ideas
  - Yellow for ideas that have been discussed
  - Blue for ideas that have been agreed upon for final voting
- Allow time for reflection to identify the process they followed, what worked well, and what they could have done differently.
- Ask students to reflect on and describe how the skills they learned in doing the task could be applied to other areas of study or life.
- Conduct a class discussion on how the excursion plans could be evaluated and facilitate agreement on the criteria to be used. Following an evaluation against the agreed criteria, allow students to vote for the excursion they would like to go on.

For students working at Stage C on the cognitive skills progression, who are typically learning to share and connect information:

- Draw up a list of requirements for the excursion, two of which are challenging to satisfy in one excursion (i.e. requirements that are contradictory to each other).
- Specify a planning stage for students to decide on a method for generating and selecting ideas for the destination. Set the task of presenting this plan as a flow chart.
- Ask students to draw a diagram of the solution paths they explored, showing how they worked together to select the options they chose (destination, mode of transport, attractions to visit).
- When students have spent some time attempting to satisfy the 'contradictory' requirements, allow them to select one requirement to exclude from the list, and continue with their planning.
- Allow time for reflection at the end of the task to identify the process they followed, what worked well, and what they could have done differently.
- Ask students to reflect on and describe how the skills they learnt in doing the task could be applied to other areas of study or life.
- Before allowing students to vote on the excursions, conduct a debate with each group arguing for the excursion idea of another group.

For students working at Stage D on the cognitive skills progression, who can typically identify connections between multiple pieces of information and use systematic exploration:

- Set challenging requirements for students to address in the excursion. For example, outline specific information that needs to be collected in relation to a science or history topic. Build a connection to current learning across curriculum areas.
- Allow students to discuss, negotiate and decide on a process for planning the excursion. As part of this process, set the task of researching and selecting appropriate graphic organisers and planning and presentation tools for analysing and presenting the proposed approaches.
- Once they have tabled their ideas for an excursion, but before they have selected the one to present, change some parameters or goals to necessitate a re-planning activity. Guide students to use the same planning tools and graphic organisers to update their planning to accommodate the changes.
- Allow time for reflection to identify the process they followed, what worked well, and what they could have done differently.
- Ask students to reflect on and describe how the skills they learnt in doing the task could be applied to other areas of study or life.

Variations for Students at Different Stages on the Social Skills Progression

Some students show particular strengths in some aspects of complex tasks but are less proficient in other aspects. This is illustrated in Table 14.10, which shows, for example, that students who were working at the first stage on the cognitive skill progression could potentially be working at any one of four different stages of proficiency in the social aspects of collaborative problem solving. Teachers may need to take both of these pieces of information into consideration when planning targeted learning experiences for their students. Variations of teaching strategies, interventions or experiences for students working at different stages on the social skills progression could include those listed below.

For students working at Stage A on the social skills progression, who are typically developing their confidence to participate in collaborative tasks:

- Use small groups or pairs to allow students to become comfortable with the basic skills of collaboration. Allow students to choose partners with whom they are comfortable to work. For example, a *clock buddies*[2] strategy might be used for assigning pairs.
- Before students start the task, explicitly identify one listening skill you would like the students to demonstrate. Describe and model the listening skill. During the task, provide positive feedback when you observe students using the selected listening skill.
- Explicitly identify verbal cues in the context of discussions during the task. Where necessary, guide students through appropriate responses to these direct cues.

[2] Please refer to *Definition of Terms* at the end of the chapter.

For students working at Stage B on the social skills progression, who typically require support and scaffolding to actively participate in a collaborative task:

- Keep the group sizes small and, to promote engagement, start off with a discussion on how the task is relevant for building skills that are necessary and useful in everyday life. Link the goal or topic of the task to previous learning.
- Encourage students to 'have a go'. Discuss the consequences of avoiding risks in the context of group collaboration. Ask students to watch out for their fellow students taking a risk in participating and contributing ideas, and point it out when they do.
- Identify points during discussion where communication is not clearly understood. Ask the student to repeat what he/she said. Ask another student to explain what he/she heard. Provide opportunities for students to try alternative ways of communicating their ideas.
- Explicitly identify non-verbal cues in the context of discussions during the task. Guide students through ways to adapt a response to accommodate non-verbal cues.
- At the end of each session, allow time for reflection, and ask students to identify examples of positive behaviours and approaches displayed by themselves and others in their team.

For students working at Stage C on the social skills progression, who are typically learning to recognise their partner's role in a collaborative task:

- Ask students to each propose one idea, then re-allocate ideas to different students who must try to persuade the group to adopt the idea.
- Provide a different set of resources to individuals or sub-groups to motivate students to collaborate. For example, one group could be given access to various forms of maps, and another could have all the information relating to transport – timetables, route diagrams. They should be instructed to communicate verbally without allowing the other group visual access to their materials.
- Set goals for positive behaviours such as providing encouragement to other group members. Use a *Y chart*[3] to brainstorm how these could be recognised and the impact they could have.
- Identify opportunities for reflection and use a *freeze-frame*[4] strategy for students to discuss what is working or not working, and to identify options to proceed.
- At the end of each session, allow time for reflection and ask students to identify examples of successful strategies and positive behaviours displayed by themselves and others.

For students working at Stage D on the social skills progression, who are typically learning to share resources and information and be aware of their own and their partner's performance on a collaborative task:

[3] Please refer to *Definition of Terms* at the end of the chapter.

[4] Please refer to *Definition of Terms* at the end of the chapter.

- Group size could be increased to create a greater challenge in achieving a positive collaborative dynamic. In order to motivate all students to participate, the group can be given an additional task of evaluating the style and level of contribution of all group members against agreed rubrics. The students could be asked to present a pie chart that they construct jointly, to show individual contributions to the task.
- Further challenge can be provided to students by removing face to face collaboration, allowing online communication only, in the form of emails, shared documents and chats.
- Set goals for putting into practice positive group behaviours such as providing feedback to other group members to improve their contributions. Use a *Y chart*[5] to brainstorm how these behaviours could be recognised and the impact they could have.
- During the task, identify opportunities for reflection and use a *freeze-frame*[6] strategy for students to discuss what is working or not working, and to identify options to proceed.
- At the end of each session, allow time for reflection, and ask students to identify examples of successful strategies and positive behaviours displayed by themselves and others in their team.

Example: Learning in Networks – Building Intellectual Capital

Teaching and Learning Intention

This section presents ideas for teaching and learning sequences designed to develop students' skills in creating and using social media and online resources to generate new knowledge and make it accessible. Based on the work of Wilson and Scalise (2015), the skills to be developed include:

- understanding the use and purpose of tags;
- thoughtful organisation of information;
- interrogating data for meaning;
- understanding the role of social media in providing access to knowledge, sharing knowledge and creating new knowledge;
- finding and consulting experts in an online environment;
- evaluating online information;
- effective presentation of data and knowledge;
- understanding audience and cultural context; and
- creating online products for a purpose.

[5] Please refer to *Definition of Terms* at the end of the chapter.

[6] Please refer to *Definition of Terms* at the end of the chapter.

Theme: Development of a knowledge base. Students are given the task of putting together a website as a representation of a body of current knowledge on a topic. The topic can be entirely determined by the students, or selected from a list of topics as an integral part of a curriculum area. As part of the task, students are expected to use social media to access information, as well as to invite participation in a learning network, to organise information for their purpose, and to create new knowledge using multiple sources and experts.

Differentiation for Stages on the Skill Progression

The section below presents the task in different forms to suit each of the four stages on the progression of skills in building intellectual capital. The stages of proficiency progress from emerging builders, who have some knowledge of interacting online to organise information, to functional builders who have a broader perspective on how knowledge can be organised as well as an ability to collate and represent knowledge. The next stage in the progression describes proficient builders, who are able to employ social media in their purpose of seeking out relevant information to build collective knowledge. As students build their proficiency, they progress to becoming visionary builders who are able to take a leadership role in designing social media and shaping architectures for building collective knowledge.

For emergent builders:

- Provide a list of three or four topics for students to choose from for the creation of a knowledge base. Use topics related to those being covered in class, for example in science, cultural studies, or history.
- Small groups or pairs can be used for students to support one another in the use of unfamiliar technologies. There are likely to be many opportunities for peer coaching by students with particular technological skills.
- To establish preliminary skills on tagging, present a collection of tags and ask students to classify them according to different purposes such as:
    - to make a point;
    - to unify people with a common cause;
    - to collect information;
    - to promote ease of finding information;
    - to guide readers or audience; or
    - to engage interest.
- Set up different contexts for students to create their own tags and use them for the various purposes listed above, then allow students to apply this skill to the topic for the website they are developing.
- Ask students to brainstorm phrases for tags on each topic chosen by the students and then group information into tags. Keep these on display on a ‘twitter wall’ for the duration of the project. Allow students to add ‘tweets’ and reorganise tags on the wall.

For functional builders:

- In order to build awareness of presenting information in an appropriate way for an audience, discuss a variety of social media sites and set students the task of identifying the target audience.
- As a group task, ask students to identify the top three social media sites, given a set of criteria, such as age group, purpose or risk. This will involve students searching for and interpreting reviews.
- Ask students to identify the audience for whom they are building their knowledge website, and explore what that means for the way they present information.
- Set a sub-task for students to design a survey to find out about an aspect of their topic. Provide an example of a survey tool and ask students to find at least one more tool, explain which one is better for their task and provide reasons.

For proficient builders:

- Demonstrate basic use of Web 2.0 as a data visualisation tool, and allow students to present an aspect of their topic using Web 2.0.
- Present a variety of websites with contradicting viewpoints (e.g., website on moon landing, believers/sceptics regarding alien life) and conduct a discussion on how to evaluate the credibility of the websites.
- Jointly develop a set of criteria for evaluation that students can apply to the sources of information for their topics.
- Ask students to survey a population on an aspect of their topic, and post results on their websites. Discuss sources of bias that could result from the population surveyed. Show an example of a change in results when the survey population is changed.

For visionary builders:

- Start off with a session on creativity and brainstorming for students to select topics for a strategic purpose, for example, a commercially viable project, or a campaign for a social or environmental cause.
- Provide resources such as websites or tools that are of limited use. Allow inventions to be driven by necessity to promote creativity.

Variations for Students at Different Stages on Other Skills Progressions

Earlier in this chapter, adaptations or variations were suggested to cater for the range of levels of social skills in collaborative problem solving observed for a particular class of students, but the cognitive skills remained the primary focus of the learning goal. In a similar way, these suggestions can be used and adapted to suit the tasks designed to teach the building of intellectual capital and other aspects of ICT literacy skills. Once teachers become familiar with students' patterns of strengths from the profile reports (see Fig. 14.3), they can look at how to overlay multiple strategies or adjustments that address the learning needs of individual students on more than one skill domain to promote learning simultaneously on multiple progressions.

Summary

This chapter has outlined a framework for using assessments to inform the teaching of skills that were identified in the ATC21S project. The assessments are used to pinpoint a proficiency level on the empirically derived progressions for social and cognitive collaborative problem solving skills, as consumers and producers in networks, and for building social and intellectual capital in the context of ICT literacy. An understanding of each of these domains and the levels on the corresponding progressions can give teachers a starting point to understand the zone of proximal development (Vygotsky 1978) for their students – in other words, to identify which skills their students are ready to learn and should be able to develop with scaffolding from more capable others and opportunities to practise their skills. This knowledge can be developed into teaching plans and strategies to be used in the classroom, as demonstrated by the examples given in this chapter. The next step in establishing the feasibility of the approach outlined in this chapter is to evaluate the effectiveness of teaching strategies developed in this way, by checking student progress through assessments over time.

Definition of Terms

Freeze-Frame

During a group discussion there may be opportunities to re-focus the discussion or deal with conflict by instructing students to 'freeze' the discussion so that the situation can be analysed in more depth. Alternative responses or actions can be created with the benefit of time for thought. Prompts can be given such as:

'What led to this situation?'
'What were you planning to say?'
'What response do you think that would lead to?'
'What other possibilities are there?'
'How would a different question or action change the discussion?'

Y Chart

A Y Chart is a visual form of presenting ideas on how to recognise or understand the characteristics of a particular behaviour or situation. Students usually create their own Y Charts (Fig. 14.5) through brainstorming what the behaviour or situation 'looks like', 'feels like' and 'sounds like'. It helps to focus attention on observable characteristics that students can use to identify these behaviours or situations.

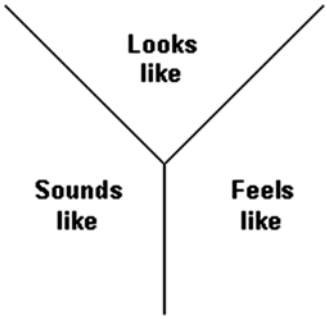


Fig. 14.5 Framework for Y-Chart brainstorming

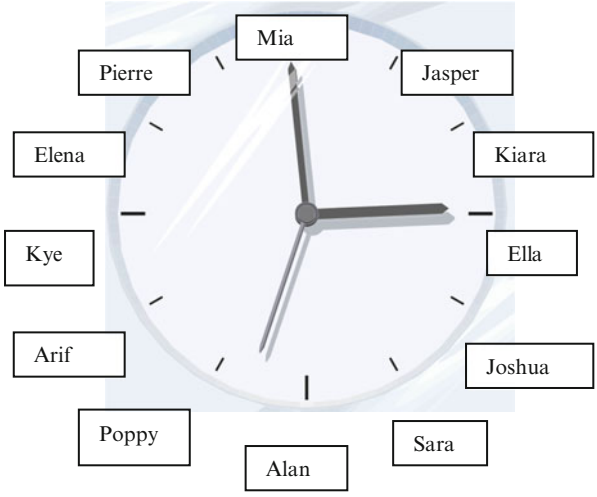


Fig. 14.6 Format for clock buddies exercise

Clock Buddies Strategy

Clock buddies (Fig. 14.6) provides a quick way of pairing students. Each student is given a clock with a space for a name beside each hour on the clock. The students are then given the task of finding a different partner for each hour on the clock and to fill in the names in the appropriate spaces, and ensure their name is in the same space on the partner's clock. The teacher can then direct the students to use their 7 o'clock buddy for a task, for example.

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