

A LITERATURE REVIEW ABOUT ONE OF THE SUCCESSFUL SKILLS OF THE 21ST CENTURY: COLLABORATIVE ABILITY STUDENT

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Abstract: One of the most crucial abilities for students to cultivate is the capacity to engage in collaborative endeavours. Despite the growing interest in collaboration as a skill required of students, the context of collaboration itself remains unclear. The objective of this literature review is to examine the conceptualisations, definitions and understandings of collaboration as presented in the research literature. Collaboration can be defined as a process whereby members of a group interact with one another in order to fulfil their roles and to solve problems or achieve goals collectively. In order to achieve this, it is essential that responsibility is shared. The most frequently employed indicators are those identified by Trilling and Fadel, namely cooperation, flexibility, responsibility, compromise and communication. It is incumbent upon educators to consider how the design of assessment tasks can be modified to encourage all students in a group to participate, share thoughts, gather resources and ideas, manage tasks, manage time and communicate effectively.

Keywords: Collaborative, 21st Century, Cooperation.

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Introduction

We are now in the 21st century, which is bringing about fundamental changes in various aspects of life.¹ In this century, everyone is expected to have good thinking skills and social attitudes. Similarly, in the world of education, education integrates knowledge, skills, attitudes and mastery of technology and information.² In this century, students are required to master skills. In this context, Voogt and Roblin have proposed 12 skills that students need to master in the information age, called “21st century skills”.³ These skills are grouped into three main categories: learning skills, literacy skills and life skills (also known as 3L). It is the first category, learning skills, that will be the main focus. Educators and students recognise that learning skills consist of the 4Cs, namely critical thinking, creativity, collaboration and communication.⁴

One of the most important skills for students to have and develop is the ability to collaborate. In fact, collaboration has long been known in the world of education as a learning approach. Currently, educators are beginning to experience a paradigm shift that collaboration is not only an approach, but also an important skill, and not just a means of teaching and assessing academics. Although there is a growing interest in collaboration as a skill required by students, collaboration itself is still conceptually unclear. Although the literature has provided many definitions and ways of operationalising collaboration, the question remains: What is collaboration and how can collaboration be taught and assessed in schools? The purpose of this literature review is to explore the conceptualisations, definitions

¹ Silfia Ilma et al., “Students Collaboration Skills in Science Learning,” *Proceedings of the 2nd International Conference on Innovation in Education and Pedagogy (ICIEP 2020)* 619, no. Iciep 2020 (2022): 204–8, <https://doi.org/10.2991/assehr.k.211219.037>.

² Elmawati Elmawati and Dadang Juandi, “Mathematical Critical Thinking Ability In Indonesia: Systematic Literature Review (SLR),” *Symmetry: Pasundan Journal of Research in Mathematics Learning and Education* 7, no. 2 (2022): 210–21, <https://doi.org/10.23969/symmetry.v7i2.6426>.

³ Joke Voogt et al., “21 St Century Skills Discussion Paper,” 2010.

⁴ Elmawati and Juandi, “Mathematical Critical Thinking Ability In Indonesia: Systematic Literature Review (SLR)””; Asri Fauzi et al., “Implementasi Case Method (Pembelajaran Berbasis Pemecahan Kasus)” 9, no. 3 (2022): 809–17; Ilma et al., “Students Collaboration Skills in Science Learning”; Rina Dwi Setyawati et al., “Improving Mathematical Critical Thinking Skill through STEM-PJBL: A Systematic Literature Review,” *International Journal on Research in STEM Education* 4, no. 2 (2022): 1–17, <https://doi.org/10.31098/ijrse.v4i2.1141>.

and understandings of collaboration in the research literature. Important initial questions include What is collaboration? What indicators are used to measure collaboration? And how can collaborative skills be measured?

The method used is a literature review using descriptive analysis. Data were obtained from research articles that used collaborative capabilities in the period 2010 to 2022 and theoretical references relevant to the cases or problems found. This review is based on a number of empirical and conceptual articles on collaborative capabilities. The research findings in these articles were then analysed to identify collaborative skills at all levels of education. The data search was carried out using the Scopus database, which was accessed using the keywords “collaborative skills”, “collaborative abilities” and “collaborative skills”, and 25 documents were found in the initial search.

Collaboration, a Conceptual Perspective

Collaboration has many meanings, there is no agreement on what collaboration is, although it was stated that collaboration means providing opportunities for students to work together.⁵ Group work is often a simple division of labour or a ‘free-rider’ experience, where students share tasks and rely on the most competent group members to move the group product forward.⁶ In contrast, collaboration actually requires different social and cognitive processes.

Collaboration is seen as a skill expressed by Child and Shaw, Mercer, Zillmer and Kuhn.⁷ Collaboration as a means of improving

⁵ Andrew J. Rotherham and Daniel T Willingham, “Ej889143,” *American Educator* 34, no. 1 (2010): 17–20.

⁶ Gavriel Salomon and Tamar Globerson, “When Teams Do Not Function the Way They Ought To,” *International Journal of Educational Research* 13, no. 1 (1989): 89–99, [https://doi.org/10.1016/0883-0355\(89\)90018-9](https://doi.org/10.1016/0883-0355(89)90018-9).

⁷ Silmon Child and Stuart Shaw, “Collaboration in the 21st Century: Implications for Assessment,” *A Cambridge Assessment Publication*, no. 22 (2016): 17–22; Gary W. Ladd et al., “Grade-School Children’s Social Collaborative Skills: Links With Partner Preference and Achievement,” *American Educational Research Journal* 51, no. 1 (2014): 152–83, <https://doi.org/10.3102/0002831213507327>; Neil Mercer, “The Quality of Talk in Children’s Collaborative Activity in the Classroom,” *Learning and Instruction* 6, no. 4 (1996): 359–77, [https://doi.org/10.1016/S0959-4752\(96\)00021-7](https://doi.org/10.1016/S0959-4752(96)00021-7); Nicole Zillmer and Deanna Kuhn, “Do Similar-Ability Peers Regulate One Another in a Collaborative Discourse Activity?,” *Cognitive Development* 45, no. July 2017 (2018): 68–76, <https://doi.org/10.1016/j.cogdev.2017.12.002>.

students' mastery of content knowledge and other key cognitive skills such as critical thinking and problem solving.⁸ In this view, students work in groups to support more effective learning of academic knowledge and skills. There are also those who interpret collaboration as a process or outcome of teamwork, as expressed by French et al, Zhuang et al, Zillmer and Kuhn, and Cleeton.⁹ It is therefore important to clarify whether collaboration is seen as a means to an end where collaboration is the desired outcome (collaboration as an outcome) or, conversely, whether collaboration is seen as an end in itself (collaboration as a process).

The research literature on collaboration reflects both views, although historically the dominant paradigm has been the first: collaboration as a means to enhance students' acquisition of important cognitive skills such as critical thinking and problem solving.¹⁰ In this view, students work in groups to support more effective learning of academic knowledge and skills. The teacher then assesses whether the intellectual outcomes have been achieved by the individual or by the group.

Collaboration as an outcome implies that the end product in terms of the content and productivity of the group takes precedence over the means to achieve the end.¹¹ Collaboration as an outcome focuses on the quality of the product provided by the student or group to draw conclusions about content learning. Therefore, it is better to distribute work among group members for independent

⁸ Deanna Kuhn, "Thinking Together and Alone," *Educational Researcher* 44, no. 1 (2015): 46–53, <https://doi.org/10.3102/0013189X15569530>.

⁹ Brian French et al, "An Investigation of the Psychometric Properties of a Measure of Teamwork among High School Students," *Psychological Test and Assessment Modeling* 58, no. 3 (2016): 455; Xiaohua Zhuang et al., "Development and Validity Evidence Supporting a Teamwork and Collaboration Assessment for High School Students," *ETS Research Report Series* 2008, no. 2 (2008): i–51, <https://doi.org/10.1002/j.2333-8504.2008.tb02136.x>; Zillmer and Kuhn, "Do Similar-Ability Peers Regulate One Another in a Collaborative Discourse Activity?"; Glen U. Cleeton, "Education for Life and Work," in *Making Work Human* (Yellow Springs, OH, US: Antioch Press Publishers, 1949), 144–68, <https://doi.org/10.1037/13246-007>.

¹⁰ Kuhn, "Thinking Together and Alone."

¹¹ Child and Shaw, "Collaboration in the 21st Century: Implications for Assessment."

completion than to rely on the work of high achievers (or other undesirable learning practices).¹²

On the other hand, collaborating is also seen as a necessary skill for working and living in society, and is associated with 21st century skills.¹³ Here students work in groups to improve their ability to work together. Therefore, the focus of this learning is on the quality of interaction between students. Of course, increased knowledge and academic skills are also a result of collaborative activities, but they are not the focus of collaborative learning. Instead, the focus is on the nature and quality of collaborative activities and interactions between group members/learners. Collaboration as a process focuses on the quality of interactions between learners.

In several literatures, it is stated that to be able to collaborate, students need knowledge, skills, and cognitive and social dispositions to create high-quality interactions between students.¹⁴ Collaboration involves social interdependence, communication, negotiation, reflection and task management. Social interdependence requires certain types of interactions to be fostered within groups.

Johnson and Johnson¹⁵ clarify three ways students can interact with each other, which can be seen in the table below:

Table 1. Types of Interactions Between Students

Promotive Interaction: Collaborative	Oppositional Interaction: Competitive	No interaction: Individualistic
Individuals believe that they can achieve their goals only if other individuals are in the same situation	Individuals believe that they can achieve their goals only if other individuals in the situation fail to achieve their goals.	Individuals believe that achieving their goals is not related to what other individuals would do in the same situation.

From the table above it is known that:

1. Students believe that they are together, because they can achieve their goals only if other students in the group also achieve their goals (promotive interaction: collaborative);

¹² Brigid Barron, “When Smart Groups Fail,” *Journal of the Learning Sciences* 12, no. 3 (2003): 307–59, https://doi.org/10.1207/S15327809JLS1203_1.

¹³ Kuhn, “Thinking Together and Alone.”

¹⁴ Child and Shaw, “Collaboration in the 21st Century: Implications for Assessment.”; Pierre Dillenbourg, “What Do You Mean by ‘ Collaborative Learning?’” 1, no. March (2014).

¹⁵ Carla Evans, “Measuring Student Success Skills: A Review of The Literature on Collaboration,” *Center For Assessment*, 2020, 1–18.

2. Students believe that they can achieve their goals only if other Students in the group fail to achieve their goals (oppositional interactions: competitive); And
3. Students believe that achieving their goals is not related to what other students in the group do (no interaction: individualistic).

The more social interdependence there is in a collaborative learning activity or project, the more facilitative interactions will occur. Individualistic interactions between students in groups are more likely to occur when learning activities or tasks require a simple division of labour.

Collaboration differs from cooperation in terms of student interaction.¹⁶ In cooperative learning activities, students usually share the work, complete the task individually and then collect their respective contributions. Therefore, cooperatives do not require collaboration or facilitative interactions. This does not mean that division of labour cannot take place in cooperative learning activities; coordination of group thinking and work processes still takes place within the cooperative.¹⁷ In contrast to individuals working alone, cooperative learning can produce better group performance outcomes because the division of labour allows more to be achieved. On the other hand, cooperative learning (or poorly designed collaborative learning activities) can lead to more ‘free riding’ or ‘social loafing’ behaviour, where individuals do not contribute equally to group goals.¹⁸ This often frustrates students working in groups.

As mentioned above, there are many definitions of collaboration in the research literature. Most are general, but some are specific to collaborative problem solving, as one of the contexts in which collaboration can occur.¹⁹ Below are several definitions of collaboration according to experts.

¹⁶ Dillenbourg, “What Do You Mean by ‘ Collaborative Learning ?’”

¹⁷ Ibid.

¹⁸ Barron, “When Smart Groups Fail”; Salomon and Globerson, “When Teams Do Not Function the Way They Ought To”; David A. Sears and James Michael Reagin, “Individual versus Collaborative Problem Solving: Divergent Outcomes Depending on Task Complexity,” *Instructional Science* 41, no. 6 (November 1, 2013): 1153–72, <https://doi.org/10.1007/s11251-013-9271-8>.

¹⁹ OECD, “Pisa 2015 Collaborative Problem-Solving Framework,” 2017; OECD, “What Students Know and Can Do,” *PISA 2009 at a Glance I* (2019), <https://doi.org/10.1787/g222d18af-en>.

1. "Collaboration occurs when the achievement of a goal requires more than any one person can accomplish alone, and therefore requires the pooling of resources with others".²⁰
2. "Collaborative problem solving is a joint activity in which two or more people work together, contributing resources that they alone control, to progress through a series of cognitive states involving the collection and analysis of information and the formulation of a hypothesis that they jointly decide to test".²¹
3. "Collaboration is an individual's capacity to work with other people in a process that requires interdependence to solve a problem, achieve a goal, or complete a task".²²
4. "Collaborative problem solving competence is the ability of an individual to engage effectively in a process in which two or more agents attempt to solve a problem by sharing the understanding and effort required to arrive at a solution and by pooling their knowledge, skills and efforts to achieve that solution".²³
5. "Collaboration can be thought of as communication plus additional competencies related to conflict resolution, decision making, problem solving, and negotiation".²⁴
6. "Collaboration is a skill that invites students to actively contribute by working together and interacting during learning so that learning is easier to understand".²⁵
7. "Collaboration skills are the ability to exchange thoughts or ideas and feelings between students at the same level".²⁶

²⁰ Esther Care, Claire Scoular, and Patrick Griffin, "Assessment of Collaborative Problem Solving in Education Environments" 7347, no. July (2016), <https://doi.org/10.1080/08957347.2016.1209204>.

²¹ P. Griffin and E. Care, "A Framework for Teachable Collaborative Problem Solving Skills," 2015.

²² Sarah Lench and Ross Crosby Anderson, "Essential Skills and Dispositions: Developmental Frameworks for Collaboration, Creativity, and Self-Direction," *Emotion*, no. October (2015): 1–19.

²³ OECD, "What Students Know and Can Do"; OECD, "Pisa 2015 Collaborative Problem-Solving Framework."

²⁴ Jim Soland, Laura S. Hamilton, and Brian M. Stecher, "Measuring 21st Century Competencies: Guidance for Educators," *Asia Society Global Cities Education Network Report*, no. November (2013): 68.

²⁵ Junita Junita and Krisma Widi Wardani, "Efektivitas Model Pembelajaran STAD dan CIRC Terhadap Peningkatan Keterampilan Kolaborasi Siswa Kelas V SD Gugus Joko Tingkir Pada Mata Pelajaran Tematik," *JPDI (Jurnal Pendidikan Dasar Indonesia)* 5, no. 1 (2020): 11, <https://doi.org/10.26737/jpdi.v5i1.1688>.

8. "Collaboration is the ability to participate in any activity to build relationships with other people, respect each other's relationships and teamwork to achieve the same goal".²⁷
9. "Collaboration skills are the skills to work together effectively and show respect for diverse teams, practice fluency, and the willingness to make decisions necessary to achieve common goals".²⁸

According to the definitions above, collaboration is when in a group there is interaction between members, working together to provide the best role and working together to solve problems or achieve goals. To achieve this goal, there needs to be shared responsibility. Apart from that, it can also be seen that there are several fundamental aspects that differentiate collaboration from other collaborative activities, namely as follows.

1. Two or more pupils working together
2. Active participation in joint activities, e.g. solving problems, completing tasks, designing products, etc.
3. Combining the knowledge, skills and efforts of all members of the group.

²⁶ Maharani Lelasari, Punaji Setyosari, and Saida Ulfa, "Pemanfaatan Social Learning Network Dalam Mendukung Keterampilan Kolaborasi Siswa," *Prosiding TEP & PDS*, 2017, 167–72.

²⁷ Hilna Putria, Luthfi Hamdani Maula, and Din Azwar Uswatun, "Analisis Proses Pembelajaran Dalam Jaringan (DARING) Masa Pandemi Covid- 19 Pada Guru Sekolah Dasar," *Jurnal Basicedu* 4, no. 4 (2020), <https://doi.org/10.31004/basicedu.v4i4.460>; K. A. Sari, Z. K. Prasetyo, and S. W. Widodo, "Pengembangan Lembar Kerja Peserta Didik IPA Berbasis Model Project Based Learning Untuk Meningkatkan Keterampilan Kolaborasi Dan Komunikasi Peserta Didik Kelas VII," *Jurnal Pendidikan Matematika Dan Sains*, no. April (2017): 5–24; Monica Feronica Bormasa, "Pengaruh Peran Pemerintah Desa Terhadap Pemberdayaan Masyarakat," *Cerdika: Jurnal Ilmiah Indonesia* 1, no. 3 (March 25, 2021): 255–66, <https://doi.org/10.36418/cerdika.v1i3.48>; Ha Le, Jeroen Janssen, and Theo Wubbels, "Collaborative Learning Practices: Teacher and Student Perceived Obstacles to Effective Student Collaboration," *Cambridge Journal of Education* 48, no. 1 (2018): 103–22, <https://doi.org/10.1080/0305764X.2016.1259389>.

²⁸ Yokhebed Yokhebed, "Profil Kompetensi Abad 21: Komunikasi, Kreativitas, Kolaborasi, Berpikir Kritis Pada Calon Guru Biologi Profile of 21st Century Competency: Communication, Creativity, Collaboration, Critical Thinking at Prospective Biology Teachers," *Bio-Pedagogi* 8, no. 2 (2019): 94, <https://doi.org/10.20961/bio-pedagogi.v8i2.36154>.

Genuine collaborative activity implies an authentic context and also encourages students to pool their knowledge and skills and to work interdependently rather than in parallel and individualistically. The challenge in creating collaborative structures is to develop ways to increase opportunities for facilitative interactions or collaborative activities.

Dillenbourg²⁹ notes that simply placing students in collaborative learning groups does not necessarily produce interactions that are expected to trigger learning mechanisms (e.g. induction, deduction, compilation) or cognitive mechanisms (e.g. knowledge generation, internalisation, reduction of cognitive load). To increase the likelihood of collaboration as defined above,³⁰ it is suggested that teaching and assessment focus on four interrelated factors: the type of interaction (negotiation, conflict resolution), the situational requirements for more/less collaboration (interdependence, interactivity), the impact of collaboration on individual and group products (e.g. improved learning, reasoning, justification, explanation and final product quality) and the cognitive processes activated (e.g. perspective taking, argumentation, justification, explanation, analysis). These four markers of collaborative learning require the teacher to (a) carefully prepare the initial conditions, (b) assign students specific roles or tasks in the group, (c) provide productive interactions by including interaction rules, and (d) monitor and organise the interaction.

In addition, collaboration is a means of achieving the goal of increasing students' content knowledge so that common measures of academic achievement can be used. However, when teaching and assessing collaborative processes, we need to consider the extent to which the collaborative actions or behaviours of interest can be observed or reported. These collaborative skills include:

1. Planning and making group decisions
Making group decisions about how best to manage and complete a task or project, working with the group to assign roles or tasks, using negotiation or conflict resolution skills needed to plan and make group decisions.
2. Communicate thoughts with the group
Seeking clarity in others' thinking, respectfully expressing how the thinking makes sense or is lacking in some way, seeking

²⁹ Dillenbourg, "What Do You Mean by ' Collaborative Learning '?"

³⁰ Ibid.

- alternative perspectives and input from all group members, elaborating on others' explanations.
3. Contribute resources, ideas, and efforts and support group member.
Contributes ideas, effort and resources; supports group members as required, taking responsibility for tasks and quality of work; provides feedback on the work of others.
 4. Monitor, reflect, and adapt individual and group processes to benefit the group
Reflects on individual and group progress and processes, works with the team to adapt group efforts to achieve goals, adapts individual and/or group processes to benefit the group, asks group members about progress.

Collaboration Skills Indicators

Table 2. Several indicators of collaboration skills

Indicators	Related Framework
1. Interpersonal communication	Pearson P21
2. Negotiation or conflict resolution	
3. Task management/team regulation. ³¹	
1. Self-awareness	Essential Skill and Dispositions
2. Communication	
3. Negotiation and Decision Making	
4. Contribute and support	
5. Monitoring and adaptation ³²	
1. Build and maintain shared understanding	PISA
2. Take appropriate action to resolve the problem	
3. Build and maintain a team organization. ³³	
1. Demonstrate the ability to collaborate effectively and respectfully with diverse teams	P21
2. Train flexibility and independence to assist in making decisions necessary to achieve common goals	
3. Assume shared responsibility for shared work and	

³¹ Emily R Lai, "Collaboration " A Literature Review," *Pearson*, no. June (2011): 1–49; Em Ily, R Lai, and Michaela Viering, "Assessing 21st Century Skills: Integrating Research Findings National," no. April (2012).

³² Lench and Anderson, "Essential Skills and Dispositions: Developmental Frameworks for Collaboration, Creativity, and Self-Direction."

³³ OECD, "Pisa 2015 Collaborative Problem-Solving Framework."

value the individual contributions made by each team member. ³⁴	
<ol style="list-style-type: none"> 1. Task-related process skills (problem solving, decision making, task planning and coordination, strategy formulation, coordination, goal setting, performance management) 2. Cooperation with other people (adaptability and interpersonal skills) 3. Influence team members through support and encouragement (building self-confidence, social support) 4. Resolving conflicts or disagreements between team members through negotiation strategies (conflict resolution and communication) 5. Mentorship with other team members (leadership, and helping other members).³⁵ 	ETS Collaborative Problem Solving
<p>Collaboration as a process that focuses on the quality of student interactions</p> <p>Social Maintenance</p> <ol style="list-style-type: none"> 1. Social interdependence 2. Communication 3. Cooperation/division of work <p>Socio cognitive</p> <ol style="list-style-type: none"> 1. Share resources 2. Introduction of new ideas 3. Conflict resolution <p>Collaboration as a result of focusing on the quality of participants or output/product groups</p> <p>Cognitive change/learning</p> <ol style="list-style-type: none"> 1. Achieved through a collaborative process 2. Before and after students' knowledge/understanding <p>Product</p> <ol style="list-style-type: none"> 1. Solution to the assigned problem.³⁶ 	Cambridge Assessment
Collaboration and teamwork are ways of working that	
ATC 21S	

³⁴ Partnership for 21st Century Learning, "Framework for 21st Century Learning," *P21 Partnership for 21st Century Learning*, 2007, 2.

³⁵ Zhuang et al., "Development and Validity Evidence Supporting a Teamwork and Collaboration Assessment for High School Students."

³⁶ Child and Shaw, "Collaboration in the 21st Century: Implications for Assessment.," Simon F.J. Child and Stuart Shaw, "Towards an Operational Framework for Establishing and Assessing Collaborative Interactions," *Research Papers in Education* 34, no. 3 (2019): 276–97, <https://doi.org/10.1080/02671522.2018.1424928>.

consist of knowledge, skills, attitudes/values/ethics with four sub-skills:

1. Interact effectively with other people
2. Work effectively in diverse teams
3. Manage projects
4. Guide and lead others to be responsible to others.³⁷

-
1. Collaboration
 2. Flexibility
 3. Responsibility
 4. Compromise
 5. Communication.³⁸

The main dimensions of collaboration include:

ATC 21S

1. Social interdependence
2. Interpersonal skills
3. Processes related to tasks

Specifically, collaboration includes knowledge, skills, and attitudes, such as:

1. Interact effectively with others and have meaningful conversations;
 2. Knowing when is the right time to listen or speak (social regulation);
 3. Work effectively in diverse teams (conflict resolution and team management)
 4. Introducing new ideas and sharing resources;
 5. Exercise flexibility and a willingness to assist in making the compromises necessary to achieve common goals;
 6. Bearing shared responsibility for teamwork;
 7. Perspective taking
 8. Appreciate the individual contributions made by each team member.³⁹
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The most commonly used indicators are those identified by Trilling and Fadeln, namely cooperation, flexibility, responsibility, compromise and communication.

³⁷ Patrick Griffin, Barry McGaw, and Esther Care, *Assessment and Teaching of 21st Century Skills, Assessment and Teaching of 21st Century Skills*, vol. 9789400723, 2012, <https://doi.org/10.1007/978-94-007-2324-5>.

³⁸ Bernie Trilling and Charles Fadel, *21st Century Skills- Learning for Life in Our Times, Journal of Sustainable Development Education and Research*, vol. 2, 2009.

³⁹ Care, Scoular, and Griffin, "Assessment of Collaborative Problem Solving in Education Environments."

Measurement of Collaborative Skill

There are at least five categories of collaborative assessment types: (a) self-report or peer report, (b) global rating scale, (c) standardised assessment, (d) observational measures, and (e) performance assessment.⁴⁰

Table 3. Types of Collaborative Assessment with Brief Descriptions and Some Benefits/Challenges from a Measurement Perspective

Assessment Type	Description	Benefits	Challenges
Self- or peer-Reports	Student self- and/or peer-report (survey, questionnaire, assessment or reflection)	Easy and cost effective to administer; could improve group processes, motivation, and engagement	Response set biases such as Social desirability bias; susceptible to coaching and faking. ⁴¹
Global rating scales	Completed by teachers; asked to rate students collaboration skills	Provide reliable scoring across students by any one teacher	Time consuming difficult for teachers to observe and rate all students in their class(es); halo effects; lack of consistent interpretation possible across teachers. ⁴²

⁴⁰ Joshua Cox, Brandon Foster, and David Bamat, “A Review of Instruments for Measuring Social and Emotional Learning Skills among Secondary School Students In Collaboration with the Social and Emotional Learning Research Alliance,” no. October (2019); Thomas R. Dye, *Understanding Public Policy*, ed. Stephanie Chaisson, Fourteenth (United State: Pearson Education, 2013); Ily, Lai, and Viering, “Assessing 21st Century Skills: I Ntegrat Ing Research Findings National.”

⁴¹ French et al., “An Investigation of the Psychometric Properties of a Measure of Teamwork among High School Students”; Leeann M. Lower, Tarkington J. Newman, and Dawn Anderson-Butcher, “Validity and Reliability of the Teamwork Scale for Youth,” *Research on Social Work Practice* 27, no. 6 (October 1, 2017): 716–25, <https://doi.org/10.1177/1049731515589614>; Bram De Wever et al., “Assessing Collaboration in a Wiki: The Reliability of University Students’ Peer Assessment,” *The Internet and Higher Education* 14, no. 4 (September 1, 2011): 201–6, <https://doi.org/10.1016/j.iheeduc.2011.07.003>; Todd R. Kelley et al., “Creating a 21st Century Skills Survey Instrument for High School Students,” *American Journal of Educational Research* 7, no. 8 (September 28, 2019): 583–90, <https://doi.org/10.12691/education-7-8-7>.

Standardized assessments	Selected and/or constructed response items, situational judgment tests, computer simulations	Use in large-scale educational applications; provide reliable measures for individuals or groups	Tasks may not mirror authentic scenarios; susceptible to social desirability bias, coaching and faking, and confounding variables (e.g., verbal or reading ability). ⁴³
Observational measures	Teacher observation of type of talk happening in groups	Based on actual student behaviors (verbal/nonverbal); related to enacted curriculum	Labor intense: not feasible for large-scale testing. ⁴⁴
Performance assessments	Application of knowledge and	Authentic and more meaningful	Cost; concerns about reliable

⁴² French et al., “An Investigation of the Psychometric Properties of a Measure of Teamwork among High School Students”; Zhuang et al., “Development and Validity Evidence Supporting a Teamwork and Collaboration Assessment for High School Students.”

⁴³ Care, Scoular, and Griffin, “Assessment of Collaborative Problem Solving in Education Environments”; Jiangang Hao et al., “Initial Steps Towards a Standardized Assessment for Collaborative Problem Solving (CPS): Practical Challenges and Strategies,” in *Innovative Assessment of Collaboration*, ed. Alina A. von Davier, Mengxiao Zhu, and Patrick C. Kyllonen, Methodology of Educational Measurement and Assessment (Cham: Springer International Publishing, 2017), 135–56, https://doi.org/10.1007/978-3-319-33261-1_9; Alina A. von Davier et al., “Interdisciplinary Research Agenda in Support of Assessment of Collaborative Problem Solving: Lessons Learned from Developing a Collaborative Science Assessment Prototype,” *Computers in Human Behavior* 76 (November 1, 2017): 631–40, <https://doi.org/10.1016/j.chb.2017.04.059>; Jiangang Hao et al., “Psychometric Considerations and a General Scoring Strategy for Assessments of Collaborative Problem Solving,” *ETS Research Report Series* 2019, no. 1 (2019): 1–17, <https://doi.org/10.1002/ets2.12276>.

⁴⁴ Mercer, “The Quality of Talk in Children’s Collaborative Activity in the Classroom”; Merce Garcia-Mila et al., “The Effect of Argumentative Task Goal on the Quality of Argumentative Discourse,” *Science Education* 97, no. 4 (2013): 497–523, <https://doi.org/10.1002/sce.21057>; Sylvia Rojas-Drummond and Neil Mercer, “Scaffolding the Development of Effective Collaboration and Learning,” *International Journal of Educational Research* 39, no. 1 (January 1, 2003): 99–111, [https://doi.org/10.1016/S0883-0355\(03\)00075-2](https://doi.org/10.1016/S0883-0355(03)00075-2); Carla van Boxtel, Jos van der Linden, and Gellof Kanselaar, “Collaborative Learning Tasks and the Elaboration of Conceptual Knowledge,” *Learning and Instruction* 10, no. 4 (August 1, 2000): 311–30, [https://doi.org/10.1016/S0959-4752\(00\)00002-5](https://doi.org/10.1016/S0959-4752(00)00002-5).

skills to a new or novel situation	and engaging for students	scoring and generalizability of student scores (task by occasion by student interactions). ⁴⁵
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These types of collaborative assessment range from less to more standardised, and the level of standardisation is related to the intended use of the assessment information. For example, less standardised types of assessment, such as self-reports or peer reports, are primarily intended for formative use in the classroom or for research. In contrast, standardised assessments (e.g. situational judgement tests, computer simulations) are primarily intended for large-scale summative assessment.

There are pedagogical, practical and technical considerations when selecting (or designing) measures of 21st century skills.⁴⁶ Instructional considerations relate to the use of assessment information. For example, is the measure intended to be used formatively or summatively? Is it intended to provide actionable information for teachers or useful feedback for learners? Is the assessment appropriate to the level, context or culture? Practical considerations relate to cost and ease of administration, delivery and scoring. Technical considerations focus on validity, reliability and fairness. What educators want from the assessment results will influence which instruments are used.⁴⁷ In developing the test instrument to be used, the following considerations are usually made.

1. define the targeted construct;
2. create a task to get the desired response;
3. choose the item type;

⁴⁵ Lynn S. Fuchs et al., “Mathematics Performance Assessment in the Classroom: Effects on Teacher Planning and Student Problem Solving,” *American Educational Research Journal* 36, no. 3 (January 1, 1999): 609–46, <https://doi.org/10.3102/00028312036003609>; Marlene Scardamalia et al., “New Assessments and Environments for Knowledge Building,” in *Assessment and Teaching of 21st Century Skills*, ed. Patrick Griffin, Barry McGaw, and Esther Care (Dordrecht: Springer Netherlands, 2012), 231–300, https://doi.org/10.1007/978-94-007-2324-5_5.

⁴⁶ Soland, Hamilton, and Stecher, “Measuring 21st Century Competencies: Guidance for Educators.”

⁴⁷ Mark Wilson et al., *Perspectives on Methodological Issues, Assessment and Teaching of 21st Century Skills*, vol. 9789400723, 2012, <https://doi.org/10.1007/978-94-007-2324-5>.

4. consider various administrative issues;
5. determine the value, code, or score that will be given to the student's response;
6. pilot the assessment, using a large and diverse sample of students;
7. model and analyze responses, taking into account technical issues such as validity, reliability, and fairness of the test.⁴⁸

The development of a valid collaborative assessment is based on the meaning and operationalisation of the collaborative construct and the purpose and use of the assessment information.⁴⁹ In most educational settings, teachers want to assess what each learner knows and can do in relation to the process of collaboration and the outcomes of collaboration (not just what the group can do). However, collaboration takes place in a group context, which can obscure individual contributions.⁵⁰ Furthermore, if the aim is to assess students' sophistication in collaborating, is it necessary to observe students actually collaborating in a group context, or is it sufficient to see whether students can correctly answer questions about effective collaboration?

If the aim is to measure collaboration as a process, then assessments should be designed to collect evidence of the quality of students' interactions rather than the quality or quantity of group products.⁵¹ However, if the aim is to measure collaboration as an outcome, then the group process mentioned by Webb⁵² above may actually slow the group down, and the most efficient way to produce a high quality end product is to have students share the work. The most efficient way to produce a high quality final product is to have students share the work, complete the work independently and rely on the high achievers to carry the load of the group. In this way, free-riding may actually help groups to maximise the quality of the final product, even if it is not considered a best practice for improving student learning.⁵³

⁴⁸ Evans, "Measuring Student Success Skills: A Review of The Literature on Collaboration."

⁴⁹ Wilson et al., *Perspectives on Methodological Issues*.

⁵⁰ Lai, "Collaboration " A Literature Review."

⁵¹ Ibid.

⁵² Noreen M. Webb et al., "Equity Issues in Collaborative Group Assessment: Group Composition and Performance," *American Educational Research Journal* 35, no. 4 (1998): 607, <https://doi.org/10.2307/1163461>.

⁵³ Ibid.

Conclusion

Collaboration is often touted as a critical skill for students to succeed in 21st century work and life. However, the term remains conceptually vague and requires careful definition of the construct, as well as greater clarity of its components, so that educators can teach students essential collaborative skills and provide meaningful, actionable feedback on their progress. collaboration over time. Collaboration can be seen as the process or the outcome of joint activity, although the former is usually more in line with how these skills are being used in the 21st century skills movement. Collaborative skills are both generic and content/context specific, as collaborative skills themselves do not tend to vary across content areas. However, the content/context in which collaborative activities take place can have a significant impact on students' ability to transfer their skills.

Assessing 21st century skills such as collaboration is challenging. Educators should consider how the design of assessment tasks encourages all students in a group to participate, share thoughts, gather resources and ideas, manage tasks, organise teams and communicate effectively. What could potentially conflict with instructional goals is the creation of collaborative rubrics for scoring and grading students. Given the lack of empirical evidence on how students should develop competence in collaborative domains at the end of a given time period (end of class, end of semester, end of 12th grade), we recommend creating a continuous collaborative plan to delineate student performance from less to more advanced using common markers of collaborative processes from the research literature.

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