

Collaboration in the 21st century: Implications for assessment

Simon Child Research Division and **Stuart Shaw** Cambridge International Examinations

Background

In recent years, there has been an increasing focus on conceptualising and defining so-called *21st century skills*. The literature on 21st century skills includes a number of frameworks for categorising the skills and knowledge required for participation in the workplace and in society (Lai & Viering, 2012). These frameworks have been motivated by observed changes in how students (and others) have to apply and demonstrate their acquired knowledge; using advanced technologies within multicultural societies in an age of increasing economic competition (Suto, 2013). Examples include the Partnership for 21st Century Learning (P21®), Assessment and Teaching of 21st Century Skills (ATC21S) and the National Research Council (NRC).

Whilst definitions of 21st century skills differ in terms of the placement of individual skills within their frameworks (Silva, 2009), there is a degree of consensus established with regards to skill identification. Skills include creativity and innovation, critical thinking, problem solving, metacognition, information and ICT literacy, citizenship, communication, and collaboration (see Suto, 2013, for an overview). Recently, these skills have been linked to future economic prosperity for individuals and nations, as they provide key qualities required to succeed in the global skills race (see Development Economics, 2015; P21, 2008).

Given the current status of 21st century skills, there is an increased motivation to develop modes of assessment that allow students to demonstrate their abilities in these domains. As Shute and Becker (2010) note:

We need to re-think assessment, identify new skills and standards relevant for the twenty-first century, and then determine how to best assess students' acquisition of the new competencies... Moreover, the envisioned new competencies should include not only cognitive variables (e.g., critical thinking, reasoning skills) but also non-cognitive variables (e.g., teamwork, tolerance, tenacity) as the basis for new assessments to support learning. (p.3)

The appropriate assessment of 21st century skills is also important as it provides value and motivation to students, and can help structure pedagogical approaches (e.g., Swan, Shen, & Hiltz, 2006). However, any assessment has to resolve tensions related to its validity, reliability, comparability and delivery. Satisfactory construct definition for the purposes of assessment has always been considered an essential principle in testing. If these constructs are not well defined, then it is difficult to support the claims awarding bodies make about the usefulness of their assessments. Awarding bodies are challenged with the task of articulating how their assessments represent the target construct, how potential contaminating factors related to the assessment are controlled, and how the assessment achieves a desired level of reliability. This is challenging for 21st century skills due to the potential for subjectivity in the assessment process (Suto, 2013).

The status of collaboration in the 21st century

The focus of this article is the skill of collaboration. Collaboration has recently been identified as an important educational outcome in its own right, rather than just a means to develop or assess knowledge, which is learned through engagement and practice (Kuhn, 2015; Lai, 2011). Collaboration has been described as a skill that encourages learning mechanisms (such as induction, deduction and associative learning) to be enacted (Dillenbourg, 1999; Hunter, 2006).

The NRC (2011) outlined several justifications for collaboration's status as a key 21st century skill. First, there is a growing emphasis on project and enquiry-based learning. This is motivated by research that shows that collaboration has influential effects on student learning and knowledge retention (Fall, Webb, & Chudowsky, 1997; Rojas-Drummond & Mercer, 2003; Saner, McCaffrey, Stecher, & Bell, 1994; Webb, 1993). It is claimed that collaboration has distinct advantages over individual problem solving because it allows for: an effective division of labour; the incorporation of information from multiple sources of knowledge, perspectives, and experiences; and enhanced creativity and quality of solutions stimulated by ideas of other group members (Organisation for Economic Co-operation and Development [OECD], 2013). Similarly, collaboration has also been found to increase students' social competency (e.g., conflict resolution skills and use of helping behaviours) and academic self-concept (Ginsburg-Block, Rohrbeck, & Fantuzzo, 2006).

Secondly, there is an increasing need for students to be able to apply their knowledge and problem-solving skills in social settings (OECD, 2013). Organisations, faced with the need to innovate, use collaboration to combine the potential and expertise of their employees (Knoll, Plumbaum, Hoffmann, & De Luca, 2010). This is linked to recent advancements in technology, which have opened up new opportunities for how collaboration can be enacted (Salas, Cooke, & Rosen, 2008). The application of social technologies by individuals and across organisations has become a legitimate mode of enquiry (Blaskovich, 2008), and this ability has been regarded as important for the workforce of the future (OECD, 2013).

The stated importance of collaboration means that appropriately defining its construct remains an important aim. The main issue here is that the notion of collaboration, although almost universally accepted as being useful for application in the classroom and beyond, is conceptually vague (Brna, 1998). Different frameworks of 21st century skills place collaboration as either a *learning skill* (P21, 2015), an *interpersonal skill* (NRC, 2011) or a *way of working* (ATC21S, 2015). These frameworks have different conceptualisations of collaboration as a construct, and in terms of its interaction with other skills (Lai & Viering, 2012).

Aims of the article

When assessing collaboration, there is a need for a clear understanding of what is being tested, based on a theoretically-sound and agreed upon definition. In light of this important issue, this article has two main intentions. First we aim to provide an overview of how collaboration is conceptualised, and how it is distinguished from other related group activities (e.g., cooperation). Integral to this aim is the ambition to develop a coherent understanding of the abilities underlying the targeted construct.

The second aim is to discuss how the conceptualisations of collaboration underpin the development of appropriate methods of assessment. Specifically, we explore how the task given to students can potentially optimise the opportunities for collaboration to occur amongst group members. We also consider how different conceptualisations of collaboration are currently assessed, and the issues raised in the development of large-scale assessment.

Defining the construct of collaboration

The basic facets of what constitutes a collaborative activity are reasonably well rehearsed in the literature. Academics who have attempted to delineate collaboration from other related activities have articulated three fundamental aspects to collaborative learning. These three aspects are expressed in the definition provided by the OECD (2013):

*Collaborative problem solving competency is the capacity of an individual to effectively engage in a process whereby **two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills and efforts to reach that solution.** (p.6) [emphasis added]*

Each of the three emphasised aspects are important factors in the maintenance of collaborative activity. For a collaborative 'state' to be constructed (Brna, 1998) there has to be a task where the achievement of

the goal requires more than one person to pool resources. This view is shared by Roschelle and Teasley (1995), who broadly define collaboration as a "coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem" (p.70), and Dillenbourg (1999) who defines collaboration as "a situation in which two or more people learn or attempt to learn something together" (p.1). The sharing of roles and responsibilities during collaboration closely relates to the concept of the 'joint problem space' (or JPS, Roschelle & Teasley, 1995). The JPS implies that group members enter into a social contract with the joint aim of achieving a desirable outcome. In this sense, group members enter into a collaborative 'state' (Brna, 1998) that has to be effectively maintained until the problem is solved, or the outcome is reached.

There is an important distinction to be made here between collaboration as it has been defined above, and *cooperation*. These terms have often been used synonymously when referring to group-related activities (Lai & Viering, 2012) yet have important conceptual differences. Cooperation is typically a *division of labour* among group members, but can also be part of a process of allowing information to be accessed amongst group members. It occurs when a task is divided up into individually manageable subparts, which are subsequently constructed into a final outcome. To cooperate in this way, group members do not need to maintain a mutual understanding of the task goals, as individuals simply focus on their subtasks. It can also encourage asymmetric individual contributions towards the task goal. Collaboration, on the other hand, contains inherent flexibility of roles and responsibilities with regards to the various subtasks in achieving a goal (Lai, 2011).

Another key distinction is between collaboration as *process* and collaboration as *outcomes*. The collaborative 'state' is related to *process*. This broadly relates to how well the collaborative state is maintained and progressed. We have identified six fundamental facets of the collaborative process in Figure 1.

On the other hand collaboration as *outcome* implies that the final product takes precedence over the means to achieve the goal.



Figure 1: The six facets of the collaborative process

This approach assumes that the task itself has encouraged collaborative processes to be enacted, and that the task is sufficiently complex that collaboration is required for its successful completion. The separation of process (i.e., how well the collaborative state is maintained and progressed) from *outcome* (i.e., the final product following a period of collaboration) is a key distinction that emerges from the literature, and has implications for how collaboration is optimally assessed. This is discussed in the next section.

Implications for the assessment of collaboration

The complexity of collaboration as a construct leads to two main challenges for assessors. First, they must create the working conditions necessary for collaboration to be engendered and encouraged. Secondly, they must be able to pinpoint aspects of an individual's behaviours within a group task, so that a judgement can be made about that individual's general capacities for collaboration. These issues are intimately related, with aspects related to collaboration formulation constraining (or optimising) the possibilities for assessment. The approach to assessment (e.g., the distribution of individual or group marks) can also influence the potential for collaboration to be engendered.

Here we first explore how the task given to candidates can be optimised so that collaborative processes can be observed. We then consider the modes of observation available to assessors interested in either the collaborative process or outcomes.

Pre-task

It is important to note that collaboration among group members is not an automatic outcome of setting a task with a shared goal (Kreijens, Kirschner, & Jochems, 2003). Indeed, there are significant barriers to collaboration taking place at all. For example, in some cases, group members may value achieving a quick consensus above the potential difficulties that can be encountered when introducing new ideas or negotiating contrasting positions. This 'rapid' consensus may be of detriment to the eventual outcome (e.g., Janis, 1982; Rimor, Rosen, & Naser, 2010).

Collaborative success is therefore dependent on establishing optimal group dynamics. Key aspects include the development of a sense of community among individual group members, setting up relationships among group members so that they all have the opportunity to perform the same range of actions, and an equality of status of individuals. Dillenbourg (1999) refers to symmetry on three planes, all of which are required for collaboration to occur:

1. **Symmetry of action:** The same range of actions is allowed to each group member.
2. **Symmetry of knowledge:** The group members have a similar level of expertise (but different viewpoints on the task).
3. **Symmetry of status:** Individual group members have a similar status with respect to other group members.

Whilst these points of symmetry refer to collaboration in numerous (although not all) contexts, it has some important implications for the

effective assessment of collaboration. The first implication for assessors is that, before the group task is set, practitioners need to engender a sense of group identity and rapport amongst the group members. Similarly, high levels of trust and shared understanding, and depth of relationships have been identified as pre-conditions to collaboration (Monteiro & Morrison, 2014; Peters & Manz, 2007). Crucial to this is the role of the task setter, as they can encourage group members to build trust and mutual understanding *before* the assessment task (Mercer, 1996; Laurillard, 2012). To encourage true collaboration (which can then be observed and measured) assessors need to manipulate group members' experiences with one another so that channels of communication and mutual understanding are optimised *before* assessment commences.

Task setting

A fundamental element of a successful assessment of collaboration is that the task itself should provoke all members of the group to share their views and ideas on potential courses of action (Dillenbourg, 1999). As mentioned in the previous section, this can be encouraged by setting up effective pre-task relationships among group members. However, this alone is unlikely to be sufficient for collaborative strategies to be utilised. We have identified five criteria that assessors should meet when devising a collaborative problem-solving task. Some of these criteria relate specifically to the task itself, whilst others relate to aspects of group composition.

1. **Task is sufficiently complex:** The common factor in all assessments of collaboration is that group members are set a problem. Ideally the problem engenders alternative suggestions from within the group about the best course of action, or requires group members to research potential solutions to the problem. Overly simplistic or trivial tasks do not encourage group members to collaborate because there is little need to share cognitive load. High-quality collaborative tasks are thus likely to include elements of constructive argumentation (Brna & Burton, 1997).
2. **Task is ill-structured:** A good collaborative task is one that cannot be solved by one capable member of the group. Task complexity is, at least in part, determined by the structure of the task. Tasks should be sufficiently open, with more than one plausible (or defensible) solution (Webb, Nemer, Chizhik, & Sugrue, 1998). Furthermore, individual roles should not be designated by the task setter (at least initially) as this encourages unnecessary processing constraints. Strictly defined roles can also create the illusion of collaboration. This also introduces the problem of the group being led by the expectations of the task setter, which may restrict novel or innovative solutions.
3. **Task should utilise technologies that facilitate the collaborative process:** There are a number of ways in which technology can be introduced into a collaborative task: as a resource in information gathering; as a focus of the interaction; or as a collaborative partner. Tasks that involve group members collaborating using computers as a means of communication typically use email, instant messaging applications, discussion forums or videoconferencing. The advantage of these modes of communication is that they can enhance the reach of

communication, and increase the potential for different perspectives to be expressed (e.g., Thorpe, 1998). Despite these perceived advantages, it remains to be seen whether computer-supported means of communication within a collaborative task can overcome challenges created by the initial distance of participants from each other, both physically and in terms of the creation of a JPS (Kreijns, Kirschner, & Vermeulen, 2013).

4. **Group member dynamics engender negotiation:** Negotiation is unlikely if all group members agree on a solution to a problem, or if one group member forces their will or assumed knowledge onto another (e.g., in a tutoring scenario). When assessing collaboration, it is therefore important to place students in groups where there may be differences in opinion (Brna & Burton, 1997). However, the evidence on creating effective heterogeneous groups is mixed (see Webb et al., 1998). Some research has found that groups manifesting a range of abilities collaborate more productively compared to more homogeneous groups. This effect is observed more clearly in ill-structured tasks. Where the task is clearly specified, low-ability group members are more likely to display negative behaviours such as 'social loafing' (Salomon & Globerson, 1989). Social loafing appears to also be a function of group size. In general terms, the larger the group the more likely that some group members will not contribute to the task due to asymmetric interactions among group members.
5. **Group is motivated to work together:** In setting the task, the assessor needs to motivate group members to work together. If the criteria outlined above are met, then the group dynamic and the task itself are likely to be highly motivating. This is closely related to the concept of *social interdependence*, which is based on mutual encouragement and accountability (Johnson & Johnson, 1989, 2002 – see Figure 1). How group members are assessed during the collaborative task may contribute to developing social interdependence among group members. Research has found that productivity is improved when members are rewarded as a group, within a context of individual accountability (Bossert, 1988; Slavin, 1983).

Towards an assessment model for collaboration

The appropriate assessment of collaboration as a *process* or as an *outcome* reflects the distinct characteristics of these two conceptualisations.

Assessment of the collaborative process

The first aspect to consider regards the desirable characteristics of an individual who is effectively collaborating with their peers. We have identified six elements that comprise effective maintenance and progress of the collaborative state, as depicted in Figure 1. This framework may be a useful starting point in directing assessors to consider the fundamental skills within the collaborative process.

The next issue relates to how the process of collaboration can be optimally observed, from which judgements on performance can be made. Assessors have the challenging task of relating individuals' behaviours to both the context of the task and to the dynamics of the group. Appropriate adjustments of these judgements are required as group members negotiate and progress towards a solution, with a final

'best-fit' decision being made. In this process, the assessor implicitly creates an evidence base from which to ground their decision-making. The use of technology has been identified as a potential means from which observation of the collaborative process can be enhanced (e.g., Austin, Smyth, Rickard, Quirk-Bolt, & Metcalfe, 2010; MacDonald, 2003). For example, the use of wikis can provide a full record of individuals' contributions to a task, in addition to the responses from other group members (Judd, Kennedy, & Cropper, 2010). Taken together, assessors can analyse and reflect on these interactions off-line, potentially improving the evidence base from which judgements are made. However, different methods of analysis of these data are possible, and so careful consideration of how this evidence is used alongside more typical observational approaches is required.

Interestingly, there have been recent attempts to standardise the process of collaboration through the use of computer partners (see Rosen & Tager, 2013; OECD, 2013). These assessment procedures have the advantage of controlling the task scenario, so that the student can be encouraged to negotiate and offer different courses of action. It is debatable as to whether the level of control possible using this assessment method outweighs issues of ecological validity.

A third issue relates to the distribution of marks among individuals and the group. When marks are given to individuals, there is the potential for collaboration to become competition, and for individuals to feel aggrieved if their contributions are not noted. However, when marks are given at the group-level, this potentially obscures individual contributions. Further issues are raised when we consider that the usual aim of assessment (and qualifications more broadly) is for a judgement to be made on individuals. For any assessment of collaboration, then, it is imperative that group members are given individual marks. The focus of this individual mark, however, should centre on positive contributions to the collaborative process. The balance between group-level and individual-level marks for a collaborative task is an important consideration in the future development of models of assessment of collaboration.

Related to this issue is the origin of the marks: can a case be made for the assessors to be located *within the group*, via either self- or peer-assessment? These models of assessment have been identified as improving group processes, motivation and engagement, and achieving a good level of reliability (Mills & Glover, 2006; Race, 2001). However, concerns remain about their appropriateness as part of an assessment strategy for large-scale qualifications.

Assessment of collaborative outcomes

If the focus of assessment is on the learning achieved during collaboration, then the assessment itself should specifically relate to the quality of the final product. This is typically assessed by a terminal demonstration of learning either by a group presentation or the creation of a portfolio, where learning could be showcased (MacDonald, 2003). The use of portfolios, which are held centrally within a shared network, allows a longitudinal record of learning to be held by the assessor over time (Hauge & Wittek, 2002). This can encourage the assessor to understand each student's development of understanding of a topic area.

In assessing the outcome of individual learning within a collaborative context, two main considerations need to be made. First, the assessor needs to have measured each student's understanding of the topic of interest prior to the task, so that the 'before' and 'after' of learning can be established. Secondly, the assessor needs to set a task where learning relies to an extent on the collaborative process.

Conclusions and future questions

This article first aimed to briefly outline different conceptualisations of collaboration, and made the important distinction between the collaborative *process* (which is demonstrated within the collaborative activity) and the *outcome* (which is demonstrated by the quality of the knowledge or understanding of the group members). The article has also explored the implications for how the different constructs of collaboration can be assessed, focusing mainly on task conditions that need to be met for collaboration to be encouraged.

There remain several questions for future research. Specifically, the future development of effective assessments of collaboration relies on several decisions being made by developers regarding the desired direction of the assessment. These include the following:

What should be the focus of the assessment of collaboration?

The main distinction made here is between collaboration as process and collaboration as outcome. This decision routes the possible options for assessment. If the purpose of the assessment is to target the collaborative process, then assessment must focus on targeting individual contributions to the collaborative effort. However, some focus on project outcomes may be required for the purpose of student motivation, and to gather a more holistic view of a student's collaborative skill. If the aim of assessment is to measure student learning via collaboration (a specific form of collaborative outcome), then group-based assessment, for example, is not appropriate. Assessment of individual learning would likely rely on multi-stage assessment procedures.

Furthermore, the focus of assessment will be closely related to the other objectives of the target qualification. The relative importance of collaboration within the entire structure of the target qualification framework will have implications for its assessment.

If the focus of assessment is the collaborative process, how should the identified subskills be weighted?

We have identified six subskills that contribute to the collaborative process. However, the status of these skills, and how they can best be observed, is a source for future investigation.

What is the desired division of individual/group marks for students?

Giving an individual score to candidates meets the imperative for them to be rewarded for their contributions, and to prevent negative collaborative behaviours. The inclusion of a group score encourages a degree of mutual accountability which is essential in encouraging students to display the desired construct. To encourage full participation, both individual and group effort therefore need to be assessed. However, the weighting of this scoring approach remains an open question. For example, the idea of providing a single mark for an entire group related to the final outcome has been criticised on the basis of fairness.

How can technology be utilised to optimal effect?

Maintaining a consistent and reliable record of interaction is problematic, particularly when assessing large groups. For example, the use of online-based forums and wikis can provide a useful record of interactions between participants which can then be utilised for assessment purposes. Interestingly, the very process of introducing technology fundamentally

changes the aspects of the interaction that makes collaboration more likely. Technology will need to overcome significant challenges for it to be a suitable mode from which collaboration can be derived and observed.

Acknowledgements

We are grateful to Irenka Suto, Research Division, for her helpful suggestions on an earlier draft of this article. We would also like to thank Sylvia Green, Research Division, Paul Bullen-Smith, Cambridge International Examinations, and Helen Eccles, formerly of Cambridge International Examinations, for their insightful discussion over the course of the research.

References

- ATC21S (2015). *Assessment and Teaching of 21st Century Skills*. Official website. Available online at: www.atc21s.org
- Austin, R., Smyth, J., Rickard, A., Quirk-Bolt, N., & Metcalfe, N. (2010). Collaborative digital learning in schools: Teacher perceptions of purpose and effectiveness. *Technology, Pedagogy and Education*, 19(3), 327–343.
- Blaskovich, J. L. (2008). Exploring the effect of distance: An experimental investigation of virtual collaboration, social loafing, and group decisions. *Journal of Information Systems*, 22(1), 27–46.
- Bossert, S. T. (1988). Cooperative activities in the classroom. *Review of Research in Education*, 15, 225–250.
- Brna, P. (1998). Models of collaboration. *Proceedings of the Workshop on Informatics in Education, XVIII Congresso Nacional da Sociedade Brasileira de Computação*, Belo Horizonte, Brazil.
- Brna, P. & Burton, M. (1997). The computer modelling of students collaborating in learning about energy. *Journal of Computer Assisted Learning*, 13, 193–204.
- Development Economics. (2015). The value of soft skills to the UK economy. Retrieved from <http://www.backingsoftskills.co.uk/The%20Value%20of%20Soft%20Skills%20to%20the%20UK%20Economy.pdf>
- Dillenbourg, P. (1999). What do you mean by 'collaborative learning?' In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and Computational Approaches* (pp.1–19). Oxford: Elsevier.
- Fall, R., Webb, N., & Chudowsky, N. (1997). *Group Discussion and Large-Scale Language Arts Assessment: Effects on Students' Comprehension*. CSE Technical Report 445. Los Angeles: CRESST.
- Fawcett, L. M., & Garton, A. F. (2005). The effect of peer collaboration on children's problem-solving ability. *The British Journal of Educational Psychology*, 75(2), 157–169.
- Ginsburg-Block, M. D., Rohrbeck, C. A., & Fantuzzo, J. W. (2006). A meta-analytic review of social, self-concept, and behavioral outcomes of peer-assisted learning. *Journal of Educational Psychology*, 98(4), 732–749.
- Hauge, T. E. & Wittek, L. (2002). *Portfolios as mediators for collaborative learning and professional development in a distributed environment of teacher education*. Paper presented at the European Association for Research on Learning and Instruction (EARLI) Assessment Conference: Learning Communities and Assessment Cultures, Newcastle, England.
- Hunter, D. (2006). Assessing collaborative learning. *British Journal of Music Education*, 23(1), 75–89.
- Janis, I. L. (1982). *Counseling on personal decisions: Theory and research on short-term helping relationships*. New Haven: Yale University Press.
- Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research*. Edina, MN: Interaction Book Company.
- Johnson, D. W., & Johnson, R. T. (2002). Learning together and alone: Overview and meta-analysis. *Asia Pacific Journal of Education*, 22(1), 95–105.
- Johnson, D. W., & Johnson, R. T., & Smith, K. (2007). The state of cooperative learning in postsecondary settings. *Educational Psychology Review*, 19(1), 15–29.

- Judd, T., Kennedy, G. & Cropper, S. (2010). Using wikis for collaborative learning: Assessing collaboration through contribution. *Australasian Journal of Educational Technology*, 26(3), 341–354.
- Knoll, S. W., Plumbaum, T., Hoffmann, J. L., & De Luca, E. W. (2010). Collaboration ontology: Applying collaboration knowledge to a generic group support system. In G-J. De Vreede (Ed). *Proceedings of the Group Decision and Negotiation Conference 2010*, Delft, The Netherlands (p.37).
- Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research. *Computers in Human Behavior*, 19, 335–353.
- Kreijns, K., Kirschner, P. A., & Vermeulen, M. (2013). Social aspects of CSCL environments: A research framework. *Educational Psychologist*, 48(4), 229–242.
- Kuhn, D. (2015). Thinking together and alone. *Educational Researcher*, 44(1), 46–53.
- Lai, E. R. (2011). Collaboration: A Literature Review. Retrieved from <http://images.pearsonassessments.com/images/tmrs/Collaboration-Review.pdf>
- Lai, E. R., & Viering, M. (2012). *Assessing 21st century skills: Integrating research findings*. Paper presented at the annual meeting of the National Council on Measurement in Education, Vancouver, B.C., Canada.
- Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Abingdon, UK: Routledge.
- MacDonald, J. (2003). Assessing online collaborative learning: process and product. *Computers and Education*, 40, 377–391.
- Mercer, N. (1996). The quality of talk in children's collaborative activity in the classroom. *Learning and Instruction*, 6(4), 359–377.
- Mills, J., & Glover, C. (2006) *Using assessment within course structure to drive student engagement with the learning process*. Retrieved from <http://www.open.ac.uk/fast/pdfs/John%20Mills.pdf>
- Monteiro, E. & Morrison, K. (2014). Challenges for collaborative blended learning in undergraduate studies. *Educational Research and Evaluation: An International Journal on Theory and Practice*, 20(7–8), 564–591.
- National Research Council (2011). *Assessing 21st century skills*. Washington, DC: National Academies Press.
- OECD (2013). Programme for International Student Assessment (PISA) 2015: Draft Collaborative Problem Solving Framework. Retrieved from <http://www.oecd.org/pisa/pisaproducts/Draft%20PISA%202015%20Collaborative%20Problem%20Solving%20Framework%20.pdf>
- Partnership for 21st Century Learning (2015). Official website. Available online at: <http://www.p21.org/>
- Peters, L. M., & Manz, C. C. (2007). Identifying antecedents of virtual team collaboration. *Team Performance Management*, 13, 117–129.
- Race, P. (2001). *A briefing on self, peer, and group assessment*. Assessment Series Number 9. York, UK: Learning and Teaching Support Network.
- Rimor, R., Rosen, Y., & Naser, K. (2010). Complexity of social interactions in collaborative learning: The case of online database environment. *Interdisciplinary Journal of E-Learning and Learning Objects*, 6, 355–365.
- Rojas-Drummond, S. & Mercer, N. (2003). Scaffolding the development of effective collaboration and learning. *International Journal of Educational Research*, 39, 99–111.
- Roschelle, J. & Teasley, S. D. (1995). The construction of shared knowledge in collaborative problem-solving. In C.E. O'Malley (Ed.), *Computer-supported collaborative learning* (pp.69–97). Berlin: Springer-Verlag.
- Rosen, Y. (2014). Comparability of Conflict Opportunities in Human-to-Human and Human-to-Agent Online Collaborative Problem Solving, *Tech Know Learn*, 19, 147–164.
- Rosen, Y., & Tager, M. (2013). *Computer-based assessment of collaborative problem solving skills: Human-to-agent versus human-to-human approach*. Research & Innovation Network: Pearson Education.
- Salas, E., Cooke, N. J., & Rosen, M. A. (2008). On teams, teamwork, and team performance: Discoveries and developments. *Human Factors*, 50, 540–548.
- Salomon, G. & Globerson, T. (1989). When teams do not function the way they ought to. *International Journal of Educational Research*, 13(1), 89–100.
- Saner, H., McCaffrey, D., Stecher, B., Klein, S., & Bell, R. (1994). The effects of working in pairs in science performance assessments. *Educational Assessment*, 2(4), 325–338.
- Shute, V. J., & Becker, B. J. (2010). *Innovative Assessment for the 21st Century. Supporting Educational Needs*. New York: Springer.
- Silva, E. (2009). Measuring skills for 21st-century learning. *Phi Delta Kappa*, 90(9), 630–634.
- Slavin, R.E. (1983). When does cooperative learning increase achievement? *Psychological Bulletin*, 94, 429–445.
- Suto, I. (2013). 21st Century skills: Ancient, ubiquitous, enigmatic? *Research Matters: A Cambridge Assessment publication*, 15, 2–8.
- Swan, K., Shen, J., & Hiltz, S. R. (2006). Assessment and collaboration in online learning. *Journal of Asynchronous Learning Networks*, 10(1), 45–62.
- Thorpe, M. (1998). Assessment and "third generation" distance education. *Distance Education*, 19(2), 265–286.
- Webb, N. M. (1991). Task-related verbal interaction and mathematical learning in small groups. *Research in Mathematics Education*, 22(5), 366–389.
- Webb, N. M. (1993). Collaborative group versus individual assessment in mathematics: Processes and outcomes. *Educational Assessment*, 1(2), 131–152.
- Webb, N. M., Nemer, K. M., Chizhik, A. W., & Sugrue, B. (1998). Equity issues in collaborative group assessment: Group composition and performance. *American Educational Research Journal*, 35(4), 607–651.