Cristina ȚÎMPĂU
Olivia PISICĂ
Faculty of Psychology and Educational Sciences, University of Bucharest

THE TRANSVERSAL COMPETENCE COLLABORATIVE PROBLEM SOLVING

Theoretical Article

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Abstract

The importance of collaborative problem-solving in the workplace is increasing as societies and workplaces become increasingly knowledge dependent. Collaborative problem solving requires that the people combine their resources and their strategies in order to reach a common goal. The assumption here is that collaboration is essential because the task is too complex for a person to work through it alone. It may be that different people possess different information; different expertise and experience that they can bring to the problem space in order to jointly share the knowledge, experience and strategies in order to solve a particular problem. So combining resources is important. So too is the knowledge and the kinds of skills that each person possesses. So we would argue that collaborative problem-solving has these two main components. The collaborative, sharing or social aspects and the knowledge, strategic, problem-solving or cognitive aspects.

What are the capabilities that have been identified and defined as transversal competences? One view is that any skills that are essential for navigating life could be classed as transversal competences. This does not mean that many familiar skills of the 20th and preceding centuries are no longer needed. But there are new skills emerging as increasingly important. Competence encompasses the quality and transferability of that action over time and context. No one performs a skill at the same level every time. No one operates at their maximum all the time.

1. Key points on teaching key competences

Traditional classroom environments are often not the most appropriate context for the effective development of key competences. The key competence approach, with its emphasis on the application of knowledge in real world situations represents a significant departure from traditional content-based approaches where subjects are taught and assessed discretely. The main recommended approach to teaching key competences is through the provision of interactive learning environments in which learners can engage in practical, inquiry-based tasks. These environments present open-ended problems and challenges to be solved through debate, experimentation, exploration and creativity. Educational research by Dewey and Vygotsky promoting a social and constructivist approach to learning emphasizes the importance of competence development within a social learning context, where learners are engaged in active learning in real life situations. Simulating real world contexts has three main purposes: it can motivate learners more than traditional approaches, learners are more likely to remember concepts they discover on their own, and it provides a meaningful context for problem-based learning. Project-based learning is a particularly well suited method for the development of pupils' competences, as several key competences can be addressed simultaneously in a cross-curricular manner.

In summary, teaching key competences involve a greater emphasis on interactive learning environments, allowing students to work in teams on multidisciplinary topics, benefit from technology enhanced learning, and have the mental, physical, social and emotional space to collaborate on solving problems

The teachers and students in the Finnish school, for example, are part of a school which understands the importance of interactive learning environments for fostering competence development, and are also lucky enough to have access to financial resources to make this possible. Across Europe, however, a recent online survey found that teachers and head teachers alike rated insufficient financial resources for changing learning environments as one of the top 3 obstacles to teaching key competences. Investment in modernizing learning spaces so that they enable diversified and interactive learning is therefore important.

2. Key principles for teaching key competences effectively

Gordon (et al, 2009) talk about key competences, in eight steps:

Firstly, teaching should be task-based. Learners should develop key competences through active, authentic, collaborative tasks based on problem-solving. Problems should be complex and with multiple solutions, allowing students to produce the solution in a variety of forms.

Secondly, teaching should be interdisciplinary: that is, taught through contexts that combine several subject areas.

Thirdly, learning should be both collaborative and individualised: Learners must collaborate to develop social and communicative competences, but also be able to act autonomously and self-manage.

Fourthly teaching needs to be both learner- and teacher-led. For example, while project-based learning encourages pupils to be active and responsible for their own learning, activities need to be supported by guidance and explicit instruction from the teacher where relevant. In particular, learners need support to develop their ability to learn independently; also known as the 'learning to learn' competence, which we looked at earlier in this module.

Fifthly, teaching and learning where possible should be technologically innovative: Involving the pedagogical use of ICT and mobile technology can really enhance students' digital competence, as well as an array of other competences.

The sixth principle is that teaching and learning of key competences should take place both inside and outside of school. A learning environment does not have to be classroom based; it can be outdoors or even virtual. Teaching should harness the potential of extra-curricular activities and after school programmes, paying closer attention to how learners apply their informal and non-formal learning to what they learn in class.

The seventh teaching principle is that teachers should collaborate with the wider community including the social, cultural and business sectors to create more opportunities for real world learning.

Lastly, the teaching of key competences requires teachers to pay closer attention to the social and emotional aspects of learning, including the quality of relationships between and among teachers and learners. This is important as researchers have argued that supporting learners' social and emotional needs stimulates well-rounded growth in learners, which forms a basis for the development of the full range of key competences. A

personalized approach to learning has been endorsed by the new Maltese Core Curriculum Programme, which targets low ability learners at risk of failure, during the last 3 years of compulsory education, between the ages of 13 and 16. Students following the new competence-based Core Curriculum Programme are accompanied by a mentor who follows their progress and is responsible for the students' holistic development and overall wellbeing.

3. Competence/ transversal competences in world

One point view is represented by the ATC21S (America) project. It began in 2009 and one of the first questions was to do with the definition and framework and because technology had made changes to the workplace and life styles, new skills were needed as well as new emphases on older skills. In order to deal with this a symposium held at the end of the AERA conference in San Diego recommended four sets of skills be recognised as essential for adjustments to the effect of technology on life, learning and work. The skills (Table 1) were identified as those which would enable people to demonstrate new ways of thinking, ways of working, tools for working and living in the world that had emerged as a result of technology.

Two initiatives indicate that the concerns began in the 20th century – those undertaken by UNESCO and PISA. The Delors' Report (1996) marked the beginning of UNESCO's 21st century competence learning discourse - with learning to know, learning to do, learning to be, and learning to live together - forming the four pillars of learning. These four pillars are more complex than appears and shift the discussion somewhat to a philosophical level.

Learning to know includes developing the faculties of memory, reasoning and problem solving; it pre-supposes learning to learn and could usefully be extended to the concept of knowledge building. This perspective does not presume that knowledge is fixed. Learning to do implies acquisition of complex skills, but also refers to developing an aptitude for teamwork and initiative, and a readiness to take risks. Learning to live together is the pillar UNESCO emphasizes more than any other. It refers to developing an understanding of others as well as highlighting the reality that if we are to understand others, we must first know ourselves. Learning to be is founded on the fundamental principle that education needs to contribute to the all-round development of each individual. This pillar deals with what it is to be human, comprehended by intellectual, moral, cultural and physical .

The OECD's (2012) position, developed within the DeSeCo Project - Definition and Selection of Competencies - has a focus on key competencies - and classifying these competencies in three broad categories. First, individuals need to be able to use a wide range of tools for interacting effectively with others and the environment. They need both physical tools such as information technology and socio-cultural ones such as the use of language. They need to understand these tools well enough to adapt them for their own purposes. Second, in an increasingly networked and interdependent world, individuals need to be able to engage with others. Third, individuals need to take responsibility for managing their own lives through situating themselves in the broader social context.

The project Partnerships 21 took as their mission to catalyse US K12 education for the 21st century. Essentially they endorse the "fusing" of traditional academic disciplines with skills including critical thinking, communication, creativity, and collaboration - the 3Rs with the 4Cs; these are contextualised within life and career skills, and technology and media skills.

Each of the approaches to understanding transversal competences and how they fit with our notions of education and the function it serves, emphasises skills that diverge from modern traditional notions of academic disciplines. They all actually identify enabling skills - skills that we need to navigate with through our global society. They converge on a common set of transversal competences - collaboration, communication, ICT literacy, and social and/or cultural competencies; and most of them include creativity, critical thinking, productivity and problem-solving.

4. Collaborative problem solving skills

Collaborative problem solving is a complex skill requiring both social and cognitive competencies. It was rationalised by the ATC 21S project team as a composite skill arising from the links between critical thinking, problem solving, decision making and collaboration. The term "collaborative Problem Solving" was adopted from the work of O'Neill (2014) and from counselling in the work of Green (2004). Hesse et al (2015) conceptualised collaborative problem solving as consisting of five broad strands - participation, perspective taking, social and task regulation, and knowledge building and we will return to these in detail. These strands have been used as the framework for the development and field testing of scenario-based tasks designed to elicit collaborative problem solving skills. Collaborative problem solving is a set of skills that we need to rely on when the capacities or resources of just one person are not sufficient to solve the problem. We need to learn how to combine different resources and skills when faced with complex problems. The OECD has also adopted these approaches, with a slightly different interpretation and conceptual framework and will assess collaborative problem solving in 2015 PISA study.

The challenge for teachers in scaffolding student learning in collaborative problem solving, is to identify students' emerging skills and provide the right support at the right time at the right level. Teachers' assessment practices have to adjust and move from generating summative information about past performance, or as comparison of one student with others, toward assessment that helps them find the starting point for instruction and ways in which they can tailor their teaching to students learning social and cognitive skills associated with collaborative problem-solving. This is the heart of formative assessment (Table 2).

5. The nature of collaborative problem solving

The primary distinction between problem-solving by an individual and collaborative problem-solving is its social nature - the need for communication, exchange of ideas, shared identification of the problem and its elements, and negotiated agreement on connections between problem elements and relationships between actions and their effects. Collaborative problem-solving makes each of these steps observable, as they must be shared with a partner or other members of a group if a solution is to be successfully identified. These steps can be described as follows (Binkley et all, 2012):

1. A problem state must be jointly recognised, and collaborators must identify and agree on which elements of the problem each can control or monitor.
2. A representation of the problem must be shared.
3. Collaborators need to agree on a plan of action, including management of resources.
4. Plans must be executed, which may require a coordinated effort by collaborators acting together or in sequence.
5. Progress towards a solution must be monitored, different options evaluated, plans reformulated if necessary, and collaborators must decide on how to proceed in the face of positive or negative feedback.

This approach to problem-solving has been described in the literature since 1973, when Polya formalised it as a way to solve mathematics problems. It has since been adopted in the maths and science related problem solving tests of the OECD's PISA international studies. ATC21S has taken the view that this might not be appropriate for collaborative problem-solving in areas broader than mathematics and science. Collaborative problem solving can incorporate social and historical problems as well as mathematics and science, for instance. Table 3 provides a summary comparison of the different approaches taken to problem-solving and collaborative problem-solving by Polya's (1973) approach, the OECD's PISA studies, and ATC21S.

6. Collaborative problem-solving in the ATC21S study

In the ATC21S study, problem-solving was seen as a series of steps leading towards hypothesis testing and collaborative testing of ideas:

1. The first step is where each of the individuals within the collaborative team explores the problem space and identifies the elements and aspects of it. They might record their observations individually at this stage.
2. The next step involves students collecting and sharing information about problem elements and how they link together. In this process the students are identifying and collating the total amount of information about the problem by sharing information about observations and collaborating and defining the problem space.
3. Discussion then centres on whether there are patterns and links between elements of the problem, both within and across the areas of observation available to each of the participants.
4. Once the connections are identified, the discussion and collaboration begin to formulate rules or contingencies associated with actions and observations. These need to be shared across the participants' observation space. The discussion follows the "if… then" paradigm.
5. By a process of observation and collecting data about the link between actions and observations, the collaborators then begin to formulate rules or contingencies. These lead to generalisations so that the collaborators can conclude that every time a particular action takes place a particular consequence is observed. At this point they move from inductive to deductive reasoning in the hierarchy of problem solving skills.
6. At the highest ATC21S level of performance, students reflect on the kind of conclusions that are drawn from the information about exceptions to the generalisations. At this point the students are testing hypotheses by challenging generalisations. They address the issue with such expressions as "what if…"

7. Conclusion

Collaborative problem solving is therefore defined as a joint activity where two or more people work together to contribute knowledge, skills, materials and procedures and move through a series of cognitive states that involve collection and analysis of information and the formulation of hypotheses that they jointly set out to test.

There has been, and possibly will continue to be, a debate about the nature of collaborative problem solving, methods defining it and the concern that measuring it might distort its nature. In the ATC21S (Care, Griffin, 2015) project collaborative problem-solving was measured by developing algorithms that monitored and logged the kinds of

activities and communications that a pair of students shared when they were jointly setting out to solve a problem.

We explored a different approach to assessment. Traditionally when collaborative teams undertake assessment tasks, problem based learning projects, or investigations in the classroom, the assessment focuses on the outcome of the team effort. We now examine how we can identify individual skill development and their contribution to the overall team result. This is what makes the measurements of collaborative problem-solving different from almost every other problem solving group, or collaborative learning approach. The second thing that makes it different is that it is technology-based. Just reviewing a couple of simple examples of two people working their way through a particular collaborative problem solution it becomes evident that an observer gets lost in the complex interactions and activities of the participants.

The medium of delivery of the task or project can be face-to-face or through technology. With technology there is a range of ways in which the students can collaborate. This can be across different countries, classrooms and it does not matter if they are physically separated by time, location, page, opportunity or subject knowledge. What is required is that the students can simultaneously access the tasks and interact with one another via the Internet to explore potential procedures and strategies that would help them solve a complex problem. The essential aspect of the collaborative problem-solving task or a collaborative problem based learning project is that each participant in the group possesses or controls unique knowledge, expertise, experience, materials or objects that are essential to the completion of the task, the project or the problem solution. Without every individual contributing their specific resource project cannot be completed; problem cannot be solved; the task cannot be done. Collaborative problem-solving demands that every participant contributes to the work of the group and is able to understand and explain to their collaborators their role and the importance of their contribution to the solution of the task.

So it is clear that collaborative problem-solving relies upon at least two areas of skill. The students working together must have the capacity and skills that enable them to work collaboratively and to share their knowledge, expertise and suggestions of strategy. They must also have the cognitive skills that enable them to understand the problem and analyse its tasks and specific requirements. In addition the student will need to have the cognitive skills that will enable them to assemble information; build their expertise and understanding of the problem; link their shared understandings to particular procedures that will enable them to make progress in reaching the problem solution and to be able to identify patterns and strategies that can help understand connections and contingencies that will eventually enable them to make generalizable suggestions to each other about problem solution and to test those generalisations in the form of hypothesis testing.

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Table 1. The KSAVE Framework for ATC21S

Ways of thinking	Ways of working	Tools for working	Living in the real world
Creativity and innovation	communication	Information literacy	Citizenship, local and global
Critical thinking, problem solving, decision making	Collaboration and teamwork	ICT literacy	Life and career
Learning to learn and meta cognition		Learning to learn and meta cognition	Personal and social responsability

Table 2. Comparisons of organisations defining transversal competences (or c21 skills)

ATC21S	UNESCO	OECD	P21	European Commission
***Ways of thinking*: creativity and innovation**	*Learning to know*		*Learning and innovation*: creativity,critical thinking,problem solving	*Learning to learn*
***Ways of working:* communication collaboration**	*Learning to do*	*Interact in heterogeneous groups*: relate well to others,cooperate, work in teams, manage and resolve conflicts	communication collaboration	communication in mother tongue and foreign languages
***Tools for working*: information literacy, ICT literacy**	*Learning to do*	*Use tools interactively*: use language, symbols, and texts interactively, use knowledge and information interactively, use technology interactively	*Information media and technology*:information literacy, media literacy, ICT literacy	mathematical, science and technology competences, digital competence
***Living in the world*: citizenship, life and career personal and social responsability**	*Learning to be Learning to live together*	*Act autonomously*; act within the big picture form and conduct life plans and personal projects, defend and asser rights, interests, limits and needs	*Life and career:* flexibility and adaptability, initiative and self-direction, social and cross cultural skills, productivity and accountability leadership, responsabillity	social and civic competences, initiative and entrepreneurship, cultural awareness and expression
Binkley et al.	Delors et al.	OECD 2005	www.21.org	Gordon et al.

Table 3. Comparisons of approaches to problem-solving and collaborative problem-solving.

Polya 1973	PISA 2003/2012	ATC21S
Understand the problem	Explore and understand	Collect and share information about the collaborator and the task
Devise a plan	Represent and formulate	Check links and relationships , organise and categorize information
Carry out the plan	Plan and execute	Rule use: set up procedures and strategies to solve the problem using an "If, then.." process
Look back and check	Monitor and reflect	Test hypotheses using a "what if" process and check process and solutions