

Chapter 6

Pedagogical Approaches for the 21st Century Student–Driven Learning in STEM Classrooms

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ABSTRACT

The aim of this chapter is to present a conceptual and practical overview of a variety of innovative student-centered face-to-face and online pedagogical approaches for the 21st century classrooms including science, technology, engineering, and mathematics (STEM) classrooms. Various alternative innovative forms of small-group learning and online teaching/learning methods have been developed and implemented worldwide to replace or supplement the traditional lecture-based instruction. Online teaching/learning, cooperative learning, collaborative learning, problem-based learning, and team-based learning are examples of such innovative reform-based collaborative student driven pedagogies that are covered. We conclude that these innovative 21st strategies make learning in both physical and online classrooms more stimulating and motivating for students, which promote better retention of the course content, minimize dropout rates, and maximize students' learning of the course content.

INTRODUCTION

The 21st century classrooms are characterized as being student-centered, ubiquitous, digitally networked and connected, and learner driven, where the students are placed in the driver seat and are in control of their own learning in team-oriented physical and virtual (cyber) learning environments. The 21st century learners are expected to be self-directed learners and have innovative skills such as creativity, critical thinking, problem solving, higher-order thinking, collaborative and cooperative team-work, meaningful use of technology, effective communication, and global knowledge. For the last three decades, various alternative innovative small-group learning and online teaching/learning methods have been developed and implemented worldwide to replace or supplement the traditional lecture-based instruction. Online teaching/learning, cooperative learning, collaborative learning, problem-based learning, project-based

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learning, peer-led learning, peer learning, inquiry-based learning, and team-based learning are examples of such innovative reform-based student driven pedagogies that can be used in the 21st century classrooms including science, technology, engineering, and mathematics (STEM) classrooms.

In general, small-group learning methods are considered as a broad “*umbrella*” for the various forms of inductive and active student-centered instructional methods that empower the learners in small groups to work collaboratively and cooperatively with each other in a team-based environment using effective and interpersonal communication and interactive social skills to promote critical thinking and deep learning (Cartney, 2006; Fink, 2004; Springer, Stanne, & Donovan, 1999; Kalaian & Kasim, 2014; Kalaian & Kasim, 2015). In essence, students’ active and collaborative engagement in their classrooms is grounded in the Vygotsky’s cognitive and social constructivism model of learning, which stresses and views the students as active learners engaged in constructing and restructuring their own newly learned course content based on their previous knowledge, previously learned course materials, and previous experiences through social interactions in groups in team-oriented settings/classrooms (Cooperstein & Kocevar-Weidinger, 2004; Kalaian & Kasim, 2014; Vygotsky, 1978). The constructivist model of learning views learning as being a learner-centered process with students in the small groups continuously discovering, constructing, reconstructing, and restructuring their own newly learned instructional materials to fit into their existing cognitive framework in socially interactive collaborative environments. This constructivism learning theory explains the process of learning as actively constructing knowledge, which interacts with previously gained knowledge, personal experiences, beliefs, and perceptions. The theory also views and stresses that knowledge is actively and iteratively constructed and reconstructed by learners in groups working together in socially supported classrooms/environments rather than being passively and individually transmitted (transferred) to learners, which is the case in the traditional lecture based classrooms. However, constructivism is guided by the following four principles (Cooperstein & Kocevar-Weidinger, 2004):

- Learners construct their own meaningful and deep learning.
- New learning builds on prior knowledge and experiences.
- Learning is enhanced by social communications and interactions in collaborative team-based environments.
- Learning develops through open-ended authentic ill-defined problems and tasks.

In all of the forms of small-group learning methods, which are innovative student-centered pedagogies of learning, the role of the instructor changes from being a “sage on the stage” of information and knowledge dispenser (transmitter), which is the case in the traditional lecture-based classrooms, to a designer, supporter, guide, consultant, and facilitator of the learning processes in the classroom. Therefore, in all forms of small-group methods, the instructor’s ability and skills to create, support and facilitate social learning environments are essential factors to:

1. Achieve the planned instructional goals such as engaging students in collaborative learning and encouraging creativity and critical thinking, and
2. Maintain the dynamics of group functioning to maximize learning the course content.

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