Technology-enhanced teaching to promote students' active learning: Exploring new practices or consolidating teaching from the pre-COVID 19 era?

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Abstract

Both empirical studies and conceptual work suggest that technology-enhanced teaching has the potential to promote learners to actively construct knowledge by integrating new information and experiences into what they have previously come to understand, revising and reinterpreting old knowledge in order to reconcile it with the new. Due to the national and international measures to prevent the spread of COVID-19 schools around the world radically changed to teaching and learning at a distance. What can we learn from 30 years of research on technology-enhanced technology? Are we exploring new practices of just consolidating our insights into teaching and learning? Based on the outcomes of a nation-wide study on technology-enhanced teaching in secondary schools in the Netherlands, ten claims about technology-enhanced teaching in secondary education are formulated, clustered into claims about teachers' teaching, the school curriculum, teachers' professional development, educational policy and educational research. Based on this large research project from pre-COVID-19 times, effective technology-enhanced learning requires a learner-centered attitude of the teacher with an emphasis on sharing control of learning activities with students and coaching students during their learning process to reach the optimal outcomes. But is this still the most effective approach in teaching at a distance without possibilities for face-to-face interactions between teacher and students and between students? These and other questions will be addressed in an interactive session at the Vietnam Education Symposium 2020.

Introduction

The last two decades have been characterized by extensive growth in the use of technology in education, such as the application of virtual learning environments, simulation software, games and gamification, virtual experiments, visualization of complex models as well as tools that enable students and teachers to communicate and collaborate through email, electronic forums, and instant-messaging systems. In the beginning of this century, technology use mainly aimed at facilitating existing teaching approaches such as the use of presentation software, electronic whiteboards, virtual learning environments and email. More recently, technology has been applied to *adapt* teaching approaches, inspired by changing ideas about what effective teaching and learning implies and supported by the increase in smart phones, tablets, social media, smart technologies and high-speed internet connections.

In general, technology can support effective and efficient teaching and learning in three ways. First, technology can enhance teaching, such the use of *Virtual* and *Augmented reality*, *Serious gaming*, and *Smart technologies*. Secondly, technology can support flexibility in education, such as the use of Open Educational Resources and various forms of open online learning. Thirdly, technology can facilitate adaptive teaching and learning, based on, for example, learning analytics, adaptive testing and artificial intelligence. In this keynote, the focus will be on technology-enhanced teaching and learning.

Thinking on technology-enhanced teaching and learning has been influenced by several theories of learning, including behavioral learning theory, cognitive learning theory and social learning theory, rooted in the works of Dewey, Piaget and Vygotsky. Jonassen, Peck, and Wilson (1999), in their constructivist approach to learning with technology, described instructional principles or characteristics of learning environments which are based on a synthesis of several theories of learning. They argue that meaningful learning with technology only occurs when learners are engaged in knowledge construction, conversation, articulation, collaboration, authentic context, and reflection.

Barak (2006) worked this social-constructivist view out in four similar instructional principles from multiple learning theories. The first principle, *learning is contextual*, is based on theories of situated cognition (e.g., Brown, Collins, & Duguid, 1989) contending that knowledge is inseparable from the contexts and activities within which it is acquired. Learning occurs only when learners process new information in an meaningful way that makes sense within their own frames of reference. The second principle is *learning is an active process*. Learners learn better through their own experiences, than through passive acceptance of information provided by others or through technical means. Consequently, educators should see technologies as means of knowledge construction and discovery, rather than of knowledge transfer and its passive acceptance (Johnson & Aragon, 2002; Salomon, 1998). The third principle, *learning is a social process*, is based on the work of Vygostky (1978). This principle means that teacher learning is associated with the process of discourse between the learner and other people – teachers, peers, parents, and casual acquaintances. Lave and Wenger (2002) combine the first and third principle as they claim social learning to be a function of the activity, context and culture in which it occurs (i.e., it is situated). Social interaction is a critical component of situated learning -- learners become involved in a *community of practice* which embodies certain beliefs and behaviors to be acquired. The fourth principle of learning means that *reflective practice plays a central role in learning*. In his landmark work on reflection, Schön described the concept of reflection-in-action as consisting of 'on-the-spot surfacing, criticizing, restructuring and testing of intuitive understanding of experienced phenomena which often takes the form of a reflective conversation with the situation' (Schön, 1983, pp. 241-242).

Objectives

Both empirical studies and conceptual work suggest that technology-enhanced teaching has the potential to promote learners to actively construct knowledge by integrating new information and experiences into what they have previously come to understand, revising and reinterpreting old knowledge in order to reconcile it with the new. Yet times have changed. Due to the national and international measures to prevent the spread of COVID-19 schools around the world radically changed to teaching and learning at a distance. In many countries, teachers teach from either school or home and students learn from home attending classes, carrying out projects and completing assignments. But not all students do have access to technology to attend class and not all students do have a safe learning environment at home. This kind of teaching and learning at a distance also requires new skills from teachers, students and parents. But there will a post COVID-19 era and how will this look like? What can we learn from these troubled times? What can we learn from 30 years of research on technology-enhanced technology? Are we exploring new practices of just consolidating our insights into teaching and learning?

In an interactive session at the Vietnam Education Symposium 2020, together with the participants, I will try to contribute to insights how to cope with these challenges and how to exploit what we know of technology-enhanced teaching from pre-COVID-19 times in order to promote active learning in secondary education. Ten claims about effective and efficient technology-enhanced teaching are presented below, based on a large research project in the pre-COVID-19 era (Kester et al., 2018). Do these still hold? Do we have to revise these? Or do we just not know whether these claims are still relevant?

Research context

During the school year 2016-2017 data have collected from 35 secondary schools in the Netherlands. These schools participated in a nation-wide initiative to design, implement, evaluate and re-design teaching interventions with technology to support students' personalizing learning. The focus on

personalizing learning was chosen to take advantage of mobile technology to support learning processes of all students in class. These school interventions have been partly funded by the Dutch government. Various data have been collected with student and teacher questionnaires, individual and group interviews with both students and teachers, class observations, and tests and exams. For each of 43 interventions in the 35 schools, a pre-test post-test control group design have been applied. Two main research questions were formulated for each intervention:

1) How can personalizing learning with technology be implemented in secondary schools?
2) What is the effect of personalizing learning with technology on students' self-regulation, motivation for learning and achievement?

Implementation characteristics

Mobile technology has been used to support all interventions, mostly with tablets or laptops students received from schools. In some interventions, students had to bring their own device (BYOD), which was in most cases a tablet or smart phone. The interventions aimed at supporting students' personalizing learning. Personalizing learning can be approached from system-controlled instruction or learner-controlled instruction (Corbalan, Kester, Van Merriënboer, 2006). In contrast to traditional classroom instruction based on teacher-centered approaches, the use of technology allows educators to empower students to take control of their own learning. The personalizing learning interventions with technology required instructional decision across five aspects of program design: 1) pacing, 2) sequencing, 3) time allotment, 4) choice of practice items, and 5) choice of review items (Karich, Burn, & Maki, 2014; Niemiec, Sikorski, & Walberg, 1996). Pacing indicates how quickly teachers present the content to the learner. Sequencing denotes how teachers order information, such as when particular objectives or tasks are presented in relation to other objectives or tasks. Time allotment refers to the amount of time teachers give to the learner to complete the content in its entirety for a particular session. Practice items indicate the type and amount of practice on a particular objective, whereas review items are typically presented at the end of a lesson as a check for understanding. The interventions differed in the way these five aspects were addressed, but most interventions allowed learner control on at least three of the five aspects (mostly pacing, sequencing and time allotment).

Ten claims about technology-enhanced teaching in secondary education

Based on the outcomes of this study, ten claims about technology-enhanced teaching in secondary education are formulated, clustered into claims about teachers' teaching, the school curriculum, teachers' professional development, educational policy and educational research.

Teachers' teaching

In the interventions in which teachers and students both control the pacing, sequencing and time allotment of leaning activities effects were found on students' cognitive learning outcomes. With too much learner control, many students felt lost and did not know how to regulate their own learning path; with too much teacher control, many students were not motivated to their assignment and project and consequently showed lower performances at test and exams. Shared control meant that students had autonomy to decide their pace, sequencing, time allotment and practicing within a larger framework that was set by the teachers for, for example, a series of lessons or even a semester. The more intrinsically motivated students were for particular school subjects or topics, the more learner control can be established. This finding leads to the following claim:

1) Effective technology-enhanced teaching can be characterized by shared-control of learning activities by teacher and students.

With respect to teachers' pedagogy, interventions showed to be effective for all learner outcomes (self regulation skills, motivation for learning and cognitive learning outcomes) when teachers approached students as a coach of their learning instead of as an expert. From previous research (e.g., Sadler, 1989) we already know that in learning environments with shared control by teachers and students, students have to understand how monitor and redirect their own learning processes. This means that the teacher (or the technology itself) should provide feedback on how to do this. Or with other words, teachers should teach students how to learn. This emphasis on the development of self-regulation skills appears to be more important in learning environments with technology-enhanced teaching compared to regular teaching practices. This findings leads to the following claim:

2) To become effective for student learning technology-enhanced teaching requires learner-centered teaching with an emphasis on coaching students how to monitor and redirect their learning process.

In some interventions, adaptive software has been used to support students in practicing with, for example, language and math skills, and teachers with learning analytics that they could use to prepare class. These so-called computer-based assessments offer standardized tests for a particular school subject with and adaptation to students' ability level and automated feedback about students' test performance (their test scores as well as details of their answers), hints and –sometimes- tutor scaffolds. The interventions showed that the more students were practicing with the adaptive software, the better their performance on tests and exams. This finding confirms conclusions from previous research about positive cognitive effects of the use of adaptive software (Admiraal, Vermeulen, Bulterman-Bos, in press) and lead to the following claim:

3) Adaptive software and student practicing are crucial elements in the development of students' cognitive abilities.

Effects of the interventions on students' motivation for learning were mixed, depending on the level of autonomy students had to control and monitor their own learning path. This finding is related to the findings with respect to shared control (claim 1) and teachers as coach (claim 2), but it adds that it is important to understand the *need* for autonomy and support of all students. As part of their coaching role teachers can explicitly ask for information about students' need for support in order to align their support with students' needs. This finding leads to the following claim:

4) Effects of technology-enhanced teaching depend on the student needs of autonomy and support.

Self-regulation appears to be a crucial aspect in technology-enhanced teaching. This means students have to be taught what it is and how to use it for monitoring and directing their own learning process (cf., Van de Kamp, Admiraal, Van Drie, & Rijlaarsdam, 2015). In most interventions that were focused on the development of students' self-regulation skills, teaching was focused on how to prepare learning activities (planning and making choices) instead of self-regulation during learning (monitoring, redirecting, and perseverance) and after learning (reflection and evaluation). Probably, effects on students' achievement could have been stronger when teachers explicitly address these other self-regulation skills as well. This leads to the following claim:

5) Effective technology-enhanced teaching implies that students need to be develop a basic level of self-regulatory skills.

School curriculum

In some schools, the interventions were part of a change in the school vision of teaching, learning, and technology. This vision are mostly developed by the schools themselves or based on existing models such as the Kunskapsskolan, a Swedish model for 'knowledge schools' (see http://kunskapsskolan.com/). In these visions, teaching, learning activities, assessment and materials are constructively aligned and shared by all teachers. The latter means that students are similarly approached by all teachers and in all school subjects, which strengthens the effects of technology-enhanced teaching. In most cases, this also means that more effort has been put into the educational design of teaching approaches and practices. This findings leads to the following claim:

6) Constructive alignment between learning activities, learning assessment, learning materials, and school vision on teaching, learning and technology is conditional for effective technology-enhanced teaching.

Pedagogy before technology. Although many interventions were started –some of these in previous years- with the purchase of student tablets or laptops, teachers indicate that technology-enhanced teaching should be pedagogically driven. This observation is in line with conclusions from previous research that innovations in teaching with technology have entered the school sporadically: most classroom teachers use the technology to do what they always have done and choose those activities that will help them accommodate their own perspectives on teaching and learning (Liu, 2011). This leads to the following claim:

7) Technology-enhanced teaching should be pedagogically driven, not triggered by technology.

Teachers' professional development

In many interventions, teachers were well informed and supported about technological aspects of the intervention, but attention for teachers' professional development on how to apply these technology in a meaningful way was limited. Teachers indicated they needed more information and support how to share control of learning processes with their students, how to teach the development of self-regulation skills and to understand students' need for autonomy and teacher support. A stronger focus on teacher support and professional development could have made the interventions more effective. This leads to the following claim:

8) The implementation of technology in education should be accompanied with teachers' professional development activities with a focus on the pedagogy of technology-enhanced teaching.

Educational policy

Related to the findings that a more integrative approach of technology-enhanced teaching appears to be more effective, educational policies at school, regional and national level might be needed to adapt technology-enhanced teaching to what is needed in times where technology is embedded in society and education. Some fundamental questions should be addressed such as "Do all students need to reach the same ability level", "Is the same curriculum set for each student?", "How strict should requirements about teaching time be?" and "How can school buildings be organized and furnished to support student learning in modern times?". This leads to the following claim:

9) To become effective technology-enhanced teaching should be supported with changes in regional or national policies on curriculum requirements, teaching time, school buildings, and finances.

Educational research
Research on personalizing learning should take into account the situated context of the learner in order to fully acknowledge the personalized context of the learners. Yet it should also aim at generating knowledge about the personalizing learning practices. This conclusion leads to the following claim:

10) Research on technology-enhanced teaching should use mixed methods as effects on student learning and motivation can only be understood in the context of the particular intervention, teacher, students, and school.

Concluding remarks
This large research project from pre-COVID-19 times showed that effective technology-enhanced learning requires a learner-centered attitude of the teacher with an emphasis on sharing control of learning activities with students and coaching students during their learning process to reach the optimal outcomes. But is this still the most effective approach in teaching at a distance without possibilities for face-to-face interactions between teacher and students and between students? Or might a more directive attitude of teacher be necessary to guarantee engagement in learning of all students? Self-regulatory skills seem to be important to support students' independent learning in technology-enhanced teaching in class, but probably these self-regulation skills are even more important in situations where students learn from home. And what would be the role of parents when students learn from home? Adaptive software was already a feature of effective technology-enhanced teaching, but might even be more important in distance education where students can follow a more individualized learning path. In many studies, technology-enhanced teaching is more effective when it is embedded in a curriculum with constructive alignment of learning activities, materials, assessment and technology. But would a focus on pedagogy still relevant in times of radical changes in technology? Research in welcome to examine effective ways of technology-enhanced teaching in post-COVID-19 times taking a situated approach to put outcomes in the context of the teacher, student, school, home and culture.

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