Learning Environments Research (2023) 26:803–822
https://doi.org/10.1007/s10984-023-09455-z

ORIGINAL PAPER

Difference between zoom-based online versus classroom lesson plan performances in creativity and metacognition during COVID-19 pandemic

Rotem Maor[1,2] · Rotem Levi[1] · Zemira Mevarech[1] · Nurit Paz-Baruch[1] · Niv Grinshpan[1] · Alex Milman[1] · Sarit Shlomo[1] · Michal Zion[1]

Received: 25 May 2021 / Accepted: 22 January 2023 / Published online: 21 February 2023

Abstract
The COVID-19 crisis has forced education systems around the world to switch hurriedly from learning in class to learning via online technology. One of the common platforms worldwide for teaching online was zoom. Working under uncertain conditions and facing rapid changes are characteristics of the twenty-first century. Coping adaptively with these challenges requires teachers to apply twenty-first century skills such as creativity and metacognition in their teaching. The purpose of the present study was to examine whether teachers integrate metacognition and creativity in their online lessons more than in classroom instruction. To examine the research question, we analyzed 50 lesson reports (25 for each learning environment) using a mixed-method design model. We used a performance assessment that was based on a creativity metacognitive teaching reports index. Teachers reported greater use of the 'debugging' metacognitive component in online lessons than in classroom lessons. Also, an online environment could provide a suitable platform for promoting students' learning process and encourage teachers to be more creative in terms of diversifying their teaching methods and developing student's creativity. However, the originality component of creativity was less pronounced in online lesson reports. These results can contribute to the field of blended learning and to the literature dealing with the adaptation of teaching to learning environments in the twenty-first century in general and during pandemics in particular.

Keywords Classroom teaching · Creativity · Lesson plan performances · Metacognition · Zoom-based online teaching

✉ Michal Zion
michal.zion@biu.ac.il

[1] Faculty of Education, Bar-Ilan University, 5290002 Ramat Gan, Israel

[2] David Yellin College of Education, Jerusalem, Israel

Introduction

The COVID-19 pandemic continues to be an ongoing worldwide epidemic. It is not only a medical crisis but also one in other areas, including education. The COVID-19 crisis has forced education systems in Israel and around the world to switch hurriedly from school and classroom to remote learning. Teachers everywhere have been required to adjust their methods to this new reality—a reality for which they were unprepared—while receiving vague and even contradictory instructions from educational authorities. It was not just that some teachers unfamiliar technology (like zoom); but also teaching was marked by social distancing, an absence of a classroom where one could approach and support a student, and no opportunity to combine in-person and remote teaching. It has become a considerable challenge for teachers, one that requires significant effort to design lesson plans adapted to these conditions, all while struggling to maintain students' attention in a learning environment not bound by a physical classroom. The challenge is even greater regarding fostering students' twenty-first century skills, with which many teachers have less experience (Pellegrino & Hilton, 2012).

Considerable research has focused on the twenty-first century skills that could help an individual successfully navigate the challenges that they would face in the foreseeable future. (e.g. Chalkiadaki, 2018; Sylva et al., 2020). Twenty-first-century challenges, characterized by a quickly-changing reality and uncertain working conditions, have become ongoing worldwide concerns for teachers during pandemic times. The present study examined teachers' application of cognition-related twenty-first century skills by comparing online teaching with 'traditional' classroom teaching as reflected in teachers' lesson reports. Previous studies indicate that cognition-related twenty-first century skills include creativity, problem-solving, critical thinking, communication, collaboration, and metacognition (Donovan et al., 2014; Lavy, 2020; Pellegrino & Hilton, 2012; Wang & Kokotsaki, 2018; Yu & Subramaniam, 2017). In particular, many studies emphasized the importance of fostering creativity and metacognition (e.g. Ahmadi & Besançon, 2017; Hargrove & Nietfeld, 2015; Kaufman & Baghetto, 2013; Mevarech & Kramarski, 2014) on which the present study focused.

Online teaching and twenty-first century skills

Online teaching is teaching via the Internet or through other means when students are not physically present in a classroom. Online teaching enables learners to contact teachers and other learners and seek support for their learning process. They gain knowledge, construct its personal meaning, and grow out of the learning experience (Anderson, 2008). Often online courses are intentionally designed to be delivered entirely online or blended, including offline and online teaching. It requires several weeks of planning and preparation (Hodges et al., 2020; Shisley, 2020). Yet, in the COVID-19 pandemic, which started in Spring 2020, this was not the case. In many countries, the outbreak led to the immediate closure of schools, with teachers needing to start teaching remotely with little preparation or training time (Bubb & Jones, 2020). This temporary but abrupt shift in teaching modality because of the pandemic is different from the 'typical' online learning instruction. Shin and Hickey (2020) termed it 'emergency remote teaching'.

Emergency remote teaching (ERT), defined as "a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances [which] involves the use of

fully remote teaching solutions for instruction or education that would otherwise be delivered face-to-face or as blended or hybrid courses and that will return to that format once the crisis or emergency has abated" (Hodges et al., 2020). During the COVID-19 crisis, one of common platforms worldwide for teaching online was zoom, a tool that helps teachers and learners to work together and combines video conferencing, online meetings and in-conference groups. Zoom is a very effective platform for online teaching and a tool for increasing learners' motivation (Ramadani & Xhaferi, 2020).

Switching from in-person to remote teaching requires teachers to take on new roles and acquire new skills (Adnan, 2018). This technique-switching includes adapting unit plans, creating unique assignments that are fit for online learning, and continuing observation of student participation in the learning process. Implementing these changes depends on how teachers modifying the way in which they work. Therefore, it is important that teachers are equipped with the knowledge, skills, and abilities required to best adapt to teaching modes that involve online technologies (Albion et al., 2015; Bates & Sangrà, 2011; Aliyyah et al., 2020). The immediate transition to online teaching during the COVID-19 pandemic raised many concerns by teachers, primarily related to their unfamiliarity with how to deliver high-quality teaching and learning remotely; many pointed out the pressure under which they came to adjust immediately to the new conditions (Bubb & Jones, 2020). Facing the challenges of changing reality and working under conditions of uncertainty are characteristic of the twenty-first century (Sylva et al., 2020). Coping adaptively with these challenges, therefore, compels teachers to apply twenty-first century skills in their teaching. Binkley et al. (2012) suggested a division of cognition-related twenty-first century skills to help teachers and educators implement it in a classroom context. According to their division, communication and collaboration 'ways of working' and creativity, critical thinking, and metacognition are regarded as 'ways of thinking'. The present study focused on fostering metacognition and creativity in teaching. Many studies have identified a correlation between these two skills (e.g. Ahmadi & Besançon, 2017; Hargrove, 2013; Lizarraga & Baquedano, 2013).

Metacognition in teaching

Metacognition is the ability to reflect upon, understand, and control one's cognitive processes (Brown, 1987; Flavell, 1976; Schraw et al., 2006; Mevarech & Kramarski, 2014). Research focusing on metacognition distinguishes between two major components: knowledge about cognition and regulation of cognition (Brown, 1987; Flavell, 1976; Schraw & Dennison, 1994). Knowledge about cognition includes three subprocesses that facilitate the reflective aspect of metacognition: declarative knowledge ("what"), procedural knowledge ('how'), and conditional knowledge ('when' and 'why'). Regulation of cognition includes several subprocesses that facilitate the control aspect of learning. There has been extensive discussion regarding the following processes of (1) planning: setting goals and allocating resources, (2) process management: skills and strategy sequences, organization and focus, (3) monitoring: keeping track of progress in a learning activity, (4) debugging: identifying and handling errors and (5) evaluation: reflecting performance during and after a learning episode (Schraw & Dennison, 1994). Metacognitive pedagogies are designed to promote metacognition by raising students' awareness of metacognitive processes (Mevarech & Kramarski, 2014). These pedagogies include discussion and exercise, support and development of metacognitive controls, asking questions that encourage reflection on the learning process, and building a learning environment that promotes

metacognitive processes (Adler et al., 2019; Zion et al., 2005; Mevarech & Kramarski, 2014).

A large number of studies have addressed the effects of metacognition on schooling outcomes, with many of them focusing on the role of metacognition in improving student's achievements and motivation (Mevarech & Kramarski, 2014; Karaali, 2015; Perry et al., 2012; Perry et al., 2019). Researchers examining metacognition among teachers have shown that teachers applying metacognitive strategies more frequently teach more effectively (Mevarech & Kramarski, 2014; Jiang et al., 2016). Effective teachers possess 'adaptive metacognition', which involves both the adaptation of self and environment in response to different and varied classes (Lin et al., 2005; Manasia, 2015). Teachers who are skilled in promoting metacognitive processes ensure that they can make teaching plans, monitor teaching behaviors, regulate teaching methods, evaluate teaching performances, and reflect teaching activities automatically (Jiang et al., 2016).

While much research has examined the effects of metacognitive pedagogies on schooling outcomes, less is known at present that pertains to embedding metacognitive pedagogies in fully-online courses. One study that examined metacognition in online teaching revealed that metacognition skill can affect the students' feeling of interest while coping with learning tasks in a massive open online courses (MOOC) setting (Tsai et al., 2018). Previous studies focused on the integration of metacognitive strategies in online lessons during a routine period when the lessons are well designed. The current study, however, focused on the application of metacognitive strategies in lesson plans for online teaching during a worldwide crisis. Because online teaching has only recently been used in elementary schools, questioning the extent to which teachers utilize online teaching to integrate metacognition in their lessons plans is valid. The present study addressed this question.

Creativity in teaching

Guilford (1950) defined creative thinking as divergent thinking that focuses on providing multiple solutions to a given task, in contrast to convergent thinking that focuses on one solution to a problem. Torrance (1963) suggested four components for assessing creativity: (1) Fluency—a variety of ideas generated on a particular subject in response to a stimulus; it is assessed by the number of suggested responses; (2) Flexibility—related to different types of ideas, approaching a problem in different ways; it is assessed by the number of different categories of answers or ideas raised; and (3) Originality—thinking in a unique way and creating unique actions; it is assessed by a statistical rarity (Silver, 1997). Elaboration—the fourth component, which refers to the details in the responses, has often been excluded from studies; this study, as well, addressed only the first three components of fluency, flexibility, and originality.

In education, it is common to refer to two types of creativity—teaching creatively and teaching for creative thinking (Brinkman, 2010; Yu & Subramaniam, 2017). Teaching creatively refers to using different approaches that can arouse curiosity and make learning more interesting and effective, which can be accomplished by using various instructional methods such as video, animation, and graphics to achieve teaching goals (Brinkman, 2010; Wood & Ashfield, 2008; Yu & Subramaniam, 2017). Teaching for creative thinking means applying a teaching method that aims to develop students' creative thinking or behavior (Mevarech & Kramarski, 2014; Cremin, 2009). This teaching method requires teachers to be open to unconventional and original ideas and to

dedicating time during class to open-ended questions that allow students to express creative ideas (Beghetto, 2007; Brinkman, 2010).

Online teaching literature advocates that teachers integrate creativity into their online lessons by using diverse instructional methods and approaches (Muirhead, 2007). When leading emergency remote teaching, the integration of creativity in teaching is even more critical. Educators should acquire the pedagogical creativity needed to engage learners and stimulate learning (Mohmmed et al., 2020). Ahmad (2020) stated that the COVID-19 pandemic taught many teachers the value of creativity in education, helping to enable them to face challenges posed by emergency remote teaching. Does online teaching during a worldwide crisis make a change in the integration of creativity in lesson planning? To the best of our knowledge, this is an open issue.

Rationale and research questions

Twenty-first-century cognitive skills are important for preparing citizens for the challenges that we face this century. The literature reviewed above emphasizes that fast transformation to online teaching has forced many teachers to apply teaching strategies for which they were not properly prepared. This becomes all the more challenging as regulations keep changing and the future of the school year, in the coming days and weeks, remains uncertain. Therefore, teachers need to be trained in writing lesson plans that integrate creativity and metacognition aspects. One of the methods to assess the implementation of creativity and metacognition in lesson plans is using a performance assessment.

Performance assessment is most easily defined by what it is not—a formal test. In a performance assessment, individuals must construct an answer, produce a product, or perform an activity. Because such assessments allow individuals to construct or perform an original response rather than just choose an answer out of several options, performance assessments can measure individuals' cognitive thinking and their ability to apply knowledge to solve problems (Darling-Hammond, 2017). One of the performance assessment methods uses scoring rubrics (a performance index) to indicate explicitly the expectations for an assignment. It does this by listing the assessment criteria and by describing levels of quality of each of these criteria (Reddy & Andrade, 2010). The use of a performance index as a classroom assessment instrument is widely employed at the school level (Panadero & Jonsson, 2013), especially in relating to student assessments. For instance, Suratno et al. (2019) assessed the level of students' creativity thinking by using a performance index. Another study examined the effect of a performance index in flipped learning activities on students' learning achievement, metacognitive awareness, and cognitive load (Zhang et al., 2019). To the best of our knowledge, no previous studies of online lessons used a performance index to examine the integration of creativity and metacognition. Therefore, the purpose of the present study was to examine if there is a difference between creativity and metacognition performances, expressed within online teachers' lesson plans created during the COVID-19. The study compared and contrasted those same performance categories expressed in classroom teachers' lesson plans that were created before the pandemic. It is likely that, in meeting the new challenges of world-crisis conditions and a quickly-changing reality, teachers integrate metacognition and creativity in their online lessons plans more than in classroom instruction.

Method

Participants

Twenty-five Israeli elementary school teachers participated in the study. Elementary schooling in Israel lasts six years, from first grade to sixth grade. Teachers can earn a Bachelor of Education degree and a teaching certificate from teaching colleges, academic colleges, or universities. Studies usually last four years and include the basics of education as well as an extension in all the subjects required to be taught in the elementary schools (e.g. language, mathematics, science, history, and geography). The participant's individual years of experience ranged from 2 to 35 years. All participants were home-room teachers who teach various subjects (e.g. language, math, or science) according to the Israel National Curriculum, which was not changed during the COVID-19 pandemic. The Ministry of Education provided recommendations that we contact teachers who were identified by the Ministry as those who continued to teach with dedication during the challenges associated with the pandemic. The convenience sampling procedure which we then used enabled us to use email messages and social networks to contact the teachers who became participants.

Measurements and procedures

To examine their lesson-planning performances, participants submitted written reports of two lessons that they taught, one for teaching online and one for a classroom lesson that they had taught before the COVID-19 outbreak. After we provided them with an explanation regarding the concepts of creativity and metacognition, teachers were instructed to include in these reports the way in which they integrated creativity and metacognition for each lesson type. Data were collected from March to May 2020. Teachers' reports were analyzed using a mixed-methods design that combined qualitative and quantitative analysis. Overall, we analyzed 50 lesson reports, 25 for each learning environment.

Qualitative analysis

The goal of the qualitative analysis was to develop an index that measures creativity and metacognition in lesson plan performances. Two reviewers read the lesson plan performances several times to detect meta-cognition and creativity elements in each learning environment. Arrangement and construction of information were used to interpret and understand the meaning of the data (Pidgeon, 1996). Based on the qualitative analysis and previous research assessing the twenty-first century skills of metacognition and creativity (Mevarech & Kramarski, 2014; Michalsky et al., 2007; Schraw & Dennison, 1994; Torrance, 2008), the Creativity Metacognitive Teaching Reports Index (CMTRI) quantitative index was developed. The index assesses the extent of using metacognitive processes (planning, process management, monitoring, debugging, and evaluation) and creativity (fluency, flexibility, and originality) in teaching as reflected in teachers' lesson reports. To check reliability, we interviewed a sample of six of the 25 participants to determine if we indeed understood what they meant in their lesson reports with regard to integration of creativity and metacognition in teaching.

Table 1 shows the lesson plan performance indicators for metacognition. Based on previous research that measured meta-cognition using an index (Zion et al., 2015), the number

Table 1 Lesson plan performance indicators for metacognition[1]

Indicator	Prominent expression (3)	Moderate expression (2)	Low expression (1)	No expression (0)
Planning: Does the lesson have clearly defined and justified goals?	Teacher defines and justifies clear goals, requiring the students to do so as well. For example: "Students learned multiplication and area measurement by experiencing the school grounds, producing a meaningful outcome. **The students** also **planned what they have to do** in order to measure a new planting lot in the school yard." (DM[2])[2]	Only the teacher defines and justifies a goal. For example: "Choosing observation as the appropriate type of experience to give the students a notion of the summer season and know-how of the right equipment."(DM[3])	Teacher defines a goal but does not justify it. For example: "The goal of the lesson was to exercise and memorize in numbers up to 20."(DM[4])	Lesson report does not detail goals.
Process management: Does the teacher break down the learning process into stages? Are the students aware of the stages and involved in the process?	Teacher presents work stages and involves students in learning process. For example: "I asked students to suggest how we can measure the hardness of an object, **in order to encourage them to plan an experiment and think through its different stages. We then went over these stages together.**"(DM[3])	Teacher presenting work stages without involving students in learning process. For example: "Setting a schedule: ten-minute preparation before the observation. Then, twenty minutes for the students to freely explore the grounds in pairs."(DM[3])	Teacher defines what the students should learn, without explaining how they would learn it. For example: "Following learning and exercise, the students were able to indicate grammatic association correctly." **No detail of the different learning or exercise stages.** (DM[5])	Teacher does not define what students should learn, nor how they would learn it.

Table 1 (continued)

Indicator	Prominent expression (3)	Moderate expression (2)	Low expression (1)	No expression (0)
Monitoring: Does the teacher require students to monitor their ongoing progress?	Teacher asks students to check their ongoing progress, setting at least two milestones to stop and examine the progress in light of the goals defined. For example: "The students planned an ad, **then read out each other's ads**. They later paired up and **helped each other embellish their scripts.**"(DM[6])	Teacher asks students to check their ongoing progress, setting one milestone to stop and examine the progress in light of the goals defined. For example: "**The students had to exercise consideration** to decide which length of bands to use for every polygon they prepare. Can they use a single length? Can they combine several?"(DM[7])	Teacher asks students to address the goals defined, but initiates no further guidance on the matter. For example: "Emphasizing **that there are several possible answers in every case**."(DM[8])	Lesson report does not include monitoring progress.
Debugging: Does the teacher identify problems? Are solutions suggested?	Both teacher and students identify and solve problems. For example: "**Some of the students were too shy to speak in front of the entire class** during presentation, **so they would be assisted by their team members**. This was excellent teamwork."(DM[9])	Only the teacher identifies and solves problems. For example: "**My problem was that I could not look at their notebooks and suggest corrections** like I usually do. **This taught me that it is better to record the lesson** so I can send it to students who missed the zoom meeting."(DM[10])	Only the teacher identifies problems; no solution suggested. For example: "Not all students attended the lesson and I had no control over attendance. One student disappeared a few minutes into the lesson."(DM[11])	Teacher does not mention problems at all.

Table 1 (continued)

Indicator	Prominent expression (3)	Moderate expression (2)	Low expression (1)	No expression (0)
Evaluation: Does the teacher critically assess their own work? Are students asked to evaluate their work?	Teacher critically evaluates their own work and asks that the students evaluate theirs. Teacher refers to at least one 21st-century skill. For example: "At the conclusion stage, **I asked the students to reflect upon and understand the processes of self-learning**. What did I do well? Did I get everything? What would I add or change? What I did was to apply 21st-century skills."(DM[2])	Only the teacher evaluates their own work; refers to at least one 21st-century skill. For example: "At the planning stage, **I was aiming to promote fluency** among the students and in myself as a leader in the student council. As I was planning the lesson, **I was considering** ideas that **I could use** during the session, different and original ideas. A presentation, an open question, dialog cards, a collective posting board, a game."(DM[12])	Only the teacher evaluates their own work; no reference to 21st-century skills. For example: "Remote learning has helped me break free from the confines of space and time. This form of learning enables access to students and teachers all over the world, offering different learning methods."(DM[13])	Teacher does not evaluate their own work.

[1]The words in bold highlight the main theme

[2]Teachers' code for research purposes

Table 2 The lesson plan performance indicators for creativity

Indicator	Very prominent expression (4)	Prominent expression (3)	Moderate expression (2)	Low expression (1)	No expression (0)
Flexibility: Are the teacher's different ideas from a wide variety of categories?	Ideas of three or more different categories, in addition to promoting student creativity For example: **Creative teaching methods** "We **watched a video** showing words with the letter C." "The **students were asked to find household items** beginning with C and show the class." "**I read out several words** and the students had to spot the letter C in those words." **Promoting creativity** "I gave the students a creative assignment—make the letter C out of household items and show the class."(DM[10])	Ideas of three or more different categories For example: "**I wrote on a piece of paper** *'I'm bored'* and asked—'is boredom good or bad?" The students responded and then I offered my own opinion. After that, every student was asked to bring an item beginning with the same letter as their name. **I made a video** documenting the activity and **sent the students links to choose a personal song**."(DM[15])	Ideas of two different categories For example: "**Showing a presentation** of divisibility rules for the numbers 2, 3, 5, 6, 9, 10, and then **some games**. Game 1: The teacher shows an action card. Game 2: Students take turns rolling dice, teacher shows a four-digit number. Game 3: Teacher rolls three dice."(DM[16])	Ideas of only one category For example, all ideas concern text: "Students were asked to find different types of **text** in the sources they read." "Students were asked **to come up with a text** that can drive an activity." '"Students were asked **to locate** sources for activity-driving **texts**."(DM[6])	Applying only in-person or online instruction (the teacher provides the material without using any other teaching methods (e.g. video, presentation)

Table 2 (continued)

Indicator	Very prominent expression (4)	Prominent expression (3)	Moderate expression (2)	Low expression (1)	No expression (0)
Fluency: Does the teacher apply different methods and ideas? Do they encourage student creativity?	Teacher applied at least three different teaching methods as well as promoted student creativity For example: **Creative teaching methods** "We **watched a video** showing words with the letter C." "The **students were asked to find household items** beginning with C and show the class." "I **read out several words** and the students had to spot the letter C in those words." **Promoting creativity** "I gave the students a creative assignment—make the letter C out of household items and show the class."(DM[10])	Teacher applied at least three different teaching methods "Showing an environmentally-themed **video**, vocabulary acquisition using **dialog cards**, **teamwork** and **presentations**."(DM[9])	Teacher applied two different teaching methods "It was a two-part lesson. Part one: we **watched the film** *Dot and Anton*. Part two: **worksheets** designed for two levels."(DM[8])	Teacher applied a single teaching method Experiential learning: "**Comparing percentages presented as areas in a certain shape**. Comparing an amount and a percentage of it."(DM[14])	Applying only in-person or online instruction (the teacher provides the material without using any other teaching methods (e.g. video, presentation)

Table 2 (continued)

Indicator	Very prominent expression (4)	Prominent expression (3)	Moderate expression (2)	Low expression (1)	No expression (0)
Originality: How rare are the teacher's ideas?	Applying original teaching methods (seen at a frequency of 15% or less), in addition to promoting student creativity	Applying original teaching methods seen at a frequency of 15% or less in the study Example: **Original teaching methods** Learning by sense awareness showed up only once: the teacher handed out an assortment of assignments for the students to carry out using their senses. "Every student tries to put an unseen item into a package while blindfolded." **Promoting creativity** "Look at your skin and think—why is it important? Why do we need skin?"(DM[17])	Applying original teaching methods seen at a frequency of 16% to 40% in the study Example: Using a cooperative presentation	Applying original teaching methods seen at a frequency of over 40% in the study Example: Using a video or a presentation	Applying only in-person or online instruction (the teacher provides the material without using any other teaching methods (e.g. video, presentation)

The words in bold highlight the main theme

of categories for the meta-cognitive indicators was 4 [0 (not at all)–3 (high)]. Table 2 follows indicators that are similar to those used in Table 1, with one exception–an additional level (level—4—very high) was used to measure creativity. We added the additional level to measure creativity to cover the two aspects of creativity in teaching: teaching creativity and teaching for creativity. Yu and Subramaniam (2017) have argued that teaching creatively can serve as a stepping stone toward cultivating creativity among students. In other words, teachers have to be creative in their teaching in order to be able to develop creativity among their students. Based on Yu and Subramaniam and on previous studies dealing with this subject (e.g. Mevarech & Kramarski, 2014; Brinkman, 2010), the only teachers who scored 4 were those whose level of teaching creativity was high (3) and also developed student's creativity. Table 2 shows the lesson plan performance indicators for creativity.

Two additional themes emerged during the content analysis that focused on the index development. We observed differences between the two learning environments in the structure of the lessons, as well as differences between the two learning environments in promoting students' learning process.

Quantitative scoring and analysis

The use of creativity and metacognitive skills in lesson plans was assessed by the CMTRI quantitative index. As mentioned above, the index was developed based on the qualitative analysis and on previous research assessing the twenty-first century skills of metacognition and creativity.

Two reviewers separately analyzed the indicators for teachers' lesson reports. The goal of the quantitative scoring and analysis was to classify lesson reports according to the level of each CMTRI indicator and to examine differences between online and classroom lesson reports in the integration of creativity and metacognition in teaching. Data scoring and analysis included the following stages. First, each reviewer read the lesson reports several times and then classified each report by the level of each indicator based on the CMTRI. The reviewers supported their classification with examples. Second, the reviewers compared their classifications and ultimately reached 95% agreement regarding the analysis process and the final scoring. (Differences were discussed until consensus was achieved.) Third, each indicator in online and classroom lesson reports was subject to separate analysis using paired sample *t*-tests.

Table 1 is organized on the left side with the definition of each component of metacognition. Later, the levels of each component are explained, accompanied by examples from the teachers' lesson plan performances.

Table 2 also is organized with the left side providing the definition of each component of creativity. Later, the levels of each component are explained and accompanied by examples from the teachers' lesson plan performances.

Results

Qualitative analysis

To examine the contribution of online teaching to teachers' creative and metacognitive lessons plans performances, we first used a qualitative analysis to analyze the lesson reports submitted by the teachers. In addition to the index development (mentioned in detail in

the Method section), the analysis revealed differences between the online and classroom lesson reports in both the structure of the lessons and in promoting students' learning process. The classroom lesson reports, in most part, were constructed in a traditional and strict form, that had been taught in teachers training institutions. This lesson structure includes opening, lesson body, practice, and ways for evaluating students' achievements. In these lessons, teachers mostly indicated the way in which they plan the goals for each lesson. For example, one participant indicated: "the goal of the activity was to produce explicit and implied information out of the poetic text by identifying and analyzing aspects of the poem" (DM8) and the learning process. Another participant's example of a learning process goal might include "setting a schedule: ten-minute preparation before the observation. Then, twenty minutes for the students to freely explore the grounds in pairs" (DM3). This plan, however, did not include an explicit mention of any part that students must take in planning and managing their learning process.

Noticeably, the structure of the online lesson reports was in most parts more flexible and did not contain all the elements of a traditional lesson plan (opening, lesson body, practice, and ways for evaluating students). Also, teachers explicitly mentioned in their lesson reports that one of the lesson goals was to enable students to plan and manage their learning process. With regard to what they did to guide students to plan their learning process, one participant stated that "the goal of the lesson was to emotionally vent using dialog cards. What are students' views about the student council's activity in the days of social distancing? The students were invited to come up with ideas and draw plans for activities promoting the school community during the pandemic" (DM12). Regarding what teachers did to guide students to manage their learning process, another participant stated that "I asked students to suggest how we can measure the hardness of an object, in order to encourage them to think through the experiment's different stages. We then went over these stages together" (DM3).

Quantitative analysis

Following the qualitative analysis, the lesson plan performances were analyzed according to the CMTRI performance index using paired sample *t*-tests. Table 3 presents the mean

Table 3 Differences between online and classroom lesson plan performances using twenty-first century skills

Skill area	Skill	*M (SD)*		*t*
		Online	Classroom	
Metacognition	Planning	1.92 (0.61)	1.96 (0.81)	0.25
	Process management	2.00 (0.50)	1.92 (0.49)	0.70
	Monitoring	1.00 (1.26)	0.88 (1.17)	0.42
	Debugging	1.00 (1.11)	0.48 (0.96)	2.48*
	Evaluation	1.12 (1.01)	1.32 (1.03)	0.94
Creativity	Fluency	3.48 (0.71)	3.20 (0.91)	1.90
	Flexibility	2.88 (1.20)	2.24 (0.93)	2.03*
	Originality	1.31 (0.69)	2.80 (1.19)	3.26**

*$p < 0.05$; **$p < 0.01$

scores, standard deviations (in parentheses), and *t*-values by learning environments (separated by online vs. classroom teaching).

Table 3 shows significant differences between online and classroom lesson reports in debugging, flexibility, and originality, suggesting that teachers' mean scores for debugging and flexibility were higher in online lessons than in classroom lessons, whereas the mean score for originality was higher in classroom lessons than in online lessons. In addition, marginal differences were found in fluency ($p = 0.07$), indicating higher mean scores on online lessons than on classroom lessons. No other significant differences were found.

Discussion

The purpose of the current study was to examine the two twenty-first century skills, *metacognition* and *creativity,* in the context of their application in online teaching during the COVID-19 pandemic and compare them to the same skills in classroom teaching situations. Because the COVID-19 outbreak required swift changes in teaching, imposing a need to perform professionally in times of uncertainty (Bubb & Jones, 2020), with both of these conditions being characteristic of the twenty-first century, we hypothesized that teachers would report a greater use of *metacognition* and *creativity* skills in the lessons that they taught remotely than in similar lessons taught in the classroom. We first discuss findings regarding metacognition, and then findings regarding creativity. We conclude by discussing the advantages and challenges of integrating metacognition and creativity in online teaching, identifying the study's limitations, and suggesting directions for future research**.**

Contribution of online teaching to teachers' metacognitive lesson plan performances

Teachers reported greater use of the metacognitive debugging component in online lessons than in classroom lessons. Stated otherwise, in the online lessons, teachers placed more attention on identifying difficulties during the lessons, devising their own solutions, and responding to students' suggested solutions. It is likely that the reason for these differences is the new working environment, where teachers face the unfamiliar challenges of online teaching (Albion et al., 2015; Bates & Sangrà, 2011; Aliyyah et al., 2020).

No significant differences were found between the two lesson environments in terms of the other metacognition components (planning, process management, monitoring and evaluation) in the quantitative analysis. However, the qualitative analysis revealed that teachers tend to promote students' learning process in online lessons by enabling them to plan and manage their learning process, while they tend to do this less in lessons taught in class. It is possible that, because students have good digital skills, teachers feel more comfortable about enabling them to be responsible for their own learning process when they teach online lessons.

Another finding was that teachers generally made little use of the metacognitive components' debugging, monitoring, and evaluation in both lesson types (means ranged between 0.48 and 1.32 on a scale of 0–3). This finding is in line with previous studies showing the infrequent explicit activation of metacognitive components by elementary school teachers, because many of them have less experience with integrating metacognition in teaching and they usually encounter difficulties when trying to implement these skills in their lessons (Dignath & Buthner, 2015; Pellegrino & Hilton, 2012). These difficulties are even greater

when it comes to a new learning environment, such as zoom. We recommend that professional development programs help teachers with ways to integrate these skills in online and classroom learning environments because numerous studies have pointed out their positive impact on students' outcomes (e.g. Naimnule & Corebima, 2018; Perry et al., 2019) and on the effectiveness of teaching (e.g. Jiang et al., 2016).

Contribution of online teaching to teachers' creative lesson plan performances

The study revealed that online lessons, relative to classroom lesons, were more creative in terms of fluency and flexibility, but not originality. Teaching methods were more diverse and teachers made more extensive use of techniques for developing students' creativity in online lessons. Additionally, the qualitative analysis revealed that the online lesson's structure was characterized as being more flexible than the structure of the classroom lessons that usually formed in a traditional way (containing all the elements of a lesson plan as taught in teacher training institutions). This flexible form might open the door for creativity because it enables more space for diversifying the teaching methods. These findings are in line with the online teaching literature about fostering creativity (Muirhead, 2007). This is especially so in the prevailing emergency remote teaching process during the COVID-19 crisis, in which learning occurs in difficult situations, such as uncertainly, instability, and avoidance of social gathering (Ahmad, 2020; Hodges et al., 2020; Li, 2021; Shin & Hickey, 2020). Integrating creativity into teaching during the pandemic helped teachers worldwide to face challenges posed by emergency remote teaching. This could have changed teachers' perceptions regarding the importance of creativity in education (Ahmad, 2020; Noor et al., 2020).

A different picture emerged regarding the originality component of creativity. We found that originality was more pronounced in classroom lessons than in online lessons in that teachers used more unique teaching methods and promoted student creativity in less common ways in the lessons that they taught in class. That is, although teachers tend to enrich their online lessons with more than one teaching method (e.g. watching a video; game) and made use of various activities to promote students' creativity (e.g. drawing; model-building), these methods and activities were less unique than those they used in class. A possible explanation of these findings could be related to the immediate closure of schools and the limited experience that teachers had in online teaching (Bubb & Jones, 2020; Li, 2021; Noor et al., 2020). It is likely that the rapid transition to an online learning environment, coupled with the difficulties related to its unfamiliar technology, made teachers invest less thought in developing unique lessons. Rather, they probably preferred to use ready-made lesson plans adapted for the online learning environment.

Theoretical and pedagogical implications

The present study indicates that the online environment can provide a suitable platform for promoting students' learning process and encourage teachers to be more creative in terms of diversifying their teaching methods and developing students' creativity. However, the difficulties involved in the transition to teaching online might leave teachers with fewer resources to devote to new teaching methods or new ideas for developing students' creativity. Therefore, it is important for policy makers to encourage teachers to invent new ways of teaching and devise special activities for the students, especially when it comes to online lessons. Encouraging originality among teachers can help to ensure that online lessons are not a mere copy of classroom lessons, but rather are intended and originally designed for the online environment.

Theoretically, these findings support previous studies that pointed out the importance of integrating metacognition and creativity in online learning environments, especially during times of worldwide crisis (e.g. Ahmad, 2020; Mohmmed et al., 2020; Tsai et al., 2018). Using an index that was specifically developed for this study, we expanded the support for our findings by emphasizing differences between the two learning environments in integrating various components of metacognition and creativity.

In summary, the COVID-19 pandemic forced schools to make immediate changes in teaching and learning. On the one hand, this change involved many difficulties but, on the other hand, it provided an opportunity to gain knowledge about a teaching platform that encourages the use of metacognition and creativity. The advantages and challenges of integrating metacognition and creativity in online teaching, as found in the present study, can contribute to the field of blended learning. Blended learning, which combines online and face-to-face learning, is assumed to combine the advantages of both (Graham et al., 2013). The integration of fluency and flexibility and promoting students' learning process were found to be more suited to the online platform, while originality was better achieved in face-to-face learning. Because online teaching is here to stay, it is important to take into account its advantages and to work through its challenges in order to achieve the ideal integration of metacognition and creativity in online teaching environments.

Limitations and directions for future research

Limitations of this research include the convenience sampling method that was employed. Because this sampling method limits the ability to generalize findings from the study, future studies should involve data obtained from more representative sampling. Also, this study focused on primary school teachers, but teachers working with different age groups could report different implementations of metacognition and creativity in their lessons. Therefore, future researchers should include teachers from all levels of education. In addition, the online lesson reports used for this study are based on lessons that took place during crisis, under the pressure of fast transformation in the modes of teaching and focused only on one platform of online teaching (Zoom). Because it is likely that these conditions affected the results, it is recommended that future studies involve the integration of metacognition and creativity in a more-routine period and to include the usage of various platforms of online teaching (e.g. Connect or Teams). Future studies comparing the integration 21st skills in online and classroom learning environments could also add an important dimension by conducting observations in both environments. Finally, the CMTRI index suggested in this article can be used to develop new evaluation methods for integrating metacognition and creativity in teaching based on performance index.

Acknowledgment We would like to thank Ori Stav and Ze'ev Kaplan for their editorial assistance.

Funding Israel Science Foundation, 2690/17, Michal Zion.

References

Adler, I., Zion, M. & Rimerman-Shmueli, E. (2019). Fostering Teachers' Reflections on the Dynamic Characteristics of Open Inquiry through Metacognitive Prompts. Journal of Science Teacher Education, *30*(7), 763–787. https://doi.org/10.1007/s10984-023-09455-z

Adnan, M. (2018). Professional development in the transition to online teaching: The voice of entrant online instructors. *ReCALL: The Journal of EUROCALL, 30*(1), 88.

Ahmad, T. B. T. (2020). Teaching remotely during COVID-19: opportunities for creativity and innovation. *IIUM Journal of Educational Studies, 8*(1), 1–3.
Ahmadi, N., & Besançon, M. (2017). Creativity as a stepping stone towards developing other competencies in classrooms. *Education Research International, 2017*, 1–9.
Albion, P. R., Tondeur, J., Forkosh-Baruch, A., & Peeraer, J. (2015). Teachers' professional development for ICT integration: Towards a reciprocal relationship between research and practice. *Education and Information Technologies, 20*(4), 655–673.
Aliyyah, R. R., Rachmadtullah, R., Samsudin, A., Syaodih, E., Nurtanto, M., & Tambunan, A. R. S. (2020). The perceptions of primary school teachers of online learning during the COVID-19 pandemic period: A case study in Indonesia. *Online Submission*, *7*(2), 90–109.
Anderson, T. (Ed.). (2008). *The theory and practice of online learning*. Athabasca University Press.
Bates, A. T., & Sangra, A. (2011). *Managing technology in higher education: Strategies for transforming teaching and learning*. Wiley.
Beghetto, R. A. (2007). Does creativity have a place in classroom discussions? Prospective teachers' response preferences. *Thinking Skills and Creativity, 2*(1), 1–9.
Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining twenty-first century skills. In P. Griffin, B. McGaw, & E. Care (Eds.), *Assessment and teaching of twenty-first century skills* (pp. 17–66). Springer.
Brinkman, D. J. (2010). Teaching creatively and teaching for creativity. *Arts Education Policy Review, 111*(2), 48–50.
Brown, A. L. (1987). Metacognition, executive control, self-regulation and other more mysterious mechanisms. In F. E. Weinert & R. H. Kluwe (Eds.), *Metacognition, motivation and understanding* (pp. 65–116). Erlbaum.
Bubb, S., & Jones, M. A. (2020). Learning from the COVID-19 home-schooling experience: Listening to pupils, parents/carers and teachers. *Improving Schools, 23*(3), 209–222.
Chalkiadaki, A. (2018). A systematic literature review of twenty-first century skills and competencies in primary education. *International Journal of Instruction, 11*(3), 1–16.
Cremin, T. (2009). Creative teachers and creative teaching. *Creativity in Primary Education, 11*(1), 36–46.
Darling, H. L. (2017). *Developing and measuring higher order skills: Models for state performance assessment systems*. Learning Policy Institute.
Dignath, C., & Buttner, G. (2015). Fostering self-regulated learning among students by means of an electronic learning diary: A training experiment. *Journal of Cognitive Education and Psychology, 14*(1), 77–97.
Donovan, L., Green, T. D., & Mason, C. (2014). Examining the twenty-first century classroom: Developing an innovation configuration map. *Journal of Educational Computing Research, 50*(2), 161–178.
Flavell, J. H. (1976). Metacognitive aspects of problem solving. In L. B. Resnick (Ed.), *The nature of intelligence* (pp. 231–235). Erlbaum.
Graham, C. R. (2013). Emerging practice and research in blended learning. In M. G. Moore (Ed.), *Handbook of distance education* (3rd ed., pp. 333–350). Routledge.
Guilford, J. P. (1950). Creativity. *American Psychologist, 5*, 444–454.
Hargrove, R. A. (2013). Assessing the long-term impact of a metacognitive approach to creative skill development. *International Journal of Technology and Design Education, 23*(3), 489–517.
Hargrove, R. A., & Nietfeld, J. L. (2015). The impact of metacognitive instruction on creative problem solving. *The Journal of Experimental Education, 83*(3), 291–318.
Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. *Educause Review, 27*, 1–12.
Jiang, Y., Ma, L., & Gao, L. (2016). Assessing teachers' metacognition in teaching: The teacher metacognition inventory. *Teaching and Teacher Education, 59*, 403–413.
Karaali, G. (2015). Metacognition in the classroom: Motivation and self-awareness of mathematics learners. *Primus, 25*(5), 439–452.
Kaufman, J. C., & Beghetto, R. A. (2013). In praise of Clark Kent: Creative metacognition and the importance of teaching kids when (not) to be creative. *Roeper Review, 35*(3), 155–165.
Lavy, S. (2020). A review of character strengths interventions in twenty-first-century schools: Their importance and how they can be fostered. *Applied Research in Quality of Life, 15*(2), 573–596.
Li, Z. (2021). Creativity and opportunity: How COVID-19 fosters digital dance education. *Digital Creativity, 32*(3), 188–207.
Lin, X., Schwartz, D. L., & Hatano, G. (2005). Toward teachers' adaptive metacognition. *Educational Psychologist, 40*(4), 245–255.

Lizarraga, M. L. S. A., & Baquedano, M. T. S. A. (2013). How creative potential is related to metacognition. *European Journal of Education and Psychology, 6*(2), 69–81.
Manasia, L. (2015). Creating A-HA moments in teaching practice: Routine versus adaptive metacognition behaviors in teachers. *Proceedings of the Scientific Conference AFASES* (pp. 1255–1262).
Mevarech, Z. & Kramarski, B. (2014). *Critical Math for Innovative Societies: The Role of Metacognitive Pedagogies*. Paris, OECD Publishing.
Michalsky, T., Zion, M., & Mevarech, Z. R. (2007). Developing Students' Metacognitive Awareness in Asynchronous Learning Networks in Comparison to Face-to-Face Discussion Groups. *Journal of Educational Computing Research, 36*(4), 395–424.
Mohmmed, A. O., Khidhir, B. A., Nazeer, A., & Vijayan, V. J. (2020). Emergency remote teaching during Coronavirus pandemic: The current trend and future directive at Middle East College Oman. *Innovative Infrastructure Solutions, 5*(3), 1–11.
Muirhead, B. (2007). Integrating creativity into online university classes. *Journal of Educational Technology & Society, 10*(1), 1–13.
Naimnule, L., & Corebima, A. D. (2018). The correlation between metacognitive skills and critical thinking skills toward students' process skills in biology learning. *Journal of Pedagogical Research, 2*(2), 122–134.
Noor, S., Isa, F. M., & Mazhar, F. F. (2020). Online teaching practices during the COVID-19 pandemic. *Educational Process: International Journal, 9*(3), 169–184.
Panadero, E., & Jonsson, A. (2013). The use of scoring rubrics for formative assessment purposes revisited: A review. *Educational Research Review, 9*, 129–144.
Pellegrino, J., & Hilton, M. (2012). *Education for life and work: Developing transferable knowledge and skills in the twenty-first century*. National Academies Press.
Perry, J., Lundie, D., & Golder, G. (2019). Metacognition in schools: What does the literature suggest about the effectiveness of teaching metacognition in schools? *Educational Review, 71*(4), 483–500.
Perry, V., Albeg, L., & Tung, C. (2012). Meta-analysis of single-case design research on self-regulatory interventions for academic performance. *Journal of Behavioral Education, 21*(3), 217–229.
Pidgeon, N. (1996). Grounded theory: Theoretical background. In J. T. R. Richardson (Ed.), *Handbook of qualitative research methods* (pp. 75–85). The British Psychological Society Books.
Ramadani, A., & Xhaferi, B. (2020). Teachers' experiences with online teaching using the zoom platform with EFL teachers in high schools in Kumanova. *SEEU Review, 15*(1), 142–155.
Reddy, Y. M., & Andrade, H. (2010). A review of rubric use in higher education. *Assessment & Evaluation in Higher Education, 35*(4), 435–448.
Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education, 36*(1–2), 111–139.
Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19*, 460–475.
Shin, M., & Hickey, K. (2020). Needs a little TLC: Examining college students' emergency remote teaching and learning experiences during COVID-19. *Journal of Further and Higher Education, 45*, 973–986.
Shisley, S. (2020, May). Emergency remote learning compared to online learning. *Learning Solutions Magazine*.
Silver, E. A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *ZDM Mathematics Education, 29*(3), 75–80.
Suratno, S., Komaria, N., Yushardi, D., & Wicaksono, I. (2019). The effect of using synectics model on creative thinking and metacognition skills of junior high school students. *International Journal of Instruction, 12*(3), 133–150.
Sylva, K., Sammons, P., Melhuish, E. C., Siraj, I., & Taggart, B. (2020). Developing twenty-first century skills in early childhood: the contribution of process quality to self-regulation and pro-social behaviour. *Zeitschrift für Erziehungswissenschaft, 23*(3), 465–484.
Torrance, E. P. (1963). The creative personality and the ideal pupil. *Teachers College Record, 65*, 220–226.
Torrance, E. P. (2008). *Torrance tests of creative thinking: Manual for scoring and interpreting results. Verbal Forms A and B*. Scholastic Testing Service. Inc.
Tsai, Y. H., Lin, C. H., Hong, J. C., & Tai, K. H. (2018). The effects of metacognition on online learning interest and continuance to learn with MOOCs. *Computers & Education, 121*, 18–29.
Wang, L., & Kokotsaki, D. (2018). Primary school teachers' conceptions of creativity in teaching English as a foreign language (EFL) in China. *Thinking Skills and Creativity, 29*, 115–130.
Wood, R., & Ashfield, J. (2008). The use of the interactive whiteboard for creative teaching and learning in literacy and mathematics: A case study. *British Journal of Educational Technology, 39*(1), 84–96.
Yu, C. X., & Subramaniam, G. (2017). A mentoring approach for developing creativity in teaching. *Malaysian Journal of ELT Research, 14*(2), 1–19.

Zhang, Y., Chen, B. L., Ge, J., Hung, C. Y., & Mei, L. (2019). When is the best time to use rubrics in flipped learning? A study on students' learning achievement, metacognitive awareness, and cognitive load. *Interactive Learning Environments, 27*(8), 1207–1221.

Zion, M., Adler, I., & Mevarech, Z. R. (2015). The effect of individual and social metacognitive instruction on students' metacognitive performances in an online inquiry discussion. *Journal of Educational Computing Research, 52*, 50–87.

Zion, M., Michalsky, T., & Mevarech, Z. R. (2005). The effects of metacognitive instruction embedded within an asynchronous learning network on scientific inquiry skills. *International Journal of Science Education, 27*(8), 957–983.