Task design for online learning: the case of middle school mathematics and science teachers

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Introduction: Teachers' task design in the context of online learning has been little researched by educational researchers. The current research examines the task design of science or mathematics teachers in the context of distance education based on the didactical situation theory and, in particular, situation types.

Methods: Fourteen teachers participated in the current study. They were interviewed regarding the situation types that they used to design online tasks. We used both deductive and inductive methods to analyze the transcribed interviews.

Results: The research findings showed that the teachers utilized different categories of the situation types. Moreover, the teachers utilized three types of reference as follows: the institution, the individual, and the tool. The participating mathematics and science teachers attempted to integrate argumentation into their designed tasks. Furthermore, the situation of communication was designed by the participating teachers to enable the interaction between and inside different agents of online education (students, teachers, and parents) while utilizing different communicational channels (mobile social networks, Zoom rooms, Zoom sessions, student's homes, and Google Classroom). The teachers designed situations of action to address the various aspects of learning, namely, the cognitive, social, affective, and psychological aspects.

Discussion: We argue that the design of online tasks could utilize the didactical situation of action, where the online students are requested to reflect critically on the online tasks. We recommend that teachers request reflection and feedback from their students regarding the tasks that they design for online learning.

1. Introduction

Emergency education due to COVID-19 has impacted educational research that sought to study different aspects of emergency education (Cubilla-Bonnetier et al., 2023), especially distance learning during the emergency period (Garrote et al., 2021; Masalimova et al., 2022). As distance learning was not generally used in third-world education, emergency education accounted for professional development for teachers in the field of task design.

The phenomenon of task design in emergency education necessitates educational research into the utilization of this task design during the COVID-19 pandemic. The current research aimed to examine the task design by science or mathematics teachers by utilizing the situation-type framework as part of the didactical situation theory.

These types include the reference situation, the communication situation, the argumentation situation, and the action situation. Our attempt continues previous research to study task design in mathematics and science education, as well as previous attempts by researchers to study task design in technological environments. In addition, this research considers task design in emergency education as an opportunity for professional development for teachers in using online tools in task design.

In addition, task design is essential to teaching in all online learning environments, as well as in regular classes. Emergency learning can be considered an encouraging factor for distance learning, and technology practices during this period can guide our practices in online learning at regular times. Thus, the present research can direct teachers' practices of task design in regular online learning, which points to the utility of the practices that we report in the present research.

2. Literature review and theoretical background

2.1. Task design in education

Task design refers to the process of creating or structuring a task or activity that learners will engage in as part of their learning experience (National Research Council, 2002). It involves determining the objectives of the task, selecting appropriate materials and resources, and designing the structure and format of the task to maximize its effectiveness.

Design in education has been attracting the researchers' attention because of its influence on the learning science, including mathematics, and on aiding the students in their efforts to become scientists. The benefits of task design can vary depending on the focus of this design. For example, task design could be targeted at increasing the efficiency of teaching and learning, improving communication among the learners and between the teacher and learners, increasing productivity when the tasks are designed with a clear structure and direction, and enhancing creativity when the tasks are designed to motivate one or more types of creativity.

Researchers studied the influence of task design in educational contexts. Meslec et al. (2020) stated that the content and type of cognitive handling in a task will result in a variety of team creativity. Malicka et al. (2019) examined the influence of task design on students' language proficiency in the classroom. According to her research, highly proficient speakers took advantage of accuracy in terms of cognitive complexity, while modestly proficient speakers took advantage of structural complexity. In the current study, we examined task design utilizing the perspective of the didactical situation framework, specifically the situation type aspect of it.

In electronic mathematics learning environments, Cevikbas and Kaiser (2021) claimed that task design is an increasingly important area for mathematics education research. Daher et al. (2018a,b) described tasks as mediating tools in the context of mathematics education. Fahlgren et al. (2022) reported that preservice teachers could design not only technology-based tasks based on specific criteria but also design tasks without being aware beforehand of the tasks' criteria. Bozkurt and Koyunkaya (2020) reported that preservice teachers when observing each other's

micro-teaching lessons and discussing this micro-teaching could devise and develop their designs of technology-based tasks.

2.2. Distance learning due to emergency education

Distance learning has attracted the attention of researchers since its beginning. This attention has increased during the emergency education that resulted from the outburst of COVID-19 (Hamdan et al., 2021). Different issues of distance learning due to emergency education were addressed by educational researchers. Abukhalil et al. (2021) investigated the criteria used by principals to assess the effectiveness of schoolteachers' tool use to support distance learning activities during the COVID-19 pandemic. The study results showed that the criteria that guided the principals in their assessments were associated with different aspects of teaching and learning. The study reported the following criteria that were mostly utilized in principals' assessments: the technological tools' accessibility to students, the ability of the teacher to handle them, the fit between the tool and the particular content, and their use for interactive communication in the classroom. Hamdan et al. (2021) targeted the assessment implemented by the universities through their e-learning departments during emergency education. They found that the universities went through two phases. In the beginning, they attempted to save as much as they were able to. Afterward, the assessment methods developed into ones that were dissimilar to those used before the emergency education. Alternative educational assessment methods were pursued. In the present research, we addressed a unique issue related to distance learning due to emergency education, which is task design during emergency distance learning.

2.3. Task design in technological environments

Researchers are concerned with task design and its impact on other variables across different fields and disciplines. This is especially true for technological educational environments. Mackrell et al. (2013) found that, through the use of software affordances and task design theories, instructors can efficiently create and implement teaching and learning resources. In addition, they argued that task design in the Cabri environment encourages awareness of various didactical variables. Håkansson Lindqvist (2020) concluded that technology must be included in the design process since it affects the division of responsibilities. Moreover, Håkansson Lindqvist (2020) suggested analyzing task design with technology using the following four criteria: (1) means and ends; (2) environment; (3) learning, cognition, and articulation; and (4) development.

Researchers were interested in the actual task design in technological environments. Sidawi (2009) found that teachers attempting to design activities with technology encountered many challenges, such as (1) their limited understanding of the compound relationship between technology and science, (2) their inability to transfer their science knowledge to technology design,

and (3) their inability to deeply understand the design process. The previous challenges made teachers' instruction linear without taking into account the problem context. In addition, Daher et al. (2022b) investigated mathematics preservice teachers' task design of programming activities utilizing Scratch. They found that preservice teachers were concerned with different paradoxes in the situation in their design. They were also concerned with both creative and algorithmic reasoning. In addition, the preservice teachers were not only concerned with students' devolution but also with following institutionalization. The preservice teachers' task design also included students' autonomy regarding the problem solution. The present research focuses on inservice teachers' task design during emergency education. To investigate this design, we used the didactical situation theoretical framework.

2.4. Theoretical background

The present study analyzed online tasks designed by mathematics and science teachers according to a didactical situation framework. Brousseau and Warfield (2020) described the didactical situation as organized to cause students to make a mathematical concept of their own. They stressed that organizers and students can be individuals, populations, institutions, and the like. In addition, adidactical situations are also described by Brousseau as instances of learning in which the teachers hide their involvement in the learning process and the students function without the involvement of the teacher (Brousseau, 2006). Brousseau (2006, p. 65–72) described three types of situations: the situation of action, the situation of communication, and the situation of validation. Brousseau (2006, p. 65–66) suggested that the action situation is related to what is effective, specifically the devolution and construction of knowledge processes in the classroom. Moreover, Brousseau (2006, p. 68–69) suggested that the communication situation is related to the social organization, such as to provoke the transmission of knowledge as well as the quality of social communication. Brousseau (2006, p. 68–69) suggested that the situation of validation includes the exchange of assertions and proofs between the participants in the didactical situation to arrive at an agreement regarding knowledge, where the agreement between the participants does not include "illegitimate" means, such as authority and force. Moreover, Brousseau and Warfield (2020) described four types of situations, and the fourth is the situation of reference. The situation of reference occurs when one educational agent refers to another to exchange information, tool, resource, and so on.

Table 1 illustrates the previous descriptions of the situation types.

2.5. Research rationale and goals

Laurillard et al. (2018) argued that research should address a design that supports technology use in education. Emergency education, especially the need for online learning and the use of digital tools, highlighted the need for research on technology-based task design. In this study, we investigated mathematics and science teachers' designs of online activities during COVID-19, utilizing the didactical situation theory, specifically the situation types that are part of the theory.

Researchers were interested in task design in technological environments. For example, Gustafsson (2016) developed design principles and task types for tasks that follow a multiple-choice format in the context of classroom response systems. Albay and Eisma (2021) argued that using design thinking processes can support teachers in maintaining a classroom that is creative, interactive, and engaging. The present research aimed to address an issue related to design in emergency education and related to online learning. Specifically, we attempted to understand mathematics and science teachers' designs of online tasks using the perspective of the situation types. A few studies have utilized the didactical situations framework. This is especially true regarding the use of situation types to study teachers' designs of tasks as part of distance education.

Previous research that utilized the theory of didactical situations to study task design focused on the devolution and institutionalization processes without paying special attention to the situation types (Daher et al., 2022a). In addition, only a few studies have investigated task design using technological tools for students' learning, especially tools that fit distance learning. The current research intends to contribute to this issue.

2.6. Research questions

First question: What types of didactical situations do mathematics and science teachers use in emergency distance education?

Second question: What categories of each didactical situation type do mathematics and science teachers use in emergency distance education?

3. Methodology

3.1. Research context and participants

In this study, we addressed the design of distance tasks by middle school science and mathematics teachers. A total of 14 teachers participated in the current study, who were equally distributed between mathematics and science teachers. Table 2 describes these teachers in terms of discipline and years of experience.

3.2. Data collection tools

Mathematics and science teachers were interviewed about their design of science and mathematics tasks for online learning during COVID-19. The semi-structured interview began with questions such as, "Can you describe activities that you implemented in the frame of online learning during emergency education?" The interview moved on to the most important questions, which addressed the different types of didactical situation and their characteristics. In doing so, we asked opening questions such as,

TABLE 1 Types of situations.

Situation of action	Situation of communication	Situation of validation	Situation of reference occurs
1. Devolution 2. Construction of knowledge processes	1. Provoking the transmission of knowledge 2. Provoking the quality of social communication	1. Exchange of assertions between the participants 2. Exchange of proofs between the participants	Reference of one educational agent to another to exchange 1. Information 2. Tool 3. Resource

TABLE 2 The participants in terms of discipline and years of experience.

Teacher's fictive name	Discipline	Years of experience
Salam	A mathematics teacher	13
Kamal	A mathematics teacher	12
Amir	A mathematics teacher	8
Hamida	A mathematics teacher	12
Ruba	A mathematics teacher	14
Sami	A mathematics teacher	15
Kamal	A mathematics teacher	9
Soad	A science teacher	20
Heyam	A science teacher	12
Maram	A science teacher	14
Mosab	A science teacher	16
Bayan	A science teacher	15
Adan	A science teacher	7
Samira	A science teacher	12

Can you describe activities that take care of situations of reference? Describe activities that take care of the situation of argumentation. Specific questions were also asked, such as, Do you think that it is easy to design activities that take care of situations of reference? What are the problems of designing activities that take care of situations of argumentation?

3.3. Data analysis tools

To determine how participating teachers designed online tasks for emergency education during emergencies, the analysis used both deductive and inductive reasoning. Deductive reasoning utilized the categories related to the situation type (see Table 2 for more detail).

A previous study by the same authors utilized the didactical situation framework to analyze science and mathematics teachers' task designs (Daher et al., 2022a). In that study, we utilized constructs that were different from the current one, but they were also related to the didactical situation. In that study, the main studied constructs were the processes of the situation (e.g., devolution, creative processes, and autonomy), while in the present research, the main constructs are the types of situation (e.g., reference situation, information situation, and argumentation

situation). The two studies addressed different aspects of the task situation, and on collectively considering the different aspects, the authors helped us to understand science and mathematics teachers' task designs for online education.

3.4. Validity and reliability

The trustworthiness criterion was used to evaluate the analysis method (Lincoln and Guba, 1985). Trustworthiness addresses the argument that the results are worth paying attention to (Elo et al., 2014). It was analyzed through different constructs, specifically, credibility, dependability, conformability, transferability, and authenticity. We described them according to the study of Elo et al. (2014).

3.4.1. Credibility and dependability

To justify credibility, we identified the research participants and accurately described them. This identification and accurate description also addressed dependability, which means that the data were stable in varied contexts. According to researchers, the stability of data could be obtained when the principles followed to choose participants were disclosed and clear (Elo et al., 2014), allowing us to assess and perform the transferability of the results to other contexts (Moretti et al., 2011). In our case, we interviewed math and science teachers for the ninth grade. The credibility and dependability of the research result from our description of the participants in terms of their background variables. Furthermore, they result from our attempt to take into account the homogeneity of the participants (Burmeister and Aitken, 2012).

3.4.2. Conformability

The conformability of data relates to how accurately the findings reflect information provided by the participants and how appropriate the interpretations are to the findings (Polit and Beck, 2004). We have addressed conformability in this study by calculating the agreement between coders. As part of the didactical situation, four coders searched for occurrences of phrases, indicating a situation type. Cohen's Kappa coefficient, representing the agreement between the coders, indicates that the qualitative coding is reliable and, upon computation, it resulted in the values of 0.89–0.93 for the four situation types associated with task design. For achieving agreement between coders, these values are acceptable.

TABLE 3 Categories and themes used in the deductive reasoning.

Situation type	Definition	Examples on themes
Reference situation	A situation that occurs when a participant in the situation refers to another participant	Refer to the ministry of education, refer to the book, refer to an internet site
Information situation	A situation that occurs when a participant is engaged in sharing information with other participants	Share information, interact, compare information
Action situation	A situation that occurs when a participant acts on an object in the situation	Act to change knowledge, act to motivate, act to cause positive emotion
Argumentation situation	A situation that occurs when a participant justifies a claim or an action	Justify a claim, justify an action, tries to persuade regarding a claim

3.4.3. Transferability

The concept of transferability is related to the notion that a study's findings may be extrapolated to other contexts or participants. Transferability is satisfied when giving a clear description of the context and the selection of participants. It was addressed by describing in detail the research context, including participants. It increases through a detailed analysis of the data. Table 3 shows the definition of situation types taken care of in the present research.

We started the research by looking for codes related to each situation type. For example, codes related to the reference situation include "talked to," "addressed ….," and "interacted with …." We searched then for codes related to the subject of reference. The subject could be "the teacher," "another student," "the book," and "the ministry of education." In the third phase, we attempted to relate a code from the first phase with a code from the second phase. In the fourth phase, we searched for the condition of the reference. For example, we arrived at this phase under the condition that "the design according to reference to the ministry of education occurred starting from the beginning of the emergency education."

3.4.4. Authenticity

Authenticity refers to how well researchers present a range of realities (Burmeister and Aitken, 2012; Albay and Eisma, 2021), and it is susceptible to the mistakes of inexperienced researchers who lack the necessary knowledge or skills. In this research, authenticity was examined and ensured by computing the agreement between judges. Furthermore, to ensure authenticity, we followed previous qualitative studies (e.g., Daher and Swidan, 2021; Salhab and Daher, 2023), which strengthened the authenticity of the research methods.

3.4.5. Saturation in the research

Saturation was arrived at when analyzing the 11th interview, where no new situation type was arrived at. In addition, after the 11th interview, the properties of the situation types emerged as in the previous 11 interviews. Despite the repetition of occurrences of the situation types, we analyzed the rest of the interviews, which also showed the repetition of the situation types and their properties.

3.5. Ethics statement

The present research addressed teachers' designs of online activities and relied on interviewing the participants about educational practices. A written informed consent form was signed by the participants. This form included a statement about the interview in the research being voluntary, the ability of the participant to withdraw at any phase during the research, the ability of the participant to refuse to answer any interview question, the agreement to record the interview, the anonymity of the participant, a summary of the purpose and procedure of the research, and the expected benefits of the research.

4. Results

The following sections describe the different situations addressed by the participating teachers when designing online activities as the main channel of learning in emergency education.

4.1. Situation of reference

The categories of the situation of reference were the following: reference to the ministry of education, reference to the teacher, reference to the student, reference to the book, and reference to an Internet site.

4.1.1. Reference to the ministry of education

According to reference to the ministry of education, the design started with the beginning of emergency education. Emergency education made the ministry of education intervene and suggest online tasks for the different disciplines and grades. Salam, a mathematics teacher, described the efforts performed by the ministry of education to provide appropriate materials for online learning at the beginning of emergency education. She said, "When we first started, the ministry of education offered support. It provided us with learning materials appropriate for online teaching. This hugely helped us because we were not accustomed to this type of teaching."

4.1.2. Reference to the teacher

According to reference to the teacher, the design also started with the beginning of emergency education and continued along with this education. Kamal, a mathematics teacher, described his attempts to fit the textbook into online education: "We needed to adjust the textbook into tasks that suit the online learning. To do so, we searched, found, and used technological tools valid for designing online communication and for students' investigations of the subject matter."

4.1.3. Reference to the student

According to reference to the student, the participating teachers indicated the design began in two situations. The first case occurred when the student was requested to present a topic in the subject matter to the whole class, resulting in the student becoming a reference. Soad, a science teacher, said, "I wanted the students to be active in online learning, so I requested some of them to present topics from the subject matter. For example, one student presented material about energy." The second case occurred when the students were requested to investigate by using technological tools, relations, and concepts in the subject matter. Ahlam, a mathematics teacher, said,

I wanted the students to rely on themselves in discovering the mathematical relations and concepts, so I designed tasks in which they used GeoGebra to discover the relations and concepts. During a task, the students studied the meanings of the parameters "a" and "b" in the linear function.

4.1.4. Reference to the tool

The teachers designed a didactical situation that referred to the technological tool when the emergency situation did not allow for using the regular tools. Heyam, a science teacher, emphasized the importance of technological tools that replace the traditional laboratory in which the student conducts practical experiments. She said,

In COVID-19 pandemic, it was difficult to attend the science laboratories. I designed tasks in which the student experiments through the Crocodile program. The student sees the colors of the resulting materials and can measure the heat of the reaction. The students expressed their enthusiasm of the experimentation, saying that they enjoyed working with the program and that it made them understand the content.

4.1.5. Reference to the book

Reference to the book was designed as a stand-alone task only at the beginning of the emergency education. Amir, a mathematics teacher, described his use of the regular book at the beginning of emergency education: "At the beginning, I referred the students to their own book and asked them to write their answers in the WhatsApp group." As the teachers became accustomed to online learning, they referred the students to the regular book at the end of the lesson to provide them with a resource that could help them to prepare for the exam.

Maram, a science teacher, describes her use of the book as a learning resource:

I wanted the students to have more than one resource that helps them in the preparation to the exam. When a lesson came to an end, I told the students where, in the book, they can find the material that I taught them. I told them they can use it whenever they want, especially to prepare for the exam.

4.1.6. Reference to an Internet site

When designing online tasks, the participating teachers considered the Internet site as a vital reference for students to use to study the learning material. The reference to an Internet site happened generally in three situations. The first occurred when the teacher built the Internet site. Mosab, a science teacher, described his building of Google docs and forms at the beginning of the emergency:

Internet sites helped us a lot in designing the online tasks. I used them for different tasks. For example, I used Google docs and Google forms at the beginning, because we had a workshop on the use of these tools at the beginning of the emergency. I used them not only at the beginning, but these were the first internet sites that I used.

The second situation occurred when the teacher referred the students to already-built sites. Hamida, a mathematics teacher, described sites that she referred the students to practice the new knowledge they had acquired: "I designed tasks in which the students played an online game to practice their knowledge." The third situation occurred when the teacher referred the students to a site that she or he built, but the students participated in continuing the building of this site. Bayan, a science teacher, described the online tasks she designed where students built an Internet site collaboratively:

The Padlet helped me when I wanted to raise an issue and I wanted my students to write their ideas regarding this issue. For example, I did that to solicit students' perceptions of the topic of "growth, development, and reproduction of organisms."

4.2. Situation of argumentation

The following texts describe the categories of the situation of argumentation.

4.2.1. Argumentation during the teacher's introduction of the topic

Ruba, a mathematics teacher, described her design of a didactical situation in which she asked the students to provide an explanation based on their observations. She said: "They were asked why veins have thin walls, for example, while arteries have thick walls."

4.2.2. Argumentation during students' investigation of the topic ideas

Ruba, a mathematics teacher, described her design of tasks in which the students were requested to justify their observations after they worked with a technological program. She said:

> In the tasks that I design with a technological program like GeoGebra, I ask the students to justify their observations after they worked with the technological program. For example, they tell me that the "m" parameter affects the angle that the linear function makes with the positive direction of the x-axis. I request them to justify this influence.

4.2.3. Argumentation investigated through technological programs

Adan, a science teacher, described her design of tasks in which the students are requested to justify their arguments by working with technological programs.

> I designed different educational situations in which the students were requested to justify their observations. One such situation is that related to the factors affecting the kinetic energy of a body, where a discussion took place among the students, some of them said that kinetic energy increases with increasing mass, while others mentioned that kinetic energy increases with increasing speed. It was a fruitful discussion that was followed with justification by implementing an experiment to calculate kinetic energy using the simulation program "PhET."

4.3. Situation of communication

4.3.1. Students' use of mobile social networks to communicate

Samira, a science teacher, built a WhatsApp group to motivate her students' communication during distance learning. She said,

> Each class had a WhatsApp group that I built. It was used to discuss all aspects of mathematics by the students. I also used WhatsApp to put difficult questions. These questions were designed with the assumption that students would ask about its contents, or methods of solving it.

4.3.2. Communication between the students with Zoom rooms

Salam, a mathematics teacher, used Zoom rooms to provide her students with a collective environment for the discussion of new topics. She said, "At the start of new topics, I used Zoom rooms for students to communicate and that helped them understand. This happened when the students learned negative numbers."

4.3.3. Eyes communication between the teacher and students in Zoom sessions

Sami, a mathematics teacher, stressed the relationship between communicational actions and social interaction, where interaction by the eye is crucial to students' learning. He said,

> Listening is not sufficient for the student. Just listening makes the student get lost. Students need to be engaged in the lesson and the camera needs to be on. When the student gives an explanation, it would benefit her to elaborate on specific points during the explanation. As a teacher, you provide the initial content and lead the discussion among the students in the tasks that I design. We used different applications to encourage student interaction: the interactive whiteboard, live worksheets, and FullProof.

4.3.4. Communication between parents and children at home

Samira, a science teacher, described her design of science tasks that parents and students collaborate to carry out at home: "I designed some tasks to be carried out at home, with the supervision of their parents. For example, the students carried out the solar oven task, with the supervision of their parents. This task is considered a safe one."

4.3.5. Communication among teachers, students, and parents on Zoom

Soad, a science teacher, described her design of science tasks to be presented in the parent's presence on Zoom: "I designed tasks to presented in the presence of parents in Zoom. One such task consisted of a virtual gallery that the students built with Genially."

4.3.6. Communication between teachers on the online platform

Salam, a mathematics teacher, detailed her interaction with fellow teachers in the environment of Google Classroom: "There is a group dedicated to mathematics teachers in the district. All the teachers put the online tasks that they design in the group, and the teachers use each other's task."

4.4. Situation of action

4.4.1. Action to provide students with learning materials

The first situation of action that the mathematics and science teachers wanted to design is one in which the students have learning materials so that they can continue studying. Kamal, a mathematics teacher, described his attempts to design tasks so that his students have their learning materials:

> As COVID-19 started, I focused on designing learning materials to be used by my students for all their coursework. In the beginning, this was through using the WhatsApp application to put the number of pages in the book. I requested

the students to take photos of their solutions and put them in the WhatsApp group. I corrected the solutions and sent the corrections to the students individually. It was a time of emergency. All that I wanted was to proceed with the educational process. The first goal was to provide the students with learning material.

4.4.2. Action to make students enjoy online learning

Bayan, a science teacher, described her design of tasks in the chemistry classroom to make her students enjoy their online learning:

I built a task in which I took advantage of the table of elements. The students find their symbols difficult as they are in Latin. The task required the students to build meaningful sentences from the elements symbols. They built sentences such as "Happy Eid Al-Fitr," or "Be aware in emergency." The last sentence fitted the emergency period. The students loved to participate in this task so much.

4.4.3. Action for motivating students' participation in online learning

Hamida, a mathematics teacher, described her design of a mathematics task to motivate her students' participation in online learning: "I designed tasks that included games to motivate my students to participate in online learning. One such task involved factors of numbers. I used the NCTM game applet 'Factor Game'."

4.4.4. Action to make students work collectively to solve difficult problems

The mathematics and science teachers designed online tasks to make students work collectively when they expected that the solution process of the problem would be facilitated by collective work. Ruba, a mathematics teacher, described her engagement with such a design: "When I expected the problem to be solved more easily when the students worked collectively, I designed it to be solved in Zoom's rooms. I joined each group of students to direct the process of the solution if needed."

5. Discussion

The study was conducted to examine the design of tasks implemented by science and mathematics teachers during emergency education, based on the situation-type framework. In the following section, we discuss the research findings by referring to each situation type.

5.1. Situation of reference

The participating mathematics and science teachers used different reference situations to design online tasks for their students. These references included the ministry of education, the

teacher, the student, the tool, the book, and the Internet site. It has been suggested that the previous references are of four types. The first type is the institution, with the ministry of education serving as an example. The reference to the ministry of education has been reported by researchers as supporting online learning during the COVID-19 pandemic. For example, Abukhalil et al. (2021) reported that the Palestinian Ministry of Education initiated strategies and techniques appropriate for distance learning to manage the state caused by the COVID-19 pandemic.

The second type of reference is the individual, here the teacher or the student. The teacher is the one who designed it. As a result, the teacher was actively involved in finding appropriate resources and tools for designing the online tasks, and she or he became the main reference for the didactical situation. The teacher, as a reference, does not here imply her or his role in the implementation of the lesson, but her or his main role in designing the online lessons. When the student was a reference, she or he had autonomy in investigating the mathematical or scientific relations in the subject matter. This characteristic of the student as reference points to the potential of online learning enable students' voices in an educational context, a characteristic that is enabled in technology environments (Daher, 2017).

The third type of reference is the tool. The participating teachers reported that they benefited from tools in their design in providing a means for students to experiment in order to arrive at mathematics and scientific ideas and relations. It means that the participating teachers were able to continue or start taking advantage of tools for investigative work by students in their task design (Daher, 2009). The fourth type of reference is the text and whether this text is from a regular book or an Internet site was investigated. The text here functions as a formal resource that students could refer to in order to verify their self-formulation of mathematical and scientific relations. In this situation of reference, the role of the teacher was to indicate the text rather than mediate the text. This role of the teacher is expected because the tools facilitated students' learning before they referred to the text.

5.2. Situation of argumentation

The situation of argumentation included three types of argumentation: argumentation during the teacher's introduction of the topic, argumentation during students' investigation of mathematical or scientific ideas, and argumentation investigated through technological programs. Wells (2014) argued that it is possible to focus students on the importance of quality evidence if argumentation structures and practices are introduced, and this could lead them to become more interested in math content. In the present research, we found that an attempt was made by the participating mathematics and science teachers to integrate argumentation into their designed tasks.

5.3. Situation of communication

The situation of communication was designed by the participating teachers to enable interaction between and inside different agents of online education (students, teachers, and

parents) while utilizing different communicational channels (mobile social networks, Zoom rooms, Zoom sessions, students' homes, and Google Classroom). The different interactions and channels point to the rich potentialities of communication that distance education provides for educators and students.

5.4. Situation of action

The teachers designed situations of action to address the various aspects of learning, namely, the cognitive, social, affective, and psychological aspects. Although it was a time of emergency, the teachers were concerned with the different aspects, probably because the different aspects were considered crucial for students' learning (Daher, 2011; Daher et al., 2018a; Daher and Awawdeh Shahbari, 2020).

An investigation of task design for mathematics and science teachers during online learning was conducted by Daher et al. (2022a). Using the technological tools, the participating teachers were able to design tasks that allow students to take charge of their own learning activities. A successful didactical situation was achieved by utilizing the potential of distance learning platforms.

6. Conclusion and recommendations

Emergency education arose suddenly due to COVID-19 and impacted many aspects of education, especially distance education (Naji et al., 2020). The present research sought to study the influence of online education on teachers' task design. The research results indicated that the teachers considered argumentation as part of their design. More research is needed to verify the role of argumentation in online learning of mathematics and science, especially in times of emergency.

In the frame of their concern with the didactical situation of action, the research participants were concerned with the different aspects of the student's online learning. Future studies have been requested to investigate how this concern developed, for example, which aspect the teachers were concerned with at the beginning and which one came last.

Mackrell et al. (2013) recommended that the design of tasks that include software could benefit from classroom feedback, where this feedback suggests ways in which the task may be improved. We argue that the design of online tasks could also benefit from a didactical situation of action, where students who participate in the online classroom are requested to reflect on the online tasks. We recommend that teachers request feedback from their students regarding the tasks that they design for online learning.

Yeung et al. (2012) argued that to effectively use digital technologies in the classroom, teachers must develop their digital competence. To increase teachers' confidence in applying teaching technologies, the authors suggested increasing their digital technology competence. Thus, we recommend that teachers

participate in workshops in which they discuss and implement the design of online tasks so that they become experienced in this aspect of online teaching. This would prepare them for the design of online tasks when the educational conditions demanded this design.

Radloff et al. (2019) found that preservice teachers engaged with and applied standards-based science content when they developed and implemented compost design tasks. Here, mathematics and science teachers were able to apply online teaching during emergency education through the development and implementation of task design.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

SS, RJ, ID, AA, KS, MB, and MR collected the data and performed the statistical analysis. WD wrote the first draft of the manuscript. All authors contributed to the conception, design of the study, manuscript revision, and read and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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