

Article

Secondary Students' Identities in the Virtual Classroom

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Abstract: Though researchers have paid attention to the social aspect of students' virtual and online learning, little attention has been paid to their identity. The present research intends to do so by studying students' identities when learning high-level mathematics in the virtual classroom. Fourteen secondary school students participated in the research. Data were collected using interviews with the participants before and after participating in the virtual mathematics classroom. Data analysis was done using inductive and deductive content analysis, where the deductive analysis utilized the narrative framework developed by Sfard and Prusak. The research results indicated that the virtual identities of high-level mathematics students were impacted by three factors: the design of the virtual classroom, the teacher's interactions with the student, and the personal characteristics of the student. In addition, the research results indicated that students' identities, in terms of features and narratives, changed in the case of some students, but continued to be the same in the case of other students. The reasons behind the change or the absence of change were the three above factors and their interaction. It is concluded that the virtual course design needs to take into consideration the interaction aspect of students' learning alongside factors that encourage their substantive learning.

Keywords: secondary school; students' identities; virtual classroom; learning narratives; identity features

1. Introduction

The social aspect of students' learning is attracting the attention of educational researchers (e.g., [1,2]). One issue related to the social aspect of students' learning is the one of educational identities. These identities, whether the teachers' or the learners', influence the teaching-learning practices in the classroom, whether this classroom is virtual or not [3]. Moreover, virtual education is proliferating through the online classroom, which allows students from various school levels to study different disciplines using a virtual environment (e.g., [4,5]). Though virtual schools are rising in popularity and presence, there is a relative shortage of research related to teaching and learning in these schools [6]. Moreover, Johnston, Greer, and Smith [7] say that, compared to other forms of learning, virtual learning is in its adolescence, which could explain why little research has been done on the virtual classroom concept.

The social aspect of the virtual classroom has attracted researchers' attention in the frame of their interest in social presence [8–10]. Despite this attention to the social aspect of virtual learning, little attention has been paid to students' identities in this type of learning, which is a specific issue in a developing learning environment. The present research attempts to contribute to research related to the aspect of students' identities in virtual learning by studying mathematics students' identities in this context. To do so, the present research utilizes a narrative framework for identity study, which was developed by Sfard and Prusak [11] who point to students' narratives as shaping their identities

and learning. This framework will enable us to examine the features of students' identities in virtual learning, such as actual and designated identities, and ritualized or substantial learning.

The previous argument indicates that the present research adds to the literature regarding social presence in the virtual learning space. Specifically, it adds to research on students' identities in the virtual learning space, which is attracting the attention of researchers and educators because it could support learning in general and learning as part of education in emergencies, as in the case of virtual education imposed by COVID-19. Doing that, the present research adds to the aspects of virtual identity research and suggests studying the aspects of actual and designated identity alongside substantial and ritualized learning. This analysis will enable educators to distinguish between different learner and different learning approaches, which would enable these educators to positively affect the learners' identities.

1.1. Students' Learning in the Virtual Classroom

Factors that influence students' virtual learning are instructional support, technical support, services that promote a sense of community, and the design of the learning environment. Tunison and Noonan [12] examined high schools students' first experiences of an online course, reporting that the students perceived their online experiences as empowering them and giving them freedom. The participating students had this perception, although most of them identified the teacher as the ultimate source of information. This perception resulted in positive effective consequences, resulting in students' enjoyment of their online experiences. Other researchers have pointed towards learner's autonomy as characterizing learning in virtual education (e.g., [13]). In addition, Rice [14] reported that students perceived distance learning as difficult and isolating: "Even if students are highly motivated and self-directed, in a distance education environment they can still find the experience isolating, difficult, and discouraging" (p. 437).

Students can have positive as well as negative perceptions of distance education, where factors that contribute to these perceptions are the learner's attributes, the social climate in the distance classroom regarding interaction with the teacher and with peers, and the design of the course, where these factors are interrelated. Different learners' attributes affect their learning in virtual learning: values, beliefs, and emotions about communication; the commitment to engagement in group processes; and skills in interacting [15]. Rice [14] says that learner attributes appear to play a role in the success of students in distance education.

In addition to the above, the design of the virtual course also influences student success in virtual learning [16,17] as this design influences students' engagement and interaction in the course. Thus, the design of the virtual classroom and the student's attributes affect the learning of the student in the virtual classroom, where the three factors affect students' engagement in this classroom, as well as their perceptions of learning in it.

The social climate in the virtual classroom affects students' engagement in the virtual classroom and their perceptions of their learning in this classroom [8]. At the same time, this social climate is affected by the interactions with the teacher and with peers. Interactions with peers had an effect on students' persistence with a challenging problem [18]. Moreover, Frid [18] reported that the amount of engagement and interaction by the supervisor influenced the amount of and quality of participation by students. Furthermore, particularly in the virtual classroom, Weiner [19] confirmed that a high degree of student-teacher interaction is a necessity in the virtual classroom, otherwise the social and affective aspects of students' learning will be affected negatively. The previous results indicate that the teacher's role in virtual learning is critical for the success of students' learning. This is in line with Cavanaugh, Gillan, Kromrey, Hess, and Blomeyer [20], who posited that teacher quality plays a significant role in distance education outcomes. One of these qualities is prompt feedback, which has a positive impact on student learning, progress, and connectedness [21].

The previous description relates to affective and social aspects of students' learning, where the affective aspect included their perceptions of virtual learning, while the social aspect included the

interaction in the virtual environment. The identity aspect relates to the social aspect but relates also to the participant as an individual, which makes it a special aspect of the virtual classroom.

1.2. Students' Identities in Virtual Learning

Researchers have pointed to virtual learning, in its many manifestations, as something that empowers students' identities [22,23]. Baxter and Haycock [24] associate students' experiences of their learner identity with their sense of belonging to a meaningful learning community in online and blended learning environments. Lave and Wenger [25] further associate learner identity with the feeling of being in control as part of belonging to a learning community. Deumert [26] says that we construct our identities through the stories that we tell. The contextual nature of identity indicates that people share versions of themselves in online settings [27], in this case, an educational online setting. This identity refines and evolves during the virtual class (ibid). In addition, the aspects of students' online identities, such as confidence, agency, and feelings of authority and expertise, are impacted by several factors such as their prior experience with social media, the nature of the online environment, and peer or teacher interaction [24]. Daher [3] studied, using a grounded theory approach, students' identities on social networking sites, arriving at four identity aspects: the educational aspect, the cultural aspect, the personality aspect, and the ethnic aspect. In the present research, we address the educational and personal aspects by utilizing the theoretical framework suggested by Sfard and Prusak [11] in order to analyze the development of identities of the participating secondary students.

1.3. Theoretical Framework

Sfard and Prusak [11] describe their framework as something that considers identity in terms of communicational practice. Doing so, they analyze earlier attempts, such as those by Holland, Lachicotte, Skinner, and Cain [28] and Gee [29], that utilize the communicational aspect of identity. They argue that the earlier definitions of identity, by Holland et al. [28] and Gee [29], link the notion of identity to the activity of communication, with the term 'communication' perceived broadly as referring also to a self-dialogue, that is, to thinking. Sfard and Prusak [11] say that they "embrace the idea of identity making as communicational practice, and thereby reject the notion of identities as extra-discursive entities that we merely "represent" or "describe" while talking" (p. 16).

Regarding techniques of advancing towards identities, Sfard and Prusak [11] say that the most obvious identifying technique, which they call reifying, "consists of replacing talk about actions with talk about states or, more specifically, in substituting utterances about doing with reifying sentences about being or having" (p. 16). Moreover, they talk about three properties of identities, which are reifying, endorsable, and significant: "Identities may be defined as collections of stories about persons or, more specifically, as those narratives about individuals that are reifying, endorsable, and significant. The reifying quality comes with the use of verbs such as 'be', 'have', or 'can' rather than 'do', and with the adverbs 'always', 'never', 'usually', etc., that stress repetitiveness of actions. A story about a person counts as endorsable if the identity builder, when asked, would say that it faithfully reflects the state of affairs in the world" (ibid). In addition, these properties are related to two types of narratives about a person: actual identity and designated identity. The actual identity narratives are stories about the actual state of affairs, while the designated identity narratives present a state of affairs that is expected to be the state of affairs, if not now, then in the future. The two types of identity differ in their syntax. Actual identities are "usually told in present tense and are formulated as factual assertions" (p. 18), while designated identities are "stories believed to have the potential to become a part of one's actual identity. They can be recognized by their use of the future tense or of words that express wish, commitment, obligation, or necessity, such as 'should', 'ought', 'have to', 'must', 'want', 'can/cannot', etc." (ibid).

Sfard and Prusak [11] point at narratives authored by others as among the most important sources of our designated identities, contributing to their development and change. We claim that narratives are related to the features of the identity (emergence of a new feature like effort) or the extent to a feature

(e.g., extent of effort applied in deep or surface learning). The authors note that “although narrative osmosis goes mainly from designated to actual identities, one cannot exclude the possibility of influence that travels in the opposite direction” (p. 18). They explain this direction of the identity movement as “success begets success and failure begets failure”, where the first success and failure are part of the actual identity, while the second success and failure become part of the designated identity.

Sfard and Prusak [11] say that learning shapes identity, where it helps in closing the gap between actual and designated identities. This claim makes the framework appropriate for students’ transition from the regular classroom to the virtual classroom; a transition that the participants in the present research performed. The authors differentiate between two types of learning: ritualized and substantial learning. The ritualized learning is motivated, for social reasons, by a wish to adhere to the rules of the game. In this learning, the activity importance resides in its very performance. In contrast, the effects of substantial learning would outlast classroom activities and could be assessed according to criteria independent of the personal opinions of a particular teacher. In substantial learning, the student usually performs constant backtracking and self-examination, in addition to care for the appropriateness of mathematical expression, where this appropriateness is assessed according to one’s own assessment. The previous constructs are also relevant to the present research, where we are interested in the type of learning that the participants followed in the virtual classroom.

Research questions:

1. How do the features of students’ identities change from face-to-face to the virtual classroom?
2. How do the narratives of students’ identities change from face-to-face to the virtual classroom?

2. Materials and Methods

2.1. Research Context and Participants

The present research was conducted in a secondary school, where the socio-economic status of the students’ parents in the school was low to middle. The school did not teach high-level mathematics, because usually less than twenty students in the tenth grade had the ability to learn high-level mathematics. The students were given the opportunity to participate in a high-level virtual mathematics class held by the ministry of education. Fifteen students from the school expressed their intention to participate in the high-level mathematics classroom. These students were requested to participate in an interview in which they were asked about their learning in the virtual classroom. Fourteen of these students agreed to be interviewed and thus constituted the present research participants.

2.2. Design of the Virtual Course

The design of the virtual course was decided by the ministry of education and was based on students’ asynchronous independent learning and synchronous interactions between the students and the teacher. In the asynchronous learning, the students needed to read a mathematical text, five times over the course of a week, and solve problems related to these texts, where each text was related to a sub-topic of a mathematical topic as the limit of the function. A teacher was assigned to each virtual class, and this teacher was available to the students for one hour each day, at a pre-scheduled date and time. Thus, the students had the opportunity to ask the teacher questions as part of their synchronous interaction with the teacher, on any issue related to their asynchronous learning.

The virtual course did not include forums as a means to ask questions or discuss mathematical topics, but it included assignments to which the students uploaded their answers to the mathematical questions given by the teacher. It seems that the absence of forums in the virtual course was due to the option of the one-hour of synchronous interaction between the teacher and the students each day.

2.3. Data Collecting Tools

The data were collected through a semi-structured interview that lasted between 45 and 60 min. The interviews were conducted by the first author. There were two interviews, with the same participants, at separate times. These interviews were held with the students before and after participation in the virtual classroom. In answering the pre-interview questions, the participating students described their actual identity before participating in the virtual classroom, while in answering the post-interview questions, they described their designated identity during their learning in the virtual classroom.

Examples of questions asked in the pre-interview are: 'Describe your learning of mathematics' and 'What/who influenced your learning of mathematics?'. Examples of questions asked in the post-interview are: 'What was your experience in learning mathematics in the virtual classroom?', 'Why did you participate in high-level mathematics in a virtual classroom?', and 'What differed in your experience in learning mathematics face-to-face to learning in the virtual classroom?'. The interview was voice-recorded and afterwards transcribed by an expert transcriber.

2.4. Data Analysis Tools

To analyze the data, we used inductive and deductive content analysis, which are both processes designed to condense raw data into categories or themes based on valid inference and interpretation. In the case of deductive reasoning, themes and categories were deduced from theory [30]. Utilizing deductive reasoning, we looked for themes related to metacognitive skills from the work of Sfard and Prusak [11]. These themes included: actual identity, designated identity, ritualized learning, and substantial learning. Utilizing the inductive reasoning enabled us to look for themes related to the student's identities as features of these identities, which included effort and responsibility. Table 1 shows an example of the analysis of the interviews.

Table 1. Example of the analysis of the interviews.

Participant	Text	Feature of Identity	Narrative of Identity
Researcher	Alaa, would you please tell me about your experience in the virtual classroom?		
Alaa	The teaching method made me depend on myself. It also made me pay attention to the importance of putting a plan for my study.	Depending on oneself	
Researcher	Can you tell us how you studied in the virtual classroom?		
Alaa	I read the mathematics text from the book and asked the teacher about what I did not understand. When there was not enough time to ask the teacher, I read the text two or three times until I understood it. This made me understand, not only how to solve the homework, but also the ideas behind the solving methods		Substantive learning; learning that resulted in deep understanding

3. Results

In this section, we will present the features of the participants' identities and then present the characterization of the change in the narratives of the students' identities as they moved into the virtual mathematics classroom

3.1. Features of Students' Identities

The participating students' answers revealed three themes: (1) A feature does not disappear/appear where the number of participants who reported this theme is five, (2) A feature disappears/appears where the number of participants who reported this theme is six, and (3) A feature changes its extent where the number of participants who reported this theme is ten. The features were related to emotions towards mathematics and its learning, effort in mathematics learning, persistence in learning

mathematics, and responsibility for learning mathematics. The feature did not have the same value for all the students. For example, some students reported that effort in learning mathematics emerged only when they started to participate in the virtual classroom, while others reported that effort was a feature of their learning before and during the virtual learning. In addition, individual students who participated in the virtual classroom reported more than one theme at the same time. For example, some students reported that their effort increased in the virtual classroom, and at the same time, they reported that their emotions towards learning mathematics did not change. Below, we describe each one of these themes.

3.1.1. A Feature does not Disappear/Appears

Moving from the actual identities to the designated virtual identities, five out of the fourteen students reported that their virtual identity continued to possess the same features. Two of the students reported that they continued to possess specific emotions towards mathematics in their virtual learning, another two reported that they continued to exert effort in their virtual learning of mathematics, while one student reported that she continued to have persistence in her virtual learning of mathematics.

In the pre-interview, Salam, one of these students, said: "I cannot say that I like or hate mathematics. I just know that it is good for my future, so I try to get good marks in it. In the post-interview, Salam said: "The virtual classroom did not make me like mathematics more or less. I continued to try to have good marks in mathematics because it would affect my future".

In the case of Salam, her emotions towards learning mathematics were neutral. These neutral emotions were part of her actual identity before participating in the virtual school, as well as after she participated in it. What influenced this feature, put simply, is Salam's beliefs about learning mathematics. Beliefs play a major role in mathematics learning. Kloosterman [31] says that students' beliefs about mathematics and mathematics learning have a considerable impact on various variables of their learning, such as interest, enjoyment, and motivation in mathematics.

3.1.2. A Feature Disappears/Appears

Moving from the actual identities to designated virtual identities, six out of the fourteen students reported that some features of their identity appeared or disappeared. Four of the students reported that they started to exert effort in learning mathematics, while the other two reported that they started to take responsibility over their virtual learning.

Answering the question about his experience in learning mathematics in the pre-interview, Amir said: "I like to study mathematics. It was easy for me to do so in the primary, middle, and high schools. I did not make an effort to understand mathematics because the teacher explained everything for us in the classroom". In the post-interview, Amir said: "It was not easy for me to learn mathematics in the virtual classroom. This difficulty is due to the need to depend on myself in order to understand the different topics. This made me exert effort. At the primary and middle schools, I used to learn one hour at home, but learning virtually needed much more time".

In the case of Amir, effort was not a feature of his actual identity before participating in the virtual school. This changed towards effort being part of his designated virtual identity. The change occurred as a result of the design of the specific virtual learning, where the teacher had the role of answering the students' questions at scheduled times. Course design has been identified as something that influences the different aspects of students' learning. Lee [32] reported that course design influenced student satisfaction, while Gray and Diloreto [33] reported that course design influenced students' perceived learning. The design of the course reported here requested that the students work on their own, where they could only approach the teacher synchronously at specific times. This design restricted the students' interaction with the teacher, which made some students increase their effort in order to compensate for the teacher's relatively small interaction.

3.1.3. A Feature Changes Its Extent

Moving from the actual identities to the designated virtual identities, ten out of the fourteen students reported, not the change of a feature, but the change of the extent of a feature. Six of the students reported that the extent of their effort in learning mathematics increased, two of the students reported that the extent of their persistence for learning mathematics increased, while the other two reported that the extent of their responsibility for learning mathematics increased.

Answering the question about her experience in learning mathematics in the pre-interview, Alaa said: "I am a persistent person when it comes to learning mathematics. Mathematics does not come to me easily, but I know its importance, so I try all the time to overcome its difficulties". In the post-interview, Alaa said: "Learning in the virtual classroom meant that I had to depend on myself. It is right that I could approach the teacher at scheduled times, but learning high-level mathematics in a virtual classroom meant that I needed to learn the content by myself and so had to be more persistent and responsible. The environment was new to me, inasmuch as the learning in this environment. It was one of two options; to persist and be responsible or fail the exams. This made succeeding in the virtual classroom a challenge for me, even though this classroom had a lot of task pressure. This made me a more persistent and responsible person".

In the case of Alaa, persistence and responsibility were part of her actual identity before she participated in the virtual classroom, but this persistence and responsibility increased because of the features of this classroom. These features included learning on one's own, which necessitated more persistence and responsibility. Thus, virtual learning strengthened the persistence and responsibility in Alaa's identity to become part of Alaa's designated virtual identity. It is designated in the sense that it was part of a new learning experience and, at the same time, was impacted by the design of the virtual environment. The increase in some students' responsibility, persistence, and effort in the virtual classroom could be explained by their intrinsic and extrinsic motivations [34].

Researchers have studied the things that influence persistence in online learning. Hart [35] found that factors associated with student persistence in an online program included satisfaction with online learning, a sense of belonging to the learning community, motivation, peer and family support, time management skills, and increased communication with the instructor. Here, the virtual environment was the means by which the student could complete high-level mathematics, so Alaa felt a sense of belonging to the learning environment, because through it she could achieve her goal of completing the high-level mathematics course.

3.2. Change in the Narratives of Students' Identities

The second goal of the research was to characterize the change in the narratives of students' identities as they moved into the virtual mathematics classroom. The analysis of this change revealed four themes related to this change: (1) Keeping ritualized learning of mathematics, where the number of participants who were identified as satisfying this theme was four; (2) Keeping substantial learning of mathematics, where the number of participants who were identified as satisfying this theme was three; (3) Moving from ritualized into substantial learning of mathematics, where the number of participants who were identified as satisfying this theme was three; and (4) Moving from substantial into ritualized learning of mathematics, where the number of participants who were identified as satisfying this theme was four. It should be noted that most of the students who learned in the virtual classroom had ritualized learning (eight out of fourteen), while the rest (six out of fourteen) had substantive learning. Below, we describe each one of these themes.

3.2.1. Keeping Ritualized Learning of Mathematics

Four of the participating students were motivated in their virtual learning by socially based conditions; i.e., they participated in the virtual classroom because they wanted to please their parents or friends. The ritualized learning constituted not only part of designated identity but was also,

from the beginning, part of the actual identity of these students. Answering the question about why she participated in high-level mathematics in a virtual classroom, Alaa said: “My parents expected me to learn high-level mathematics, so I had to have persistence and responsibility in my learning of mathematics in middle school. Our school did not have high-level mathematics, so my parents kept encouraging me to learn in the virtual school in order to acquire it and apply for a scientific subject at university. They said that good mark in high-level mathematics would be the first step to learning medicine or engineering at university. My parents followed up on my virtual learning. I’m now accustomed to this learning”.

The persistence and responsibility in Alaa’s actual identity, before participating in the virtual classroom, were part of her ritualized learning, because they were motivated by social means (Sfard and Prusak, 2005), and specifically by a wish to adhere to her parents’ wishes. At the same time, the persistence and responsibility in Alaa’s virtual identity, as described above, was designated by the features of the learning environment. Alaa’s learning in the virtual classroom, as expressed in her answer, was ritualized because, firstly, Alaa wanted to adhere to her parents’ wishes. Secondly, what motivated the persistence and responsibility of Alaa was to succeed in her learning in order to enter university. In addition, Alaa’s identity underwent reification as a learner in the virtual classroom. This is expressed in her use of the ‘to be’ verb in “I’m now accustomed to this learning” [11]. Thus, the development of Alaa’s designated identity included the product of being a virtual learner.

3.2.2. Keeping Substantial Learning of Mathematics

Three of the participating students were motivated in their virtual learning by internal factors. These conditions were, from the beginning, part of their actual identity. Answering the question about why he is learning high-level mathematics in a virtual classroom, Amir said: “I like mathematics, as I said before. I always did. Mathematics attracts me. I want always to know more. I think it makes me think in a logical way. This did not change in the virtual learning, despite the increased effort that I had to put into learning mathematics. In fact, putting more effort into learning mathematics made me discover that mathematical problems do not have just one solution. Now, I always look for different solutions for a mathematical problem. I enjoy this solving”.

Amir’s learning does not seem to have changed as a substantial learning. The effects of this learning, say Sfard and Prusak [11], would outlast classroom activities as they seem to be independent of the influence of parents or a particular teacher. In addition, Amir seems to have undergone reification during his virtual learning of mathematics, indicated by the word ‘always’ in his answer. This reification was already part of Amir’s actual identity, but here it developed to concern looking for different solutions to mathematical problems; i.e., with the creative doing of mathematics. This means that the design of the virtual classroom, which was characterized by effortful learning, led to creative doing being part of Amir’s virtual identity.

3.2.3. From Ritualized to Substantial Learning

Three of the participating students underwent a change in their learning, moving from ritualized to substantial learning. The relevant students pointed to the design of the virtual learning as the factor responsible for this change. Answering the question about changes in experience in learning mathematics before and during the virtual classroom, Salam said: “Before the virtual classroom, I only wanted to succeed. I was not interested in understanding the mathematical concepts deeply. The learning in the virtual classroom changed how I learn. Learning on my own made me ask questions about mathematical relations and why they are right. To answer these questions, I needed to deeply understand the mathematical concepts. This gave me insight into these concepts and relations. Now, I am not satisfied with simply applying mathematical rules. I want to understand what lies behind these rules”.

Salam moved towards substantial learning. Before the virtual classroom, she was engaged in ritualized learning, because what interested her was success in exams, without being interested in

the conceptual understanding of mathematical concepts. During the virtual classroom, she needed to depend on herself to understand these concepts. Trying to understand them alone through mathematical texts, she needed to understand the mathematical concepts and relations, especially conceptually, indicating movement towards substantial learning. Students such as Salam had the opportunity in the virtual learning to be independent learners. The virtual classroom provided the opportunity to move from a teacher-centered to a student-centered approach; therefore, students could take control of their learning and thus foster deeper learning [36].

3.2.4. From Substantial to Ritualized Learning

Four of the participating students moved from substantial to ritualized learning. The role of the teacher and the interaction between students and the teacher in the two ways of learning affected the students' learning. These factors appear in the relevant student's answering of the interview questions. Answering the question about changes in experience in learning mathematics before and during the virtual classroom, Husam said: "Before participating in the virtual classroom, I was interested in understanding the mathematical concepts deeply. During the lessons, I used to ask the teacher questions in order to understand the mathematics more deeply. I could not do that in the virtual classroom. The teacher was not there to answer all my questions, so I could not understand the mathematics deeply. I had to be satisfied with applying the mathematical rules to the problems in order to solve them. Sometimes, I did that without understanding the justification for such rule".

Husam moved towards ritualized learning. The absence of interaction between Husam and the teacher in the virtual learning affected his way of learning. Before the virtual classroom, he was engaged in substantial learning, because he wanted to understand the reasoning behind the mathematics he learned. During the virtual classroom, he needed to verify the mathematics from the teacher, but it seems that the teacher did not have the time to answer his questions. This meant that Husam had to be satisfied with applying mathematical rules to the problem in order to solve them. He did that without understanding the reasoning behind the rules, indicating movement towards ritualized learning. Students such as Husam, in face-to-face classrooms, could quickly clarify their inquiries and questions; however, in the virtual classroom, answers were not always immediate, preventing them from engaging substantively with the content and sometimes causing frustration and reducing motivation to learn [37].

4. Discussion

The present research intended to examine secondary students' identities in the virtual classroom, as well as whether these identities changed as a result of their participation in this classroom. Doing so, the present research focused on two issues: features of students' identities and narratives associated with these identities. Results indicated no specific trend regarding the development of these features and narratives, but they pointed to three factors that affected the changes of features of students' identities in the virtual classroom: the design of the virtual classroom, the teacher's role in the virtual classroom, and the student's identity before participating in the virtual classroom. Below, we discuss these factors as impacting the features and narratives of students' virtual identity.

The design of the virtual classroom, including the design of activities in this classroom, has attracted the attention of researchers' in virtual learning. Lin, Chen, and Liu [38] argue that the design of the teaching activity and the flexible application of digital learning are primary issues in technology-based education. Researchers studied the aspects impacted by the design of the virtual classroom, pointing to various such aspects as achievements as well as to the effective outcomes of students' virtual learning (e.g., [32,33,39]). For example, Blackmon [40] reported that the participants described this design as something that facilitated their virtual learning and made it enjoyable. Design affects the social climate in the virtual classroom, especially interactions between the teacher and the student(s), and interactions between the students themselves [41]. In the present case, the design was based on students' asynchronous independent learning and synchronous interactions between the students

and the teacher. Working independently resulted in increased effort by the students whose actual identity in the face-to-face classroom did not have the feature of investing much effort in the learning of mathematics.

The above argument regarding the role of the design of virtual environments in effecting the features of learners' identities leads to the conclusion that the design of the virtual classroom needs to take into consideration the different features of the actual identities of students in their face-to-face learning. Only having limited opportunities for interaction with the instructor could lead to negatively affecting features of students' identities in the virtual classroom regarding their attitudes and emotions towards learning mathematics. We are aware that the minimal options for interaction could also positively affect features of students' identities in the virtual classroom, as can be seen from the extent of effort that increased for some of the students. Thus, the design issue is complicated, but utilizing learning theories in this design could be beneficial [41].

The teacher's role affected the features and narratives of students' identities in the virtual classroom. Zilka and Zeichner [42] found that differential interpersonal communication, feedback, and forums could lead, on one hand, to a decrease in negative affective outcomes, as feelings of threat and, on the other hand, to an increase in positive affective outcomes, as a sense of challenge. In the present virtual learning, the previous factors influenced the identity aspect of students' virtual learning. Here, the role of the teacher was to answer the students' questions synchronously at specific times. This relatively restricted interaction between students and teacher affected the features of the students' designated identity as virtual learners in terms of effort. This is true also for the narratives of identity, whether they are related to substantial or ritualized learning. Here, we conclude that more attention needs to be given to the role of the teacher in the virtual classroom. This conclusion and recommendation is in line with researchers' attention to the role of teachers in the virtual classroom (e.g., [43]). One issue related to this role is whether the teacher-student interaction should be only synchronous, where asynchronous interaction has its own benefits for students' learning [40], including the formation of their identities during this learning. Thus, the virtual classroom needs to possess options for asynchronous interaction in order to support the understanding of mathematical content in this classroom.

Features and narratives of the students in the virtual classroom were influenced from those he or she possessed as part of his or her actual identity before the virtual classroom. In order to understand the mathematical content and succeed in its learning, students' identity features needed to include responsibility for their own learning, persistence, and investment of a good deal of time in this learning. Students whose persistence and responsibility were part of their actual identity before the virtual classroom increased the features of persistence and responsibility in order to meet the increased demands of them as they became independent learners in the virtual classroom.

The virtual identity of students in the virtual classroom were also affected by the learning narratives of the actual identity before the virtual classroom. The actual identity of the students before participating in the virtual classroom differed as some of them were engaged in ritualized learning, while others were engaged in substantial learning. Four types of identity movement occurred from the actual learning before participating in the virtual classroom to the learning that took place in this classroom. The first type is keeping the ritualized learning. Students who kept engaging in ritualized learning in the virtual classroom were motivated to learn high-level mathematics for social reasons, such as adhering to parents' wishes, or for achievement factors, such as completing the exams successfully. Other students kept engaging in substantial learning in the virtual classroom. What motivated these students to learn high-level mathematics was their appreciation for mathematics being a field involved with logical thought. The third type of student moved from ritualized learning into substantial learning. What motivated this move was the design of the virtual classroom, including the materials available for the students. These materials enabled conceptual learning in the form of texts involved with reasoning. The fourth type of student moved from substantial learning into ritualized learning. What motivated this move were the factors above. In this case, the minimal interaction with the teacher, as perceived by the student, which was induced by the design of the virtual classroom,

encouraged the student to be satisfied with applying mathematical rules without understanding them conceptually; i.e., without understanding how they came into being. So, it could be argued that the interaction between the actual and the designated identity of the student influenced the student's reaction to the minimal interaction with the teacher. In some cases, this interaction resulted in having to adopt conceptual understanding in problem solving, while in other cases it resulted in adopting procedural understanding. This is in line with the emphasis of Woods [44] that students need different levels of interaction with online courses in order to be successful. More research, qualitative as well as quantitative, is needed in order to further verify the issue changes in students' identities in virtual learning environments. The interaction issue is of particular importance, especially in terms of the personalized approach to that interaction, which can work well in virtual settings [45].

5. Conclusions

What affected the movement of students' identities in the virtual classroom were three factors and their interaction: the design of the virtual classroom, the teacher's role in the virtual classroom, and the features and narratives of the students as part of their actual identity before the virtual classroom. To elaborate on the interaction between the three factors, the design of the virtual classroom needs to take into consideration the teacher's role, especially the interaction options between the teacher and students, as well as between the students themselves. Students in the virtual classroom would benefit from these options being synchronous as well as asynchronous. The synchronous setting alone would be insufficient because of the limits of time, while the asynchronous setting alone would be insufficient because of the difficulty of writing mathematical symbols in the forums and the wait the student would have to endure until the teacher or other student answers his or her question. More interaction options in the virtual classroom could enrich the affective features of the student's identity, but not necessarily the behavioral features as effort.

As well as taking care in the design of the virtual classroom in terms of factors that encourage independent learning, we argue that more options for interaction need to be present in this classroom. This ensures that students could become substantive learners as a result of this independent and interactive learning. Students who cannot maintain substantive learning in the virtual classroom by learning independently can be encouraged to do so by interacting with the teacher and other students synchronously and asynchronously. The two settings could complement each other because they both contain various interaction options. This conclusion is true for virtual classes in general and classes that go virtual as part of emergency education, such as those that have become widespread as a result of COVID-19.

The design of the virtual classroom also needs to consider the features and narratives of students' identities in the regular classroom. Putting more options for interaction not only increases the role of the teacher but also supports students in terms of the varied features and narratives of actual identity. The virtual classroom needs to include options for flexible teaching and learning, whether personalized or differentiated, where the personalized learning is student-centered while the differentiated learning is teacher-centered [45]. For example, the flipped notion of the classroom can add more options to the virtual classroom by providing appropriate videos and tailoring the activities according to the flipped notion.

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