

Mathematics Teachers of Digital Natives Challenge with Technology: Polygons¹

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Abstract: This study aims to investigate the perceptions of mathematics teachers of secondary school students, who are currently named digital natives, and their views on the use of technology in the teaching process of polygons. This study employed qualitative case study design and was conducted with 3 secondary school mathematics teachers working in Manisa during the 2021-2022 academic year. The participants were chosen by convenience sampling method. Semi-structured interviews were used after the polygons teaching process was completed. Content analysis method was used as data analysis. When the results were examined, participants mostly defined technology as a concept that makes our lives easier and saves us time and effort. All of the participants reported that the use of technology would be beneficial in the teaching process of polygons. In addition, the interactive board and computers were determined as the most basic technological equipment used by the participants. The participants mostly emphasized technical challenges they faced while using technology such as disconnection of internet and touch-screen malfunction.

Keywords: Mathematics Teachers, Digital Native Students, Technology, Polygons.

1. INTRODUCTION

Technological advances have led to the emergence of the concept of information society. Technological tools such as telephone, computer, internet and automobile have become indispensable in information societies (Karabulut, 2015). Prensky (2001) announced the concepts of “digital native” and “digital immigrant” to clarify the cultural and social dynamics created by technology in the information society. While the concept of digital native refers to the generation born after 1980 and growing up in technological opportunities, digital immigrant indicates the generation born before 1980 and later encountered with technological developments (Kakirman Yıldız, 2012). Computer games, instant messaging and the internet have a significant role for digital natives (Prensky, 2001). Digital natives can

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be defined as the children of the 21st century who have put technology at the center of their lives and take part in the digital world with their unique language (Karabulut, 2015).

Digital natives who grew up with technology, internet and digital communication tools and their teachers using printed resources differ across adopting and learning information and their perspectives on learning (Bilgic et al., 2011). As digital natives use technology for learning purposes and social communication, their needs for accessing and sharing information are welcomed in digital environments (Tonta, 2009). Digital natives generally prefer multimedia materials such as pictures, videos and animations instead of written materials (Şahin, 2009). The students, who grew up with technology, prefer to use digital resources for researching and learning as well as obtaining the information they need while doing their assignments through online environments (Ardıç & Altun, 2017).

Technological advancements in the 21st century have significantly impacted not only the education system but also learning and teaching methodologies, permeating various facets of life (İşman, 2011). The Ministry of National Education has undertaken the Movement to Enhance Opportunities and Improve Technology (FATİH) project with the aim of nurturing individuals who are attuned to the demands of the modern era, fostering their ability to question, research, and proficiently utilize information (İslamoğlu et al., 2015). Additionally, the Education Information Network (EBA) was established to curate and disseminate educational content with a focus on integrating technology into teaching practices (Yazlık, 2019). Complementing these initiatives, in-service training programs were meticulously designed for teachers and administrators to empower them in the effective implementation of technological tools within the framework of the FATİH project (Ayvacı et al., 2015).

Changing social conditions cannot underestimate teachers' roles in the education system (Köse & Demir, 2014). Teachers' qualifications are determining factor on the effectiveness of the education system as they have a significant role in conducting classroom learning practices (Demir & Bozkurt, 2011). Families having insufficient knowledge about technology do not guide their children regarding the use of technology, which has increased the significance of teachers with high technology self-efficacy (Sezer et al., 2017). Individuals adapting to technological developments as required by the age can only be trained by teachers who have assimilated information and communication technologies and who have high competencies in the aforementioned fields (Çelik & Bindak, 2005). It is of utmost importance for teachers to develop themselves professionally, especially in technology, and to follow innovations as required by the age (Şen & Sevim, 2006). Moreover, teachers need to know how to use the technological affordances functionally in learning the target objectives during the educational process (Valanides, 2018). Teachers' lack of using technology in teaching processes reduce the efficiency of technological opportunities (Öçal & Şimşek, 2017). The approaches related to technology integration in education consider teachers' deficiencies in using technology as the biggest obstacle to effective use of technology in teaching processes (Odabaşı & Kabakçı Yurdakul, 2013).

The integration of information and communication technologies into learning environments has enriched learning processes and increased visuality in learning activities (Tekinarslan et al., 2015). Besides, computer technologies have contributed positively to the concretization

of abstract concepts in the teaching process and to increase teaching quality (Yılmaz et al., 2000). In this regard, it may be wise to mention the significance of using technology in lessons such as mathematics and geometry, which mostly involve abstract concepts.

One of the sub-learning areas of mathematics, geometry provides visual and spatial skills to students (Keskin, 2019). Information and communication technologies may be used to embody abstract concepts and make learning meaningful in mathematics and geometry instruction (Öçal, 2017). Abstract concepts in mathematics can be presented in a concrete way to promote students' learning by taking advantage of computer technology (Karataş & Güven, 2015). In addition, information and communication technology tools such as computers, interactive boards, tablets, dynamic geometry software such as GeoGebra, Geometer's Sketchpad and virtual manipulatives such as EBA, Morpa Campus, Vitamin Eğitim are used in mathematics teaching (Ural, 2013). Relevant literature covers many studies regarding the positive effect of using technology in mathematics lessons on students' achievement (Ay & Başbay, 2017; Göksu & Köksal, 2016; Karakarçayıldız, 2016; Yılmaz & Yüksel, 2019). Several studies also revealed that the use of technology in mathematics lessons positively influences students' mathematics lesson attitudes (Arslan & Bilgin, 2020; Yücel & Koç, 2011) and reduces their mathematics anxiety (Çelik, 2014; Kutluca et al., 2015). Hence, it is recommended that both national and international curricula include the use of technology in mathematics instruction (MoNE, 2018; NCTM, 2000). Upon analyzing the studies on mathematics teachers' views about the use of technology in the instructional process, the interest level of mathematics teachers regarding the use of technology is high, yet they have difficulty integrating technology into the lessons (Erduran & Taşdan, 2018; Önal & Çakir, 2016).

Since the subjects of geometry lesson are much more associated with daily life than those of mathematics lesson, it is appropriate for concretization compared to mathematics lesson (Göksu & Köksal, 2016). Polygons may be regarded as one of the most suitable subjects for concretization since it involves basic geometric concepts in mathematics class (Korucu, 2009). The use of computer technologies in the teaching process of polygons, which has a significant place in geometry teaching, will facilitate teachers' practices and contribute to increasing the quality of learning (Yılmaz, 2019). As a part of mathematics curriculum at the secondary school level in our country, the subject of polygons is taught at the 5th, 6th, 7th and 8th grade levels, as well as at the 7th grade level in the most detailed way (Ay, 2014). Thus, this study was conducted on polygons for the 7th graders.

On examining the studies conducted with teachers regarding the 7th grade polygons teaching process, the studies are mostly grounded on teachers' views about the misconceptions of the students (Özkan, 2015; Özkan & Bal, 2018), teachers' views about the effect of dynamic geometry software on the teaching process (Delice & Karaaslan, 2015) and the effect of teachers' mathematical belief levels on their behavior in the teaching process (Güler & Altun, 2018).

Thus, it is of great significance to investigate teachers' views on the use of technology in the instructional process and their feelings and thoughts when using technology due to various reasons such as the increasing importance of technology in the education system, the

emphasis on the use of technology in the curriculum and the expectation of incorporating technology into the teaching process of polygons, and the differences across the educational needs of digital natives who are accustomed to technology. Specifically, examining the perspectives of mathematics educators regarding the integration of technology in the teaching process is anticipated to play a pivotal role in not only shaping in-service training initiatives for current mathematics teachers but also influencing the curriculum for future educators. In this context, this study aims to investigate the perceptions of mathematics teachers of secondary school students, who are currently named digital natives, and their views on the use of technology in the teaching process of polygons. In order to find the answer to this purpose, the application was made after the polygons teaching process was completed. In service of this aim, answers to the following sub-problems were sought.

1. How do mathematics teachers of digital natives at secondary school define technology?
2. What technologies do mathematics teachers of digital natives at secondary school use in the teaching process of polygons?
3. What are the mathematics teachers of digital natives at secondary school' views on the benefits of using technology in the teaching process of polygons?
4. What are the challenges faced by mathematics teachers of digital natives at secondary school regarding the use of technology in the teaching process of polygons?

2. METHODOLOGY

This section presents information about the research design, the participants, the process and data analysis.

2.1. Research Design

Qualitative research methods are used in studies that aim to reveal the relationships between concepts in detail (Seggie & Bayyurt, 2021). Case studies allow detailed research on a situation and examining it with comprehensive questions (Yıldırım & Şimşek, 2016). Therefore, this study employed qualitative case study design to investigate the perceptions of secondary school mathematics teachers towards technology and their views on the use of technology in the teaching process of polygons.

2.2. Participants

The study was conducted with 3 secondary school mathematics teachers working in Manisa during the 2021-2022 academic year. The participants were chosen by convenience sampling method. The convenience sampling method refers to choosing easily accessible individuals from the population to save effort and time (Büyüköztürk et al., 2018).

This study used pseudonyms for the participants. Demographic information regarding the participants are displayed in Table 1.

Table 1. *The Information of the Teachers*

Participants	Gender	Age	Faculty	Graduation Degree	Year of Experience
Sabri Teacher	Male	49	Faculty of Science and Literature	Bachelor's Degree	25
Ayşe Teacher	Female	37	Faculty of Education	Bachelor's Degree	12
Hüseyin Teacher	Male	42	Faculty of Education	Bachelor's Degree	19

Sabri Teacher graduated from the Faculty of Science and Literature, Department of Mathematics, he has 25 years of teaching experience and he is 49 years old. He has worked within the Ministry of National Education during his teaching career, and generally, at schools with limited opportunities. Ayşe Teacher, a graduate of the Faculty of Education, has 12 years of teaching experience and is 37 years old. She has completed the "mathematics teaching" program in the faculty of education. She has generally worked at schools with high financial opportunities. Hüseyin Teacher, a graduate of the Faculty of Education, has 19 years of teaching experience and is 42 years old. He has generally worked at schools with high financial opportunities. He has worked in all schools located in low, middle and high socioeconomic regions.

Now, the participants and the second researcher work at the same school. The school is in the district center with various facilities. Beside there is an interactive whiteboard in the classrooms, there are four copiers, including color printing. There are three computers and printers that teachers can use.

2.3. Data Collection Tools

Semi-structured interviews (see Appendix) were conducted with the participants. Interviewing is one of the most widely used data collection tools in social sciences and qualitative studies (Chadwick et al., 1984). The interview form was created from the literature by the researcher and a pilot study was conducted after the two experts' opinion. There were no changes in the interview questions after the pilot study. Only experience has been gained in asking questions and getting answers.

2.4. Data Analysis

Semi-structured interviews were conducted after the polygons teaching process was completed. Semi-structured interviews were recorded during the data collection process, and the audio recordings were transcribed in the computer environment. The researcher took notes during the semi-structured interviews. Moreover, participants were asked to review the transcribed interview data as part of the member-checking process to identify and avoid possible bias. The notes were organized and transcribed in the computer environment. Content analysis method was used as data analysis. The identified codes were classified according to their similarities and differences, and similar codes were categorized under themes. Another field expert has also evaluated the obtained data. The percentage of agreement among researchers was calculated using the Miles & Huberman (1994) reliability

formula [Reliability = Agreement / (Agreement + Disagreement)]. The agreement rate among coders was 92%. Four themes were created by categorizing the codes. The codes and themes were presented in tables with their frequency numbers in findings part.

3. FINDINGS

This section presents the perceptions of the participants regarding technology and their views on the use of technology in the teaching process with tables. These themes were noted as "Definition of Technology", "Technologies in the Teaching Process", "Benefits of Using Technology" and "Challenges Faced in the Use of Technology".

3.1. Views on the Definition of Technology Theme

The participants were requested to define the concept of technology during the interviews. The participants were identified to concentrate on the benefits and function of technology while defining the concept of technology. The definitions on technology are displayed in the Table 2.

Table 2. Teachers' Definitions Related to Technology

Participants	The Definition of Technology
Sabri Teacher	I can define it as all the materials that make our life easier.
Ayşe Teacher	I think, it as a system that includes the concepts of progress in technology, making the flow of life easier, and innovation.
Hüseyin Teacher	Technology is a concept that constantly changes and grows in the form of a snowball, and it can be defined as a set of tools that enable us to do daily work more quickly and effortlessly.

On analyzing the definitions related to technology, the participants' views mostly focus on the features of technology such as making daily life easier and doing things faster. Besides, the participants associated technology with the concepts of development and innovation.

3.2. Views on the Theme of Technologies in the Teaching Process

The sub-themes and codes related to the "Technologies in the Teaching Process of Polygons" are depicted in the Table 3 with their frequencies.

Table 3. *Data regarding Technologies in the Teaching Process*

Sub-Theme	Codes	f
Technological Tools	Wireless Peripherals (Keyboard/Mouse)	2
	Color Printer	2
	Portable Memory	2
	Computer	3
	Photocopier	3
	Smart board	3
Software	GeoGebra	1
	Canva	1
	Fatih Pen / Epic Pen	2
	Digital Books / Documents	3
Education Portals	Online Document Preparation Applications	1
	Educational Websites	3
	EBA (Educational Information Network)	3
	Social Media Environments	3

As is seen in the Table 3, the teachers frequently use technologies such as smart boards (f=3), photocopiers (f=3) and computers (f=3) in the teaching process. Besides, they mostly prefer enriched books (f=3) as the software in the teaching process. Only one participant uses applications such as GeoGebra (f=1) in the teaching process of polygons. Participants also reported that they use educational portals over the internet. EBA (f=3), educational websites (f=3) and social media groups (f=3) are the most used materials, while online test preparation practices (f=1) are less frequently preferred. Some of the teachers' views on the theme of technological tools that can be used in the teaching process of polygons are summarized as follows.

Sabri Teacher: When we say technology use during the polygons teaching process, I think of the smart board. I keep the documents I need in my USB memory stick. (Smart Board, Portable Memory)

Hüseyin Teacher: I think it is significant to use a smart board in class. I organize the documents I use in the polygons teaching process on the computer, copy them and hand out them to the students. (Smart Board, Computer, Photocopier)

Here are some excerpts of teachers' views on the software that can be included in the teaching process of polygons.

Ayşe Teacher: I frequently use the z-book version of the books we use during polygons teaching process on smart boards. Besides, I used the GeoGebra program after the pandemic process. I find it useful as we have the opportunity to engage students in the process. (Z-Books, GeoGebra)

Hüseyin Teacher: I think it is beneficial to use the applications of the reference books on the board and to watch the animations via EBA, and I use them during polygons teaching process. (Digital Books, Education Information Network (EBA))

Some teachers' views on the theme of educational portals that can be used in the teaching process are as follows.

Hüseyin Teacher: I use videos and animations from EBA or similar websites in order to attract students' attention and increase visuality. (EBA, Educational Websites)

Ayşe Teacher: I also get the documents from social media groups where educational documents are shared or from various internet sites. (Training documents and social media groups, Educational Web-sites)

Based on the teachers' views, it is most likely that many technological materials are used in the classroom and outside of the classroom preparation stages. The teachers were also found to have knowledge about the technologies that can be used.

3.3. Views on the Theme of Benefits of Using Technology

The sub-themes and codes related to the "Benefits of Using Technology" theme are demonstrated in the Table 4 with their frequencies.

Table 4. Data on the Benefits of Using Technology

Sub-Themes	Codes	f
Related to Subject Area	This contributes to the transformation of abstract concepts into tangible, understandable ones.	1
	It contributes visually	3
Related to the Lesson Process	It contributes to extending the duration of knowledge retention in the learning process	1
	It benefits a healthy communication process	1
	It increases the variety of materials in the teaching process (audial, visual)	1
	It contributes to learning that is more effective.	1
	It increases students' interest in the lesson.	2
	It saves time.	3
	It allows the transfer of books to the smartboard	3
It provides ease of work	3	

Table 4 reports on the classification of the participants' views under the two sub-themes related to the benefits of using technology: the lesson process and the subject area. Considering the participants' views on the subject area sub-theme, the most frequent code was identified as "it contributes visually" (f=3). As regards the sub-theme related to the

lesson process, the most emerging codes were as such: it provides the transfer of the books to the board (f=3), saves time (f=3) and provides ease of work (f=3). Along with the aforementioned views albeit less frequently, the participants also announced that technology contributes to the communication process with the students (f=1), increases the variety of materials in the teaching process (f=1), contributes to the permanence of learning (f=1) and provides more effective learning (f = 1).

Some examples of the participants' views on the sub-theme related to the subject area are presented below.

Hüseyin Teacher: I think that the benefits of technology to the teaching process may vary depending on the subject. For instance, visuality may be promoted through technology in polygons. (Increases visuality in subject content)

Ayşe Teacher: Mathematics is a lesson in which abstract concepts are common, the visuality may be increased to a higher level through technology and the information can be presented in a more concrete way for students during polygons teaching process. (Increases the visuality of the subject content, facilitates the concretization of concepts)

Some of the participants' views on the theme related to the polygons teaching process are depicted as following.

Sabri Teacher: Technology makes our work easier in the classroom, as it does in many other fields. We can transfer the resources, books and questions to the smart board, and we can save time and effort as we also have photocopiers. (Provides the opportunity to present the materials, saves time, makes the teacher's job easier)

Ayşe Teacher: It will be a cliché, yet this generation has different hearings, different values, different learning styles, and shorter attention spans. . . these examples can be diversified. I think it is necessary to communicate with these children in a different way. When we understand these children and present the information as they demand, we are using their language. (Facilitates communication with students)

The findings revealed that technology provides various benefits in the teaching process of polygons. The participants were found to have positive views on the use of technology in the teaching process of polygons.

3.4. Views on the Theme of Challenges in Technology

Table 5 shows the sub-themes and codes related to the theme of "Challenges Faced during the Use of Technology".

Table 5. Challenges in Use of Technology

Sub-Themes	Codes	f
Challenges related to Teacher	Teachers may have difficulty in using the software.	1
	Teachers may have problems with the classroom	1
Technical Challenges	The interactive board is susceptible to potential breakage.	1
	The interactive whiteboard's screen may experience touch-related issues.	2
	There may be a power cut.	3
	Connection problems may occur.	3

The participants' views on the theme of challenges encountered during the use of technology were grouped under two sub-themes: challenges related to the teacher and technical challenges. Participants declared that some difficulties may be experienced in the use of educational software (f=1) and that there may be difficulties in maintaining classroom order (f=1) related to the sub-theme of problems with teachers. With regard to the sub-theme of technical challenges, the teachers generally experienced power cuts (f=3) and connection problems (f=3).

Some of the participants' views on the theme of challenges during polygons teaching process related to teachers are presented as follows.

Hüseyin Teacher: The 7/F class is a class full of active and uninterested students. When we use the smart board, it can be difficult to control the class. (May have difficulty with classroom management when using the interactive whiteboard)

Sabri Teacher: I do not prefer some programs during polygons teaching process because I find them complex and difficult to use. (Teacher may have difficulty using software)

Here are some examples of the participants' views on the theme of technical challenges.

Sabri Teacher: There may be technical problems such as power cuts and internet connection cut off. When there are such problems, I do not use the smart board or inform the school information technology counselor.

Hüseyin Teacher: The electricity is cut off, the internet is cut off, or the screen of the board does not work. We experienced such problems during polygon teaching, though not very often. There may be a power cut, there may be an internet connection cut off, there may be touch problems on the screen of the interactive board.

The views of the participants on the theme of challenges encountered during the use of technology in the lesson were identified to be mostly related to technical challenges.

4. RESULTS AND DISCUSSION

The technology perceptions of secondary school mathematics teachers were discussed with research in the relevant literature. Participants mostly defined technology as a concept that makes our lives easier and saves us time and effort. Similar definitions have been found in studies conducted with teachers (Yiğit et al., 2013; Yürektürk & Coşkun, 2020). Technology for learners of the digital age can be defined as a concept that takes place in many parts of life where information is accessed, information can be structured, information is shared, communication is provided, it is used as a means of entertainment, and social status is acquired (Ardıç & Altun, 2017). Considering the role of technology in the lives of digital natives and their perspectives on technology, it may be reasonable to express that the participants' perspectives are more superficial and result-oriented. The harmony between the teachers' and the learning digital natives' perspectives on technology and the correct understanding of the learners' perspectives on technology enable to make more effective decisions on the use of technology in teaching processes (Bilgiç et al., 2011). Unlike digital immigrants, digital natives are associated with technology as soon as they are born, and the difference in the growing conditions of digital natives and digital immigrants is effective in their perceptions and perspectives towards technology (Tonta, 2009). Since the working understanding of teachers is defined with that from the past, it should be re-defined to meet today's requirements, and the seminar programs should be designed for the transition to an advanced, modern, learner-centered education model (Dereli, 2019). Koehler, Judi, and Mishra (2009) announced that teachers who are unsuccessful in following up-to-date educational technologies would also fail to demonstrate effective teaching, since they are expected to effectively incorporate technology into teaching processes along with the requirements of the age. Therefore, advances in teaching psychology and teaching methods and techniques should be effectively transferred to teachers through in-service training activities due to the effects of technological developments on social life and the changing needs of the society and the individual.

The findings suggested that the interactive board was determined as the most basic technological equipment used by the participants during the teaching process of polygons. Web-based materials such as Education Information Network (EBA) are also preferred together with the interactive whiteboard. The rapid changes in technology, the widespread use of computer technologies and the internet have great effect on the field of education (Baysan & Çetin, 2019). Digital natives often use technology with such purposes as social networks for daily information search, leisure time, research and communication; moreover, the mostly used technological tools were determined as smart phones, computers and tablets (Yalçın, 2017). It is likely to mention that the materials used by the teachers and those by the students are similar in terms of their functions. Interactive boards can be used for various different purposes as they have computer infrastructure and internet access. It would be beneficial to carry out training activities for teachers to effectively integrate educational software and web tools that can be used in interactive whiteboards during the teaching process.

All of the participants reported that the use of technology would be beneficial in the teaching process of polygons. The perspective towards technology is paramount in making the most appropriate use of the opportunities brought by technology (Çelik & Kahyaoğlu, 2007). The participants mostly indicated the benefits of technology as increasing visuality, reflecting materials and saving time. Likewise, Vural & Ceylan (2014) put forward that the use of technology is necessary for reasons such as visualizing concepts and enriching the teaching process. The findings also demonstrated that technology-based education applications make the teaching process more effective and help to save time and effort. The teachers underlined that technology has a positive effect on students' motivation and boosts students' interest in the lesson. Similar studies suggested that teachers shared the same views about the use of technology in the teaching process (Ayvaci et al., 2015; Önal & Çakir, 2016; Yürektürk & Coşkun, 2020).

The participants mostly emphasized technical challenges they faced while using technology in the teaching process of polygons. Challenges related to software were also determined in addition to electricity, internet cuts and hardware problems. Similar results emerged in some studies (Keleş et al., 2013; Türel, 2012).

5. RECOMMENDATIONS

Based upon the research findings, it would be beneficial to inform secondary school mathematics teachers regarding the software and web-based materials they can use with in-service training. Given that the participants mostly encounter technical challenges, it would be wise to find competent personnel that teachers can access quickly for the solution of technical problems. It may also be recommended to strengthen the electrical installation and internet infrastructure of schools for solving the problems.

6. ABOUT THE AUTHORS

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Appendix

Interview Form

Hello, I aim to determine the opinions of high school mathematics teachers regarding the teaching methods they use, technology, and their use of technology.

Dear teacher colleagues, I believe that you will answer the following questions sincerely. All information you provide during the interview will remain confidential. Participant information in our study will be indicated with pseudonyms. If there is no objection, I would like to record this interview with your permission. This interview is estimated to take about 50 minutes. Is there any thought you would like to share or any questions you would like to ask before we begin?

Gender : Female Male

Years of Professional Experience : 1-5 Years 6-10 Years 11-15 Years 16-20 Years 21 Years +

Educational Background : Bachelor's Degree Master's Degree Doctorate

Faculty : Faculty of Education Faculty of Sciences and Literature

Pseudonym:

Interview Questions

1. What does the concept of technology mean to you?
 - What are the effects of using technology in the teaching process on students?
 - In your opinion, what are the positive and negative aspects of using technology in mathematics education of your digital native students? Could you explain?
2. Do you think you give enough emphasis to technology in your lesson processes related to polygons?
 - During remote education, which technological equipment did you use? Could you describe your teaching process?
3. Can you describe your lesson planning process related to polygons?
 - What role did technology play in the lesson planning stage for your digital native students?

- What technological materials (software, hardware) did you use during the teaching process?
4. Are there any technological opportunities that you think would be useful and would like to have in the process of teaching polygons?
- What are these opportunities?
 - How should they be used in the teaching process for your digital native students if they are available?
5. What kind of difficulties do you encounter in integrating technology into your lessons?
- Do these difficulties limit you?
 - What measures do you take to overcome these difficulties? Could you explain?