Five-point Level of Mathematics and/or Physics in a Virtual High School: Why? Why not? Who? And So What?

Yaniv Biton	**Osnat Fellus**	**Dafna Raviv**
Shaanan College, Center for Educational Technology	University of Ottawa	Center for Educational Technology
yanivb@cet.ac.il	osnat.fellus@uottawa.ca	dafnar@cet.ac.il

Abstract

The increasingly growing number of virtual high schools around the world has engendered new modes for teaching and learning and a new area of research. While research in this field has mostly taken a comparative lens that highlights differences between traditional modes of teaching versus online teaching, research on students' perspectives has remained dearth. This study identifies students' perceptions of their learning five-point level mathematics or physics in the first Israeli virtual high school, which was launched four years ago. A survey of 41 questions was disseminated to the 86 grade-12 students who took five-point level mathematics and/or physics in the Israeli virtual high school in 2015. In addition, students' essays on what it means to be a virtual student in a virtual high school also provided valuable data. The authors examined the students' responses to shed light on the teaching and learning model employed in the virtual high school, and to identify the students' needs and the aspects of the virtual high school teaching model that need to be improved. The data provided important information on virtual learning, teacher-student relationship, environment-specific learning skills, and challenges specific to virtual learning environment.

Keywords: virtual high school, students' perspectives, mathematics, physics.

Introduction

The term virtual learning environment has been used interchangeably with terms such as distance education, e-learning, and web-based instruction (Rice, 2006), to mention just a few. For the purposes of this paper and to reflect a current perception of what virtual learning environment is, we draw on the definitions of Crean Davis and her colleagues (2014), Rice (2006), and Schlosser and Simonson (2002) to frame virtual learning environments as systems that provide technology-mediated information spaces; facilitate synchronous and asynchronous teacher-student and student-student interaction that is independent of geographical proximity; harness pedagogically rich teaching approaches; and promote statewide or district-wide curricula by gauging, inter alia, students' progress through ongoing tests, homework, evaluations and assessments of students' work. Given the multifarious aspects of this definition, we see the term as a referent of more recently developed virtual learning environments rather than as a reflection of how online programs looked like a quarter of a century ago. Looking back, it is important to note that the first online programs were launched about twenty-five years ago in the United States (Watson, Murin, Vashaw, Gemin & Rapp, 2011) and in Canada (Barbour, 2011). To date, there are about 200,000 students in Canada (Murphy, Rodríguez-Manzanares & Barbour, 2011) and 700,000 students in the US who learn in different virtual environments (Picciano, Seaman, Shea, & Swan, 2012).

Research highlights several possibilities and limitations that are engendered in virtual learning environments. For example, it was found that learners in virtual environments have higher

levels of motivation (Barbour, 2011; Noonan & Tunison, 2001), and that such environments generate wider accessibility for learning, provide quality-learning environments, improve learning skills (Berge & Clark, 2005), and enable interaction with other students and teachers who are located in distant geographical areas (Barbour, 2008). Some of the limitations identified in the literature concern the overwhelming amount of work required from the students, learners' distraction (Blau & Caspi, 2008; Kock, 2007), and technical problems (Barbour, 2008). In comparative research that looked into students' perspectives in traditional and virtual environments, studies showed conflicting results. While some studies found that students who learn in virtual environments are more satisfied with their learning experience (Summers, Waigandt & Wittaker, 2005; York, 2008), other studies found that there are no significant differences in learners' satisfaction between students who learn in virtual environments versus students who learn in traditional settings (Cavanaugh et al., 2004; Driscoll et al., 2012; Rivera & Rice, 2002; Ungerleider & Burns, 2003). Given these findings and with the exponentially increasing numbers of virtual learning programs, the extent of research that focuses on learning in virtual environments remains dearth (Barbour, 2010). It is not surprising then that there are repeated calls for continued research in virtual learning programs in general (Barbour, Siko & Simuel-Everage, 2013) and in high school programs in particular (Rice, 2006). The purpose of this paper is to contribute to the field of virtual learning by providing a snapshot of students' perceptions of their experience in the first Israeli virtual high school.

In September 2012, the Center for Educational Technology (CET) together with the Trump Foundation and the Israeli Ministry of Education launched the first virtual high school (VHS) in Israel. The purpose of the school was to address the problem of alarmingly decreasing numbers of students who opt for higher-level mathematics and physics classes. The VHS was set to make advanced courses in mathematics and physics available to students in peripheral areas where shortage of qualified teachers who can teach advanced courses in these locations prevented these students from taking these courses. As well, the Israeli VHS was set up to make these courses available to students in schools that could not open advanced classes in mathematics and physics because of the very low number of students who were interested in taking the classes. To date, the VHS offers advance classes in mathematics, physics, and civic studies. The unique model of the Israeli VHS is that of a fully online platform, which essentially means that all communication modes between the teachers, the tutors, and the students are made in the virtual environment with no face-to-face meetings.

The fully online program is free of space-related constraints and as such it allows wider populations of students to learn the above-mentioned subjects. The model employed in the Israeli VHS is comprised of synchronic lessons with a teacher and a class that has about 27 students from five or six different high schools from around the country; two to three hours of virtual tutoring that takes place in groups of up to four students working with a university student who majors in the relevant field; homework assignments that are submitted electronically, and online quizzes and tests. The learning environment in the Israeli VHS provides content through highly diverse media, interactive tools, real-time feedback, and ongoing support that is accommodated to the needs of each student.

The first cohort of the Israeli VHS graduated in the summer of 2014. The first three Figures reflect the growth and development of the VHS in the first four years of its operation. Figure 1 shows the number of participating schools that had students enrolled to the VHS. Figure 2 reflects the number of classes by subject. Figure 3 points to the number of students in the VHS.
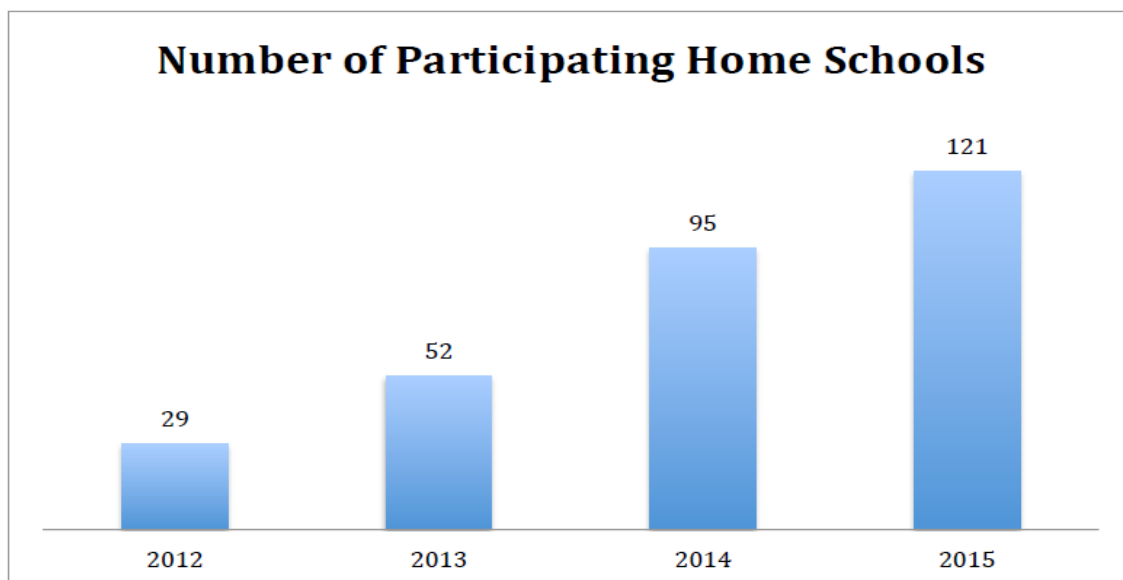
Figure 1. Number of participating homeschools

Looking at the figure, we see the growing number of participating homeschools starting at 30 and reaching 129 in the first four years of the VHS' operation.
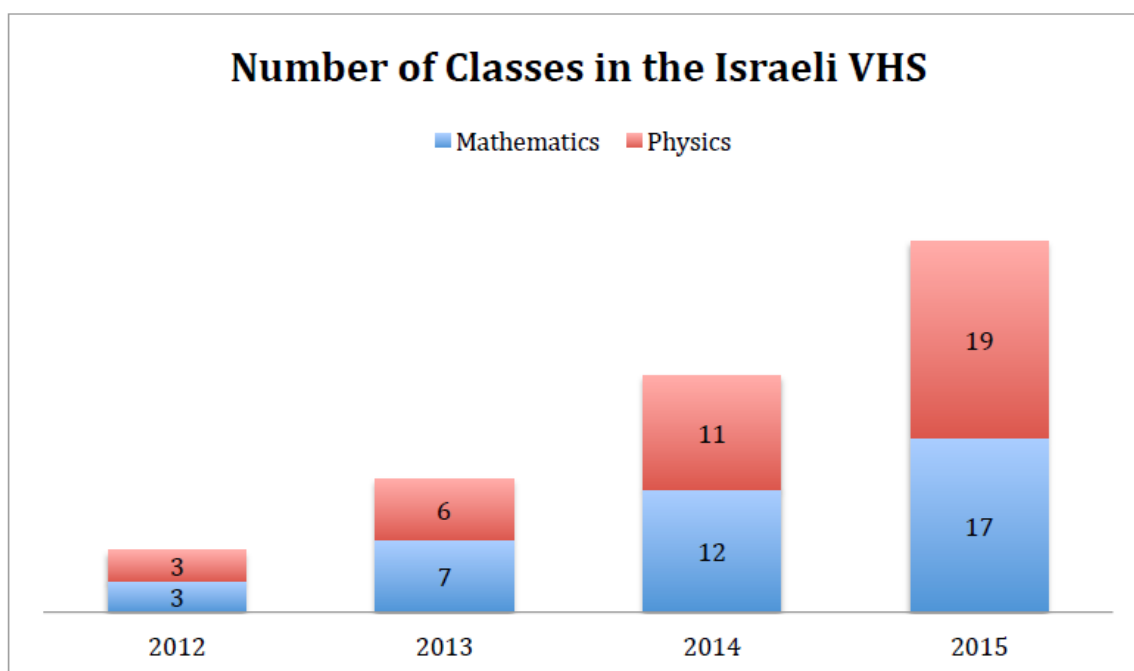


Figure 2. Number of classes in the Israeli VHS

As shown in the figure, the number of classes began with six in 2012 and got to 39 within the school's first four years of operation.
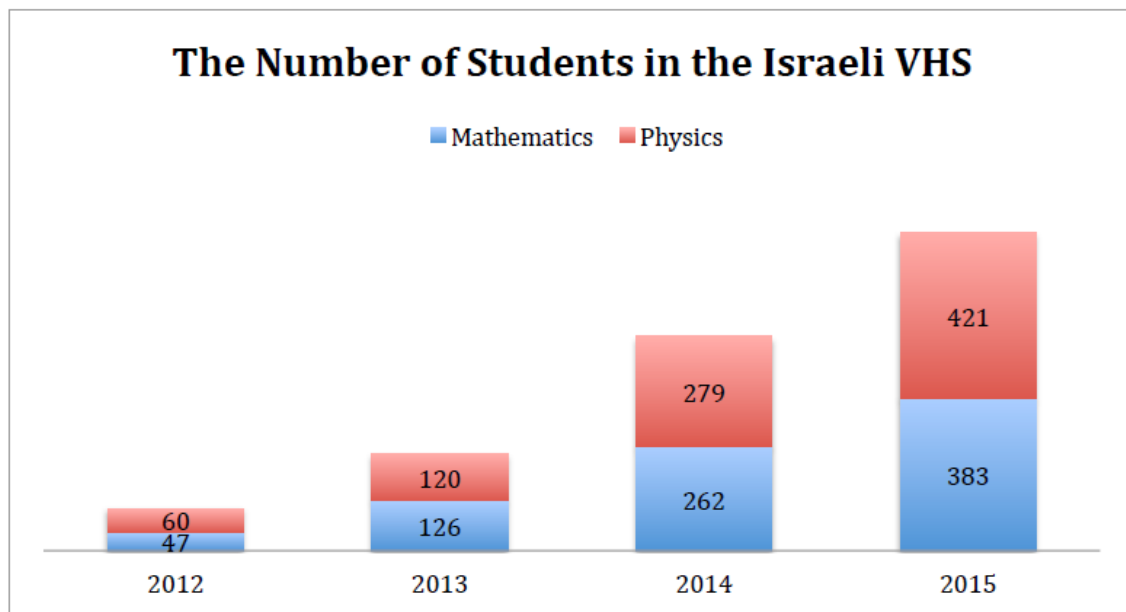
Figure 3. Number of students in the Israeli VHS

As shown in the figure, the number of students enrolled in the VHS was 131 in 2012 and grew to 891 within the school's first four years of operation.

In regard to demographics, the student population was comprised of 74% Jewish students, 11% Bedouin students, 12% Arab students. The students enrolled from all areas of Israel as Figure 4 shows.
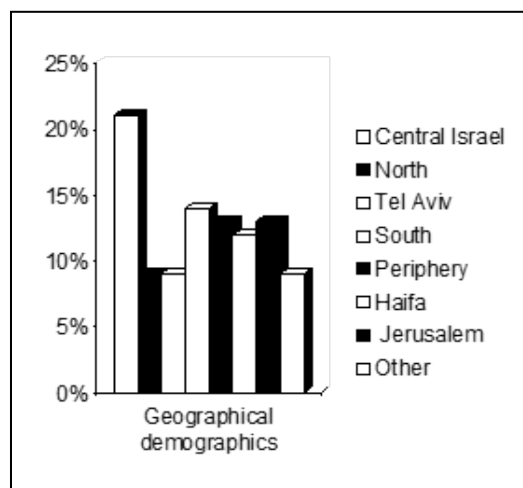
Figure 4. Geographical demographics

As shown in Figure 4, the VHS had students from all over the country.

To attend synchronic classes, the students sit at their computers in their respective homeschools. The teacher shares content through the platform of the VHS. The content is presented in the form of a presentation, a video, or any other visual aid. The VHS platform includes a great many features the teacher can use. For example, the teacher has the option of opening a "white screen" that allows a dynamic writing platform that the students too can use.
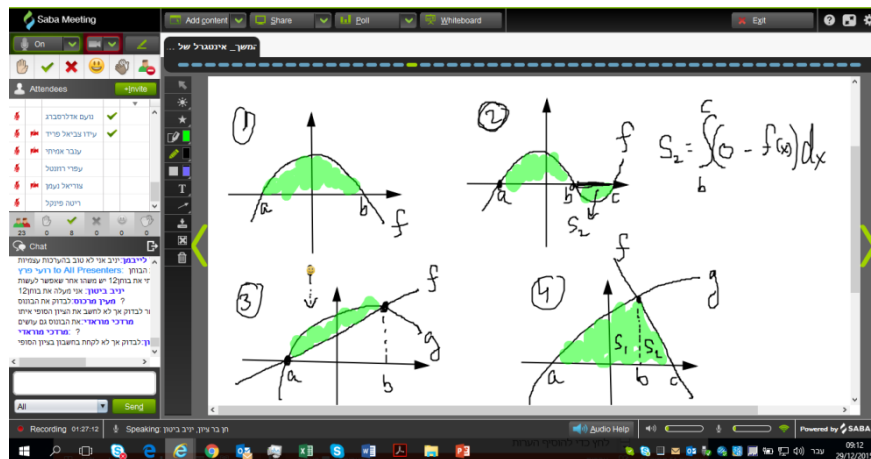
Illustration 1: White screen

As shown in this illustration, the platform in the VHS allows both teacher and students to use the white screen to share ideas and discuss them.

The platform has a few tools of communications available to the VHS teachers and students. One such tool is the integrated camera, which the teacher has the option of using to illustrate ideas using artifacts or manipulatives. This allows the student to see the teacher in a small frame in the corner of the screen. The student has a microphone that remains mute during the lesson unless the student speaks, asks or answers a question, takes part in a discussion, and so on. Another tool of communication is the chat, an integrated feature in the VHS platform that allows the student to interact with the teacher in private or, alternatively, to speak to the whole class. The latter may take place when a student answers a question or consults with other students during the lesson.

Methodology

Research Questions

This paper is partially based on data collected by the CET Research and Evaluation Unit (REU) whose purpose is to guide and gauge the development of the Israeli VHS from its inception. The REU has developed a questionnaire to identify student needs and aspects in the Israeli VHS platform that need to be improved. Specifically, this paper brings forth part of a study that was conducted on the teaching and learning in the Israeli VHS. The study included several research questions and a variety of research tools. This paper will focus on the following questions:

1. What are the students' perceptions about virtual learning in general and the virtual high school in particular?

2. What context-specific aspects do students highlight in their experience of the VHS and of traditional learning environments?

Participants

Eighty-six grade-12 students who took five-point level mathematics and/or physics in the VHS in 2015 participated in the research. Forty-one were females; forty-five were males. Among the 86 students, 50 began their studies at the VHS in September 2013, which means they attended the VHS for three full **school** years. Twenty-one students began their studies at the VHS in September 2014 and 15 joined the VHS in September 2015.

Research Tools and Data Analysis

A variety of tools were used to collect data. In this paper, we will draw on data that were collected through a questionnaire, student essays, and the SWOT technique.

An online questionnaire was put together in Google Docs. The questionnaire had 41 questions. Thirty-eight of the items in the survey were likert-scale questions; three were open-ended questions. The likert-scale questions focused on a wide range of aspects related to learning in a virtual environment in general and in the VHS in particular. Questions included reference to the year the student began his or her studies in the VHS, the subject they took, the experience of learning in the VHS, aspects of the different modes of teaching and their contribution to learning, and the available tools in the VHS.

The three open-ended questions were the following:

1. Looking back at your school years in the VHS, please note what you were most pleased with.

2. Please note what you would like to see changed in the VHS. These can be recommendations to the VHS team as to the general treatment of students, the virtual meetings with the teacher, the tutoring, the homework, or any other aspect that you think of.

3. Some think that face-to-face learning is preferable to virtual learning in preparing students for the future; others believe that virtual learning is necessary to prepare students for the job market. What is your opinion?

The combination of likert-type questions and open-ended questions was aimed to garner deeper insights about teaching and learning in virtual environments from the students' perspectives. As is acceptable in studies that rely on qualitative and quantitative analyses of data, the students' responses to the likert-type questions were analyzed with descriptive statistics. The responses to the open-ended questions were analyzed using inductive analysis in order to identify key themes (Patton, 2002) and typical patterns (Bogdan & Biklen, 1982).

Students' essays on what it means to be a virtual student in a VHS were another data source. Students were asked to share their experience of learning in the VHS and their thoughts of the differences between virtual learning and face-to-face learning. Eight essays were submitted and analyzed.

In addition, data included fully recorded synchronous lessons from the VHS repository of lessons. The lessons in the VHS are recorded and are readily available to the VHS students as well as teachers. Furthermore, all homework assignments, solutions to the exams, and students' tests are scanned and kept in the repository so that they are readily available to the teacher at any given moment. This repository of data was conducive to our efforts in better understanding students' experiences in the VHS.

Results

The questionnaire included several topics so that we can get a sense of what students thought about the subject they chose to learn in the VHS, the teaching and learning process, academic achievements in the VHS, the usefulness of the available learning tools in the VHS, and the content of the subject learned. In light of the extent of the questionnaire, we chose to focus on selected statements in some of the topics. The selection of the statements was done to provide more insights about the teaching and learning model employed in the VHS as they were perceived by the students. Students provided their responses on a five-point likert-type scale (1=strongly disagree, 5=strongly agree).

Table 1 illustrates students' perspective about teaching and learning in the VHS.

Table 1. Students' perceptions of the teaching and learning in the VHS

Statement	Mean	Standard Deviation
The VHS prepared me well for the matriculation exam	4.01	0.86
I understood the content taught by the teacher	3.81	0.98
The tutors helped me to better understand the material at hand	4.35	0.93
The tutors addressed the difficulties I was experiencing	4.28	0.97
Homework in the VHS is treated more seriously than in traditional classes	3.87	1.25
Homework helped me better understand the material at hand and improve my achievements	3.62	1.12
Learning with students from other locations in Israel was a meaningful experience for me	3.52	1.27
My homeschool supported my learning in the VHS and provided the necessary conditions to allow it	3.35	1.18

Table 2 shows the extent of usefulness students attribute to the available teaching and learning tools in the VHS.

Table 2. Students' perceptions of the usefulness of available tools in the VHS

Statement	Mean	Standard Deviation
Power Point Presentations	3.99	0.89
Recorded lessons	3.51	1.36
Geogebra and dynamic simulations	2.87	1.16
Writing and speaking tools in the synchronic environment (chat, voting, writing)	4.02	0.96
Virtual labs (for students of physics)	3.65	1.21
To what extent are there technical problems associated with the VHS?	2.88	0.70

Table 3 illustrates students' perceptions about learning in a virtual environment.

Table 3. Students' perceptions of learning in the VHS

Statement	Mean	Standard Deviation
If I had a chance, I would prefer to learn the subject at my homeschool	3.47	1.28
If I had a chance, I would learn more subjects in the VHS	2.91	1.37
While learning in the VHS, I have acquired skills that are vital for the job market	3.59	1.02
I will encourage others to take a course at the VHS	3.81	1.18
I recommend that every high school student take a course at the VHS	3.31	1.26

Table 4 shows students' level of satisfaction of their achievements in the VHS and their perceptions of maximizing learning in the VHS.

Table 4. Students' level of satisfaction in the VHS

Statement	Mean	Standard Deviation
I am pleased with my achievements in the subject I chose to learn in the VHS	3.85	1.05
I think I can do well on the matriculation exam in the subject I chose	4.06	0.79
My achievements in the VHS reflect my utmost efforts	3.41	1.18
I am pleased with my joining the VHS	4.03	1.07

An analysis was conducted of the students' essays and their responses to the following two open-ended questions:

1. Looking back at your school years in the VHS, please note what you were most pleased with.

2. Please note what you would like to see changed in the VHS. These can be recommendations to the VHS team as to the general attitude toward students, the online meetings with the teacher, the tutoring, the homework, or any other aspect that you may find relevant.

In order to make sense of the data, we employed the SWOT model of Strengths, Weaknesses, Opportunities, and Threats. The SWOT framework was put together in the second half of the 20th century by a group of researchers in the Harvard Business School (Chermack & Kasshanna, 2007). It was since used as a research tool in various contexts (e.g., Westhues, Lafrance, & Schmidt, 2001). Students' responses were first categorized into the SWOT framework. We then noticed that each of these categories generated two subcategories. Table 5 shows the different categories and provides statements from students' input.

Table 5. Analysis of students' written input using the SWOT model

Category		Students' statements
Strengths and Opportunities	The quality of the teaching staff (teacher and tutor) and teaching practices	✎ The teacher taught us in a way that makes it difficult to forget even after graduation, which allows us to understand everything in depth. The tutor was phenomenal. The way solutions were explained and the commitment in making sure we do well and the solutions of exercises in addition to those presented in the lesson. ✎ Learning in small groups so that you get personalized attention, taking homework seriously and giving constructive and to-the-point feedback on your homework.
	Technology and teaching materials	✎ No matter where you are, you can log on and simply attend the class even when you are sick at home or on a trip (with a laptop), and the lessons are recorded so that you can make up for missed material or refresh your knowledge. ✎ The use of advanced programs, like Geogebra, that help in better understanding the material.
	Unit pride	✎ The opportunity to get to know amazing teachers and new friends that I would have never met were it not for the course at the VHS. ✎ I am most pleased with the exposure to scientific environment that my homeschool does not provide
Weaknesses and Threats	Homework (heavy load, technical difficulties uploading assignments electronically	✎ The way we had to submit homework was very frustrating. Each exercise had to be written in an orderly manner, scanned, and submitted. There were so many technical problems in the process.
	The management of the lesson and the tutorial	✎ I wish the lessons were more to the point so that students would be fully engaged because it's very easy to lose your concentration when you sit at the computer.
	Technology and the learning environment	✎ Put more emphasis on the responsibility schools have to provide an adequate learning environment such as computers and quiet classes to their students.

In addition, in analyzing the responses to the second open-ended question: Some think that face-to-face learning is preferable to virtual learning in preparing students for the future; others believe that virtual learning is necessary to prepare students for the job market. What is your opinion?, we noticed students' responses generated the following three types of responses: 1) Preference to face-to-face learning; 2) Preference to a combination of face-to-face and virtual learning; 3) Preference to virtual learning. Table 6 illustrates the three categories and an example for each is provided from the data.

Table 6. Learning virtually versus face-to-face

Category	Students' statements
Preference to face-to-face learning	I think that the interactions among the students and between the students and the teacher are very important and it's far easier to manage a face-to-face discussion when you have multiple participants, this is why I think that face-to-face lessons are irreplaceable.
Preference to a combination of face-to-face and virtual learning	On the one hand learning in a virtual environment is very convenient. If I missed a lesson, it's recorded. There is an organized repository of the whole material. On the other hand, if I find something difficult to understand, I have no one to turn to for explanations because I'm the only one from my homeschool enrolled in the VHS. In addition, it's hard to learn about things that require tangible demonstrations (such as labs…) However, thanks to the VHS, I developed habits of individual work and personal responsibility. In spite of everything, this is also important for the future.
Preference to virtual learning	I see virtual learning as preferable to face-to-face learning because of the advantages it carries: 1) The student can go over recorded lessons for missed classes; 2) Extensive support and an experienced staff that is there for the student all the way; 3) It's more convenient and allows to learn anywhere, anytime.

Discussion

We would like to remind the reader that the survey given to the grade-12 students was collected in April 2016 and that 86 students out of 143 sent in their responses. The students were asked three open-ended questions that pertained to points of success, points for improvement, and preference of a learning environment. The following insights answer the 'So what?' question that we put in the title:

- **The VHS is perceived as a quality learning environment:** The students see the VHS as a place of quality, novelty, high level of professionalism of the teaching staff, advanced technology and teaching material, commitment to the students' success, investment, and respectful attitude.

- **The importance of the human capital in the VHS:** The quality of the teachers and the tutors together with the administrative staff play a key role in the students' success. The VHS model and the platform it is based on allow the accessibility of this human capital to students regardless to where they live.

- **The importance of the interpersonal interaction:** Even in the technological era, students still underscore the importance of relationship and personal connection between teachers

and students and among students. Personal relationship and unmediated connection is perceived as important to learning. Interpersonal skills are perceived as key to the future job market. The need for relationship and personalized interaction, especially in a virtual learning environment, is challenging and most students noted the lack of it as a disadvantage of the VHS model.

- **The meaning of integrating technology in learning:** Students see the integration of technology in learning as important but not at any cost. Technology needs to be user-friendly and compatible to specific needs. In this respect, homework-related use of technology was perceived as unnecessarily difficult.

- **Skills acquired in virtual learning environments:** Students reported that virtual learning develops a strong sense of responsibility, learning capabilities, and self-discipline—that are crucial to their future success.

- **Learning in a virtual environment, at times, poses difficulties to students**: Students report difficulties in maintaining concentration while working at the computer for long hours, challenges in receiving immediate feedback, a disconnect between the homeschool and the VHS which, in turn, creates a higher burden of homework, and a disruption of day-to-day life.

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