Learning Styles and Student Performance in Blended Learning

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Abstract – **Learning style is something that merits consideration when we consider the factors related to study success. This study examines, with the help of the Felder-Silverman model, the impacts of the learning styles of information technology students on learning outcomes in Master's degree program on information technology organized in accordance with the blended model. The relationship between learning outcomes and learning styles is examined with the help of course grades. In the education program targeted by this study, lecture videos play an important role in study participation. It is for this reason that learning styles, in addition to learning success, are examined here in relation to participation modes and participation activeness.**

Keywords- component; learning style; student performance; blended learning

I. INTRODUCTION

There are many things that affect students' success in study. When we consider the reasons behind study success, one important target of examination are the impacts of various learning styles. A student's individual learning style reveals how the student best receives and handles information. Awareness of students' learning styles makes it possible to take those styles into account in education planning.

It is believed that learning styles affect the choice of the field of study [1]. Also Litzinger et al [2] found differences between students of engineering, students of education and those of liberal arts. Effects of learning style on students' learning success based on grades have been investigated in [3], [4], [1] and [5], among others. Some investigations found no connection between learning style and study success [1]. On the other hand, some studies ([3], [4] and [5]) have yielded similar results of the positive effect of certain learning styles. However, learning style is only one of the factors influencing study success.

When examining the effects of learning styles, it is important to pay attention to other factors, such as the effect of various participation modes, that are related to the learning environment. This becomes emphasized especially when education has been arranged in a flexible manner so that there are several alternatives regarding how to participate in education.

The provision of Master's degree education in information technology at Kokkola University Consortium Chydenius is very strongly supported by solutions of educational technology. The central part of the education arranged in accordance with the embedded model is formed by lecture videos produced of face-to-face teaching situations. All the degree program teaching is available as real time streaming video and as on-demand video. The students can freely choose the way, from face-to-face teaching and lecture videos, to participate in education for each lecture.

In the degree program, learning with the help of videos has arisen to a very important role in study participation [6]. According to research, use of lecture videos positively affects study participation and, through that, grades [6]. This seems to indicate that students often adapt their study in accordance either with the course or with their life situation. It also seems that many of the students might not have just one single mode to participate in the education provided [6]. This means that at least in some situations students are forced to study, to a certain extent, without paying attention to their own learning styles. A learning style may affect how the student experiences the use of lecture videos [7]. For this reason, it is important to find out whether lecture videos influence the study success of some student groups. This is why, on examining the learning styles, it has been found desirable to concentrate specifically on their effect on grades in education where the students have the opportunity to use videos for study participation.

First this paper presents the learning style model used in the study. Next, the distribution of learning style results obtained through the learning style survey is presented. Here the results are examined also from the viewpoints of students' gender, distance and different participation modes. Finally, we focus on the relationship between participation activeness and learning styles as well as on the importance of learning styles on learning success.

II. LEARNING STYLE MODEL

In this research, the Felder- Silverman model [8] was used as the learning style model. The model describes students' preferences in receiving and processing information. The choice of the model was influenced by the fact that it was developed especially for engineers. The validity of the model has been justified by extensive material from different publications on the distribution of learning style results. According to that material, there are clear similarities in the learning style of engineering students ([9] and [10]). In

addition, the model has connection points with other learning style models [9]. The best known of these are the Kolb's learning style model, [11], Mayers-Brigg type indicator [12], VAK model (visual, auditory and kinesthetic learners) [13] as well as the general belief about division of students into visual-spatial and auditory-sequential learners [14] and into left-brain dominant and right-brain dominant thinkers [15] Definition of a learning style result is also fast and easy with the Index of Learning Style (ILS) questionnaire which Felder developed together with Barbara A. Soloman.

The model has four, in theory orthogonal, dimensions. The dimensions, which are shown in Fig. 1, are active-reflective, sensing-intuiting, visual-verbal and sequential-global. The ILS questionnaire includes 44 questions. For each of the dimensions, therefore, there are 11 questions. The questions have an a or b alternative. Further on, the scale from 0 to 11, which in fact is the number of the b answers for the ILS questionnaire, is used in the figures.

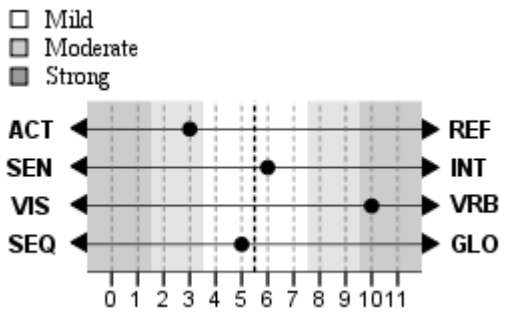

Figure 1. An example of an ILS result, where the learning style preference is moderately active, mildly intuitive, strongly verbal and mildly sequential

The preferences of active and reflective students differ in their way of handling information. Active students prefer to deal with information in the external world somehow, for example by discussing or testing that information in some way. Reflective learners observe their environment and deal with information by thinking about it. There is an equivalent of that dimension in the introvert-extrovert dimension of the Mayers-Briggs type indicator and a connection to active experimentation and reflective observation in Kolb's learning style [9]. It also has connections to Fleming's VAK model. The learning style result in the example of Fig. 1 is active.

Sensing people observe the world in a way that is different from the way intuitive people observe it. Sensors like empirical facts, data and practical procedures. They have patience for work tasks in which accuracy is required. Intuitors prefer principles and theories and are better than sensors in dealing with symbols. They are fast but might commit errors through carelessness. There is an equivalent of that dimension in the sensing-intuition dimension of the Mayers-Briggs type indicator and a connection to concrete experience and abstract conceptualization in Kolb's learning style [9]. The learning style result in the example of Fig. 1 is intuitive.

The preferences of visuals and verbals differ in the way they receive information. Visual learners are best in remembering information presented through images, diagrams and multimedia. Verbal learners remember best speech they have heard or text that is written. The dimension has connections, e.g., to the VAK model and to visual-spatial and auditory-sequential learning styles [9].The learning style result in the example of Fig. 1 is verbal.

Sequential and global learners progress differently in the learning process. Sequential learners learn at steady pace. They want to advance in logical steps to a more demanding level. Global learners, on the other hand, learn in fits and starts. First they have to perceive the whole in order to apply knowledge. Global learners might find it difficult to learn in a traditional school world, but among them there often are the most gifted students. Also this dimension has a connection to the visual-spatial and auditory-sequential learning style [9]. Sequential and global learners are also close to, for example, left-brain dominant and right-brain dominant thinkers [9]. The learning style result in the example of Fig. 1 is sequential.

One of the strengths of the Felder-Silverman model is the continuity of dimensions. Describing learning styles with continuous dimensions corresponds to reality better than classification to categories. As a result of continuity, a learning style preference can be mild, moderate or strong.

If the preference is mild, the person is better able to vary his/her learning style in different situations. In that case the learning style is well balanced in the axis concerned. In the example of Fig. 1, the result of ILS is mild on the sensing-intuiting and sequential-global dimensions. A person with a moderate preference learns best in an environment which provides support for his/her preference. A strong preference can make learning more difficult in an environment which favours a contrary learning style. In the Fig. 1, ILS result is fairly active and strongly verbal.

III. ILS Results

The material of this article consists of the learning style results of 76 Master's students in information technology. A Finnish language version of the ILS questionnaire was used in the research. For some of the students the ILS questionnaire was offered as a paper version and for others as a web form to be filled in on the web. The students responded the questionnaire under their own names; thus it has been easy to examine the results as far as different variables are concerned.

Fig. 2 shows the distribution of results along four learning style axes. Collection of the material began in 2008. With the completion of the material, the distribution forms have remained quite unchanged [16]. In Fig. 2 material, especially the sensing-intuiting and visual-verbal axes have a skewed distribution. Typically, the results in articles dealing with learning styles have been presented as averages along each learning style axis regardless of the form of distribution. In Fig. 3, the students' learning style results are presented as averages as well as boxplot diagrams on each learning style axis. The boxplot diagram attached to the figure shows the sample minimum, lower quartile, median, upper quartile and sample maximum for the material. Thus it gives a good idea about the distribution of each learning style axis. Due to the skewness of the distributions, later this kind of combined form of presentation will be used for the presentation of the results, and non-parametric tests will be used for testing.

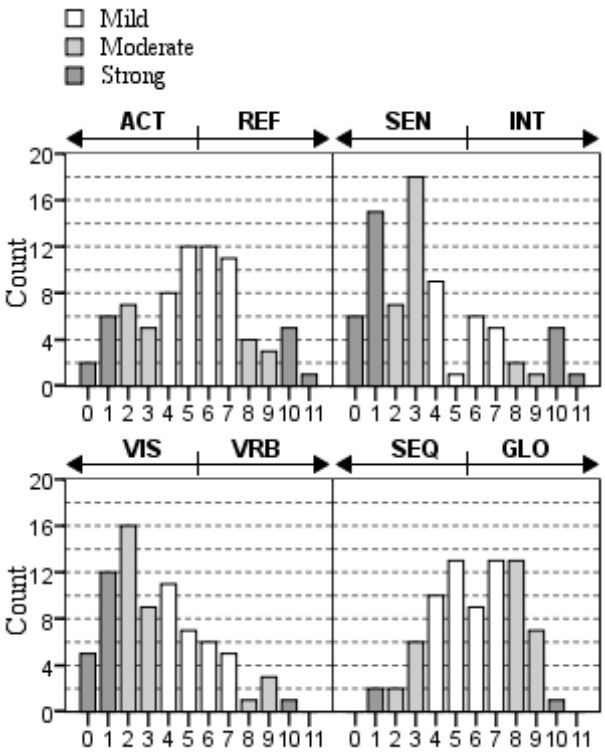

Figure 2. Frequency bars showing the students' ILS results for each learning style dimension, (N=76)

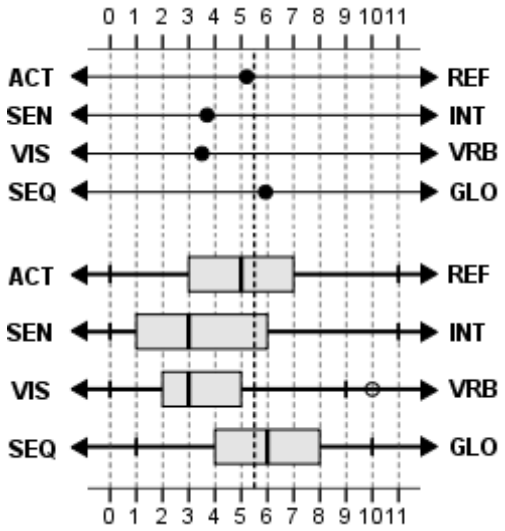

Figure 3. Averages of the learning style results and boxplot diagrams for all the material

Felder and Spurlin collected together students' learning style results published in various studies and noted that the majority of engineering students are active, sensing, visual and sequential [9]. There is a clear majority also of sensors and visuals in Fig. 3 material. Divided in categories, there were 74% of sensors and 79% of visuals. On the active-reflective and sequential-global dimensions the results were distributed more evenly. There were 53% of actives and 43% sequentials.

Fig. 4 examines the differences between the learning styles of men and women. Based on the figure, there are differences in the learning styles of men and women on all learning style axes included in the material, especially on the sensing-intuiting and visual-verbal axes.

Earlier research indicates that there are small differences between men's and women's learning style preferences. Both Rosati [17] and Felder et al. [2] have studied the learning styles of engineering students by using ILS measurements. In both of the studies, men proved to be, on average, more visual and less sequential. According to Rosati [17], men also are more active, and, according to Felder et al. [2], less sensing than women.

The results of the material of Fig. 4 are similar with the exception of the active-reflective axis. The difference on the visual-verbal axis is significant also statistically (Mann-Whitney U-test, N=76, p-value=0.0013, 1-sided test). The same applies to the sensing-intuiting axis (Mann-Whitney U-test, N=76, p-value=0.049, 1-sided test). On the other hand, a small difference that can be observed on the sequential-global axis is not statistically significant (Mann-Whitney U-test, n=76, p-value=0.161).

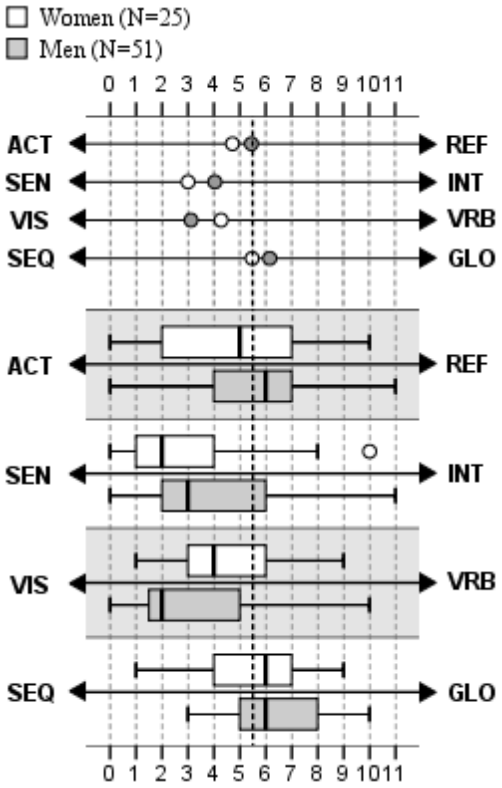

Figure 4. Averages of the learning style results for men and women and boxplot diagrams grouped by gender (N=76)

As the teaching arrangements of the Master's program enable distance study, most of the students live outside the campus town. Students who live far away knew already when enrolling to study that their participation in the program would have an emphasis on distance teaching. On the other hand, students living close to the campus are better positioned to select between face-to-face education and video lectures.

Fig. 5 examines whether there are differences in the learning styles between students from far away and those living close by. The students have been divided in two groups. Students in group A live at most 50 km away from the campus. Those living farther away belong to group B.

Fig. 5 shows that there is hardly any difference between the learning styles of those from far and those from near. Also, based on the Mann-Whitney U-tests, there are no statistically significant differences between the groups regarding any learning style axis.

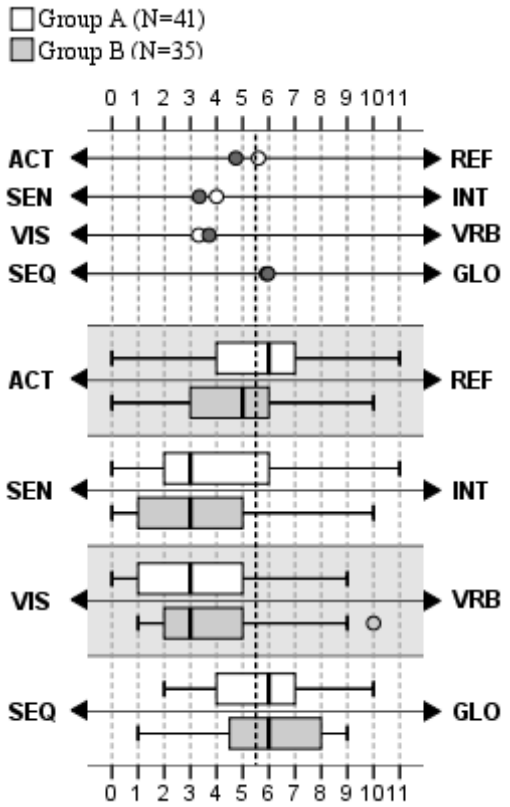

Figure 5. Averages of the learning style results for students living far from and close to the campus and boxplot diagrams about the observations (N=76)

According to the earlier results based on the log data on the media server, students living farther away from the campus participate in video-assisted education clearly more than those who live near the campus. For this reason, in addition to considering the distance between the place of residence and the campus area, the investigation wanted to examine whether the choice of participation mode affected the learning style. Fig. 6 examines the learning style results of those participating mainly in face-to-face education (the share of videos below 50%) and those participating in education mainly with the help of videos (the share of videos at least 50%). Here we had to limit the use of the material to cover only the students (n=54) the details of whose video usage were on the server and who had filled in the learning style questionnaire.

Based on Fig. 6, the learning styles for students who participate mainly in face-to-face education and for students who participate mainly with the help of videos are comparable. Also, based on the Mann-Whitney U-tests, no differences could be observed for any learning style axis. In this respect, Fig. 5 and Fig. 6 support each other well.

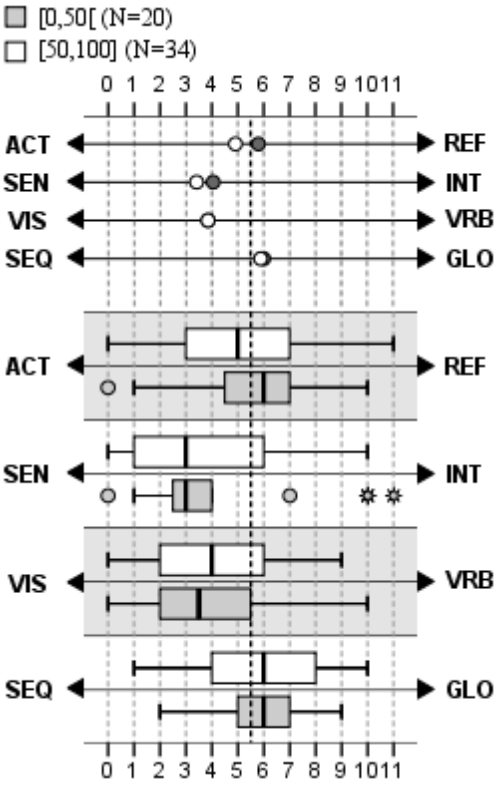

Figure 6. Averages of the learning style results and the boxplot diagram for students who participate mainly in face-to-face education and for students who participate mainly with the help of videos (N=54)

IV. Learning Styles and Student Performance

Effects of the learning style on course performance and grades obtained were examined by collecting information, from the students' transcript of records, on the courses completed and on the average of course grades for each student. The emphasis on performance and grades was not based on credits – all courses were treated on an equal footing.

Activeness in study participation affects both the course performance as well as grades [18]. Average lecture participation share for each course was calculated for the students. Based on that, they were divided into two groups: The first group included the students whose average lecture participation rate was below 80%. The average lecture participation rate for the second group was at least 80%. Here we had to limit the material to cover only the students (n=54) for whose study participation with the help of face-to-face education and videos we had information available.

Based on Fig. 7, there are observable differences between the groups in relation to all learning style axes apart from the active-reflective axis. Based on Mann-Whitney's U-tests, only on the visual-verbal learning style axis the difference is clearly significant statistically (n=54, p-value=0.028). It seems that

visual students participate slightly more unsatisfactorily in the study arranged. The differences on the sequential-global axis and on the sensing-intuiting axis are statistically significant on a 10% confidence level (p-value=0.067 and p-value=0.084, respectively). This would indicate that sensing and sequential students participate in study more often than intuitive and global students.

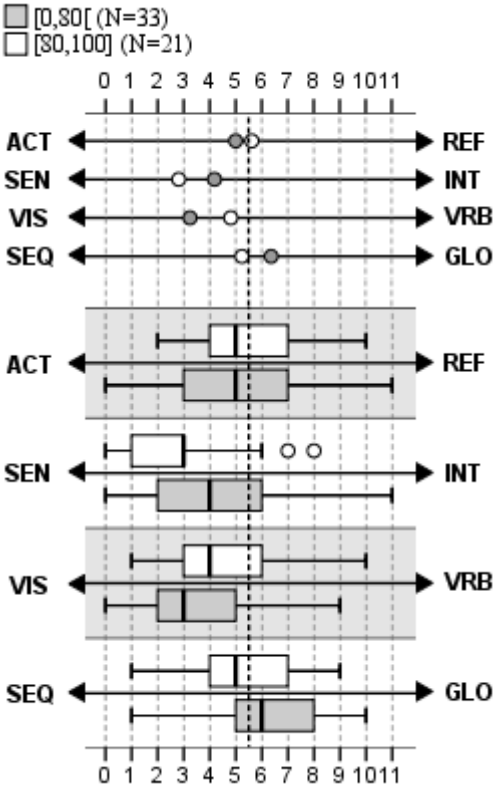

Figure 7. Averages and boxplot diagrams of the learning style results grouped according to the student's average lecture participation percentage

When the effect of learning styles on grades came under examination, the courses which were not assessed by grading were removed from the material. Altogether 76 students had competed 1140 courses assessed by grading. Thus, on average, each student had completed 15 courses. Verbal course assessment, the corresponding grades and the students' grade averages are shown in Table I.

TABLE I. FREQUENCY TABLE OF THE STUDENTS' GRADE AVERAGES

Grade	Frequency	Percent
Adequate = [1, 1.5[	1	1.3
Satisfactory = [1.5, 2.5[	27	35.5
Good = [2.5, 3.5[	28	36.8
Very good = [3.5, 4.5[	18	23.7
Excellent = [4.5, 5]	2	2.6

The students were divided into two categories on the basis of grade averages. The first category includes the students the average of whose grades was at least 3.5, and the second category includes the students the average of whose grades is below that. Fig. 8 examines the differences of these two categories on different learning style axes.

Based on the averages in Fig. 8, there are differences in the categories' learning styles both on the visual-verbal as well as on the sequential-global axis. On the other hand, based on the boxplot diagram, the difference in the averages observable on the visual-verbal axis seems to be due to the skewness of the distributions. Also, based on Mann-Whitney's U-tests, only the difference on the sequential-global axis is statistically significant (n=76, p-value=0.031, 2-sided). Sequential students have performed better than global students.

The results differ clearly from previous studies in [4], [5], and [3]. In these studies, reflective students performed better than active students during the course. In addition, in some of the sources correlation between the visual-verbal axis and exam points was detected [3] and [4]. Verbal students performed better.

Based on Mann-Whitney's U-tests, on the active-reflective axis (Fig. 8), no difference can be observed between the groups (n=76, p-value=0.416). There is no difference on the visual-verbal axis either (n=76, p-value=0.268).

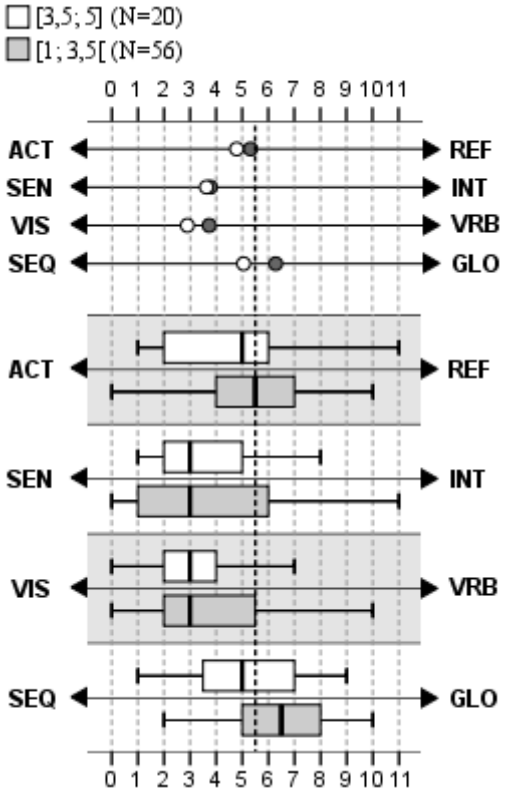

Figure 8. Averages and boxplot diagrams of the learning styles grouped according to the student's grade averages (N=76)

V. CONCLUSIONS

When considering students' study success, the effects due to learning styles must be taken into account. By examining different students, an idea can be formed about whether studying in a learning environment under consideration suits to those with a certain type of learning style better than it would suit to others. According to the results, a clear majority among the students of the Master Studies in Mathematical Information

Technology at Kokkola University Consortium are sensing and visual. In the learning styles of the men and women included in the material, there are small differences in all learning style axes. On average, men proved to be more visual and less sensing than women in a statistically significant way.

Organizing education in a flexible manner enables distance study. Even though it has been observed in earlier research that for those living farther away from the campus the importance of videos as a participation mode increases significantly, based on the results of this study there is hardly any difference between the learning styles of students who live far from the campus and those near it.

Often, at the background of the study participation mode choice there is some other practical reason, such as the student's liking of the participation mode. This is also supported by the result according to which the learning styles for students who participate mainly in face-to-face education and for students who participate mainly with the help of videos are comparable.

According to earlier studies, the opportunity to study with the help of videos, in addition to face-to-face teaching, increases participation activeness [6]. Activeness in participation, in turn, affects both course performance and grades. Actually, between the groups divided in accordance with the participation rate there are observable differences in relation to all learning style axes apart from the active-reflective axis. The difference on the visual-verbal learning style axis is significant. It seems that visual students participate more unsatisfactorily in the study arranged. The results indicate, to a certain extent, that sensing and sequential students participate in study more often than intuitive and global students.

When the grades and learning styles were examined only on the sequential-global axis, significant differences were observed, i.e., sequential students had performed better than global students. As far as the grades are concerned, the results clearly differ from those of previous studies.

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