



Learning to Become a Physics Inquirer: Environment, Process, and Challenges

Appendix to Doctoral Thesis

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1. Research instruments

Note that the students were asked to fill in their names in a questionnaire (not anonymous), since this is a group of students who volunteered to participate in the study (with parental consent see appendix 2.5), they are in fact members of the research community. Thus, the students will probably respond seriously, in a caring manner, and take responsibility for their words. In addition, being members of the research community, students are usually interested in fully cooperating and speaking honestly, because they also are interested in the benefit of research. The students know that anything related to their identity is confidential and used just to the research needs, and they are aware that their honest opinion is important for research. This type of research gives place to the voices of the participants in the study, in order to get a bottom-up explanation from the participants' answers. In this way, it enriches the research information and helps to obtain vital knowledge that is directly related to the improvement of learning and teaching through inquiry.

1.1 Preliminary Questionnaire

Preliminary Questionnaire for a Student in the Research Physics Program

Dear students,

The questionnaire you are asked to fill out is intended for research purposes and for teaching improvement and adjustment. This questionnaire is not a test and there is no need to be afraid of mistaken answers. The information you will provide in the questionnaire is confidential. Any publication in the future will not include identifying information regarding you or your school.

Thank you for your cooperation

Michal Sigron

* To answer the questionnaire on your cell phone, it is necessary to rotate the screen horizontally. After you have completed filling out the questionnaire, press 'send'.

Student Name:

Sex: Male / Female

School Name:

Grade: 10 / 11 / 12

Year "Research Physics": 1 / 2 / 3

- In the past did you perform an inquiry project in a scientific subject? Yes/No If yes, then in what scientific area and in what framework?
- What is the degree of experience in practical work in physics?

	1	2	3	4	5
	Unfamiliar activity	Slight experience	Certain degree of experience	Considerable experience	Very considerable experience
1. Observation of the teacher's examples					
2. Performance of an experiment according to the detailed briefing given by the teacher					
3. Description of an observation of a physical phenomenon					
4. Use of a spreadsheet to process the experiment data and present graphs (such as Excel)					
5. Preparation of a report of a laboratory experiment including graphs and conclusions					
6. Observation or performance of an experiment in a simulation environment					
7. Filming of a physical phenomenon or system					
8. Analysis of a video film or a physical phenomenon					
9. Construction of a model according to a scientific principle					
10. Formulation of a hypothesis					
11. Use of a computer-based laboratory with sensors					
12. Planning an experiment independently					
13. Teamwork in the laboratory					
14. Drawing conclusions from the experiment independently					
15. Performance of a different experiment between groups of students in the laboratory lessons					

16. Performance of an identical experiment between groups of students in the laboratory lesson					
17. Performance of an inquiry experiment without a detailed briefing					
18. Presentation of questions for the investigation of physical phenomena					
19. Use of a spreadsheet to create a calculation model of a physical phenomenon or formula					
20. Writing a computer program that performs a simulation of a physical phenomenon					
21. Preparation of a presentation or poster for the presentation before students or teachers					
22. Search online for information sources regarding a physical phenomenon					
23. Participation in learning excursions (such as museum, scientist's laboratory, factory)					
24. Discussion of the experiment findings, conclusions and the comparison of the conclusions to theory					

Comments:

1.2 Inquiry Skills Questionnaire

Inquiry Skills Questionnaire

Dear students,

The questionnaire you are asked to fill out is intended for research purposes and for teaching improvement and adjustment. This questionnaire is not a test and there is no need to be afraid of mistaken answers. The information you will provide in the questionnaire is confidential. Any publication in the future will not include identifying information regarding you or your school.

Thank you for your cooperation, Michal Sigron

Student Name:

Sex: Male / Female

School Name:

Grade: 10 / 11 / 12

Year "Research Physics": 1 / 2 / 3

- To what degree were these skills expressed during the 'inquiry physics' program?

	0 Not at all	1	2	3 Greatly
Performing an observation				
Asking questions				
Phrasing the inquiry question				
Positing a hypothesis				
Planning an experiment (including identifying and isolating variables)				
Performing an identical experiment for all the groups				
Performing a different experiment in different groups				
Processing the findings				
Drawing conclusions				
Oral report				
Written report				

- Choose from the aforementioned list of the skills two skills that for you were the hardest to perform. Explain your choice.
- Choose from the aforementioned list of the skills two skills that greatly develop during your inquiry work. Give examples that show this development.

1.3 Attitudes Questionnaire

Questionnaire on Attitudes towards the Process of Scientific Research and Inquiry Activities in the Framework of "Research Physics"

Dear students,

The questionnaire you are asked to fill out is intended for research purposes and for teaching improvement and adjustment. This questionnaire is not a test and there is no need

to be afraid of mistaken answers. The information you will provide in the questionnaire is confidential. Any publication in the future will not include identifying information regarding you or your school.

Thank you for your cooperation, Michal Sigron

Student Name:

Sex: Male / Female

School Name:

Grade: 10 / 11 / 12

Year "Research Physics": 1 / 2 / 3

Part 1:

1) In your opinion, to what extent is there a difference between activity in the laboratory in the school and inquiry activities you performed in the framework of the "Research Physics" Program? A large difference / a small difference / no difference

2) If there is, please note these differences (At least two).

Please address skills you acquired / were expressed, the learning style, the teaching method, the student's involvement, the teacher's involvement in the learning process, the contents, laboratory equipment, teamwork, difficulties, challenges, and so on.

Part 2: Please read the statements and note the extent to which you agree with every statement.

	Do not agree at all				Agree greatly	Do not know
	1	2	3	4	5	
1. The research hypothesis of the researcher needs to be scientifically correct.						
2. The reporting of the research results must be done precisely, objectively, and without personal interpretation by the researcher, or in other words, disconnected from his previous beliefs and theories (to the greatest possible extent).						
3. The scientific inquiry process is composed of stages in a regular chronological order (for example, in that order: choice of topic, recognition of the knowledge existing, asking question, phrasing a research question, positing a hypothesis, planning and performing an						

experiment, processing the findings, drawing conclusions, presenting results).						
4. It is necessary to plan the experiment/observation well, including the identification of the variables and the meticulous isolation of the variables.						
5. It is important to understand the theoretical background of the researched topic before going to perform the research.						
6. The teacher is the main source of information in the learning through inquiry.						
7. Only students with high intelligence can perform inquiry research.						
8. Inquiry is characterized by the minimum of instruction, suggestion and direction on the part of the teacher/instructor.						
9. Research performed in pairs / a small group is more productive than research performed by a single researcher.						
10. A mistake is an opportunity for learning and renewal and is a natural part in the research.						
11. Inquiry is necessarily the discovery of something new or unexpected.						
12. The scientific researcher must know other research studies conducted in the researched field.						
13. The research question is dynamic and can change with the progress in the research stages.						
14. The scientific researcher works precisely according to his planning when performing the research.						
15. The student's degree of independence needs to be the maximum in all stages of inquiry.						
16. Learning through inquiry is the independent and active learning of the student, which enables the student to be involved in the learning and to build his knowledge by himself						
17. In the stage of drawing conclusions, the researcher's personal interpretation is essential.						
18. Students who find the studies of sciences difficult cannot perform scientific inquiry.						
19. Unexpected results delay the progress of the research.						
20. Research is dynamic – the directions of investigation and the ways of inquiry can change during the work.						

21. It is hard for a teacher to manage inquiry activities effectively in a large class (with a large number of students).						
22. In research a mistake is failure.						
23. The inquiry process is composed of stages related to one another and the transition between them is network-like and sometimes there is a return to certain stages.						
24. Responsibility for the learning in the way of inquiry and for the performance of the work is that of the student alone						
25. Peer assessment (assessment of class/group members) is an inseparable part of the process of scientific inquiry.						
26. The research results are supposed to confirm the existing theoretical background.						
27. The research stage must end with the presentation of a product, summarizing the research process and findings.						
28. The process of scientific inquiry is not complete without looking at it critically, including the planning and organizing of the inquiry work and the adhering to the time schedule						
29. (Add)						

Part 3:

Please read the statements and note the extent to which you agree with every statement in the context of the inquiry activities you performed in the framework of "Research Physics".

	Do not at all agree				Greatly agree
	1	2	3	4	5
1. The performance of inquiry activities trained me to have the ability to learn independently.					
2. The performance of inquiry activities encouraged creativity and allowed me to make creative use of what was learned.					
3. The performance of inquiry activities developed in me abilities of teamwork and learning from peers (such as cooperation, listening, openness to accept others' opinions, to share deliberations with others, to brainstorm, to express myself in the team, to hold a respectful discussion).					
4. In the performance of inquiry activities I coped with the uncertainty.					

5. The performance of inquiry activities led to the increase of interest in physics.					
6. The performance of inquiry activities allowed the cultivation of initiative.					
7. The performance of inquiry activities cultivated my responsibility for learning and for the performance of the work required in the inquiry work.					
8. The performance of inquiry activities increased my motivation to learn.					
9. Inquiry activities undertaken in a regional class enabled opportunities for encounters between schools and cultivated a positive social atmosphere (such as cooperation, friendships, help of peers, and so on).					
10. The inquiry activities need to supply research conditions for the students (such as sophisticated laboratory and equipment, support of exerts, teachers, laboratory technicians, and scientists).					
11. The performance of inquiry activities enabled me to get to know the work of the scientific researcher.					
12. In the performance of inquiry activities I experienced active learning, which I was fully active in doing and thinking.					
13. In the performance of inquiry activities I am required to keep to schedule and to be organized.					
14. The performance of inquiry activities cultivated general and practical learning skills in the field of content and in the field of scientific inquiry.					
15. The performance of inquiry activities set for me challenges and copings with complex and open problems.					
16. The performance of inquiry activities caused me frustration.					
17. In the performance of inquiry activities I felt an opportunity to do something in an independent and experiential manner					
18. The performance of inquiry activities strengthened my knowledge in the scientific content (in physics particularly).					
19. The performance of inquiry activities strengthened my knowledge about inquiry in general.					
20. The inquiry activities were hard to perform.					
21. The performance of inquiry activities awakened my curiosity.					
22. The performance of inquiry activities caused me enjoyment.					
23. Perseverance, adherence to the goal are required for the performance of inquiry activities.					

24. Ability to cope with changes is required for the performance of inquiry activities.					
25. The performance of inquiry activities was primarily technical.					
26. The performance of inquiry activities was not effective in learning since they do not progress in an orderly manner and sometimes they get lost.					
27. In the performance of inquiry activities I needed support and considerable help from the teacher-mentor.					
28. In the performance of the inquiry activities many opportunities were given to participate actively in the learning process and to build the knowledge by yourself.					
29. In the performance of inquiry activities the teacher/instructor was always willing and available to help, support, and encourage.					
30. In the performance of inquiry activity performed in pairs enabled experience in peer learning and experience in teamwork and there was complete cooperation in the activity and learning between the group members					
31. In the performance of inquiry activities the in-depth understanding of physical concepts and principles was advanced.					
32. The performance of the inquiry activities improved my ability to present orally and stand in front of an audience.					
33. The performance of the inquiry activities takes a lot of time and planning.					
34. The performance of the inquiry activities improved my inquiry skills (such as asking questions, positing hypotheses, planning an experiment, etc.).					
35. The performance of inquiry activities dedicated time to peer assessment (assessment of class/group members/partner).					
36. The performance of the inquiry activities led to a significant contribution in the laboratory performances.					
37. The performance of the inquiry activities strengthened the mastery of computer applications, technological instruments, and measurement tools.					
38. The performance of the inquiry activities connected between the subject of physics and the technological-industrial space.					
39. Performance of the inquiry activities deepened the relationship between the areas of physics and the other natural sciences (such as mathematics, engineering, computers, electronics, and robotics).					
40. Performance of the inquiry activities contributed to my improvement in physics.					

Part 4:

In your opinion, who is responsible for the success of the research project? (More than one answer can be marked)

- The student
- The teacher-mentor
- The laboratory technician
- Your school physic teacher
- The "Research Physics" Program developers (The chief inspector of physics, the program managers at Davidson institution, the creators of the program)

Please note the extent of the responsibility of the success of research project for each person:

	1 no responsibility	2	3	4	5 great responsibility
1. The student					
2. The teacher-mentor					
3. The laboratory technician					
4. Your school physic teacher					
5. The "Research Physics" Program developers					

1.4 Summative Questionnaire

Dear students,

This questionnaire is intended to provide feedback to the staff of the Research Physics program, when you are among the first groups to experience it. The questionnaire that you are asked to fill out is intended solely for research purposes.

This questionnaire is not a test, and you are not to be afraid of mistaken answers. The information that you will provide in the questionnaires is confidential.

Every publication in the future will not include your identifying details or those of your school.

Thank you for your cooperation, Michal Sigron

Student name:

School name:

Grade:

Sex: Male / Female

Part 1:

The following is a series of statements addressing your overall experience in the inquiry project.

Read the statements and indicate the degree to which you agree with every statement.

	1 Do not agree at all	2 Unsure	3 Agree to a certain degree	4 Agree	5 Definitely agree
1. I felt that I perform the work of a scientist-researcher					
2. The ways of thinking in the project and in physics in the school are similar					
3. The responsibility for in the inquiry process in the project was primarily on the student					
4. During the project performance I experience considerable frustration and with the progress in the work I obtained unexpected results and I was more confused. I remained with a feeling of disappointment.					
5. The inquiry process necessitated the student's considerable independence and initiative					
6. Following the experience I feel that I can more easily cope with another new inquiry project					
7. I am interested in dealing in the future with research project					
8. During the performance of the project I experienced many frustrations but with the progress of the work I understood more the topic in scientific terms and I learned that perseverance and persistence are important in the research work process					
9. The project was interesting and challenging.					
10. I felt that this is a school project, not a scientific work.					
11. The responsibility on the inquiry process in the project was primarily on the teacher.					
12. In the performance of inquiry activity I experienced active learning, in which I was fully active in doing and in thinking.					
13. During the performance of the project I experienced many frustrations but the curiosity increases when unexpected outcomes are obtained.					
14. I learned to think differently from what I am accustomed.					
15. I enjoyed the performance of the final inquiry project.					
16. The inquiry process necessitates considerable initiative of the teacher-mentor.					

17. The project did not challenge me.					
18. Following the experience, I believe that every additional inquiry project presents new difficulties that need to be dealt with.					
19. The inquiry project requires responsibility and great commitment.					
20. I am not interested in coping in the future with research projects.					

Part 2:

The following table presents a series of statements addressing different possible components in the process of work on the inquiry project.

- To what degree did you experience in performing these components?
- To what degree did you experience difficulty in the coping with these components?

(Please note that in every row it is necessary to indicate two responses: regarding the degree of experience and the degree of difficulty)

	0 I did not experience	1 Very slight experience	2 Very great experience	0 I did not experience difficulty	1 A certain difficulty	2 Great difficulty
1. Choosing the topic for the project						
2. Forming different questions on the physical phenomena the project addressed						
3. Focusing the inquiry question						
4. Planning the work						
5. Planning an experiment system that can provide an answer to the inquiry question						
6. Isolating the variables						
7. Building the experiment system						
8. Solving technical problems						
9. Performing precise measurements						
10. Processing the data to obtain an answer to the inquiry question						
11. Identifying relevant sources of information (such as content sites, textbooks, or article) for the inquiry topic						

12. Learning and understanding the contents in physics required for the project						
13. Building a model that predicts a theoretical answer to the inquiry question						
14. Linking between theory and the findings of the experiment						
15. Supervision – examining actions performed during the project for the choice of new directions						
16. Documenting the inquiry process						
17. Organizing the work						
18. Meeting the time schedule						
19. Writing a presentation for reporting on the project						
20. Writing a work that summarizes the project						
21. Presenting orally to the peers and teachers						
22. Performing peer assessment (for friends)						
23. Teamwork (with the partner) during the performance of the project						
24. Modeling of calculations (writing a computer program that performs simulation) of physical phenomenon						
25. Using a computerized laboratory (sensors, computer program) and technological tools						
26. Self-managing the inquiry process						
27. Surmounting situations of uncertainty						

- Are there other aspects that you did not note? Please note them and write about each one the degree to which you experienced them, the degree to which it was hard to perform. To what degree are you satisfied with the support you received?

Part 3:

- Choose at least two components you noted in which you experienced considerable difficulty. Describe the difficulty in these components. How did you cope with these difficulties?
- Choose from the list above two-three components that you think greatly developed in your during the program.
- Tell about the changes (at least two) you performed during the research work (for instance, change of topic, change of inquiry question, change in the system of planning the experiment, change, change in the work program, conclusions, etc.) and describe what caused the change and what you learned from it.

Part 4:

The following is a series of possible goals for the program.

- What is the degree of contribution of the program to the development of improvement in each one of the goals?

	1	2	3	4	5
	Does not contribute at all	Contributed slightly	Contributed to a certain degree	Contributed greatly	Contributed very greatly
25. A deeper understanding of physical principles and concepts that I learned in the school					
26. Broadening the knowledge to physical topics beyond the learning program in the school					
27. Knowledge and understanding about the inquiry process					
28. Development of inquiry skills as required of the researcher					
29. Improvement of the achievements in physics in the school					
30. Convincing presentation of scientific argument					
31. Scientific writing					
32. Methodical thinking					
33. Creative thinking in order to solve problems that appear during the inquiry and in order to leave a situation of uncertainty or powerlessness					

34. Critical and reflective thinking on the inquiry work.					
35. Cooperation in teamwork					
36. Cooperative learning with the partner					
37. Management of the division of roles/responsibility					
38. Acceptance of the others					
39. Ability of active learning and independent learning, through which the student builds the knowledge and understanding of the content relevant to the inquiry.					
40. Personal responsibility for learning and for performance of good work.					
41. Curiosity for the studies of science and investigation of physical phenomena in particular, like the researcher's scientific curiosity.					
42. Motivation for the studies of science					
43. Resilience and flexibility in dealing with difficulties					
44. Cultivation of independent and initiative.					
45. Ability to perform peer evaluation in the broader group.					
46. Practices and tools for documentation					
47. Ability of planning and organizing the work.					
48. Self-confidence					
49. Building of a presentation and standing in front of an audience					
50. Diversification of styles of learning					
51. Coping in conditions of uncertainty					
52. Coping in situations of powerlessness/frustration					

If there are additional goals to those written above to which in your opinion the program contributed to the development or the improvement, please write them and the degree to which the program contributed to them.

Part 5:

Note the degree of satisfaction regarding the cooperation between the student and the teacher-mentor.

	1 Not satisfied	2 Slightly satisfied	3 Satisfied	4 Greatly satisfied
1 Instruction in topic choice and planning the project				
2 Response to your questions during the work				
3 Physical knowledge of the instruction staff				
4 Instruction for presentation before peers				
5 Division of roles among the team members				
6 Support of the teacher-mentor in the teamwork				
7 Cooperation of the partner in the teamwork				
8 Your cooperation in the teamwork				
9 Performance of activities at home in cooperation with the team members				

- if you are not satisfied by the teacher-mentor's instruction, please detail what bothered you.

Part 6:

- Give a "tip" / lesson that you learned to a student who is beginning this program.
- Note two strengths of the program it is important to preserve.
- Note two-three aspects of the program that should be changed and explain.

1.5 Semi-Structured Interview

The interviews were semi-structured and open. In this type of interview, the phrasing of the main questions is undertaken ahead of time, but the continuum of their presentation is not determined beforehand and there is room during the interview to add questions according to the context, when sometimes the interviewee's responses lead to spontaneous questions (also not all the questions were asked in all the interviews). The questions prepared ahead of time constituted in essence a formal interview, which sometimes is necessary to ensure the uniformity of the interview topics (Sabar Ben-Yehoshua, 2001; Shkedi, 2003). In this appendix the main questions asked in the interviews are presented:

The questions:

1. What in your opinion is the uniqueness of the research physics program?
2. Tell me about the research process you went through in the program so far (Tell about the way in which you chose the topic of the inquiry, the phrasing of the research question, describe the stages of the planning and the performance / What stages did you perform until now in your inquiry work, and what was the order of performance?).
3. How did you learn the theoretical material relevant to your inquiry? Was there independent learning?
4. Did you improve the ability to learn by yourself? If so, describe
5. Do you understand the theoretical material relevant to your inquiry? Do you feel that you have mastered the material?
6. What were your difficulties in the program and how did you cope with them? / Tell me about (other) challenges you experienced in the project and how did you cope with them?
7. Did you experience a breaking point /frustration during the project? Or a situation of lack of powerlessness / uncertainty? And how did you overcome this?
8. Did you develop creativity in the program? How was this expressed?
9. Tell me about the teamwork between you and your partner in the inquiry project. Was there a division of roles between you? If so, describe.

10. In your opinion, what is preferable, to perform inquiry work in a pair or alone?
Why?
11. What did you learn about yourself from the teamwork with the partner?
12. Who do you think has greater responsibility for learning and success of the project – the teacher-mentor or the student? can you describe how this is expressed?
13. Is there a change in the degree of responsibility for your learning following the performance of the inquiry in the program? If so detail
14. Describe your teamwork with the teacher-mentor. How was the interaction between you? What do you think about the teacher-mentor's degree of involvement? (Tell about the attitude of the teacher-mentor, his response to your questions. To what degree was the teacher-mentor involved? Give examples. Are you satisfied with the guidance? Did this suit your expectations?)
15. Did the program improve your self-efficacy (belief in yourself) to do things independently/alone?
16. Was there the evaluation of peers in the broader group? Tell how this was in actuality. What do you think about this instrument?
17. Was there peer learning in the broader group?
18. How was your relationship with the participants in the broader group in general? Did the relationship you created in the inquiry work help you / were you helped by one another?
19. What did you learn about yourself from the program?
20. What did you learn in social terms from the program?
21. What did the program contribute to you in the personal aspect? in social terms?
22. Do you feel that you can do further inquiry work?
23. Did the program give you the motivation to learn physics in the future or to learn research, to engage in inquiry in the future?
24. With what are you satisfied in the program? With what are you not satisfied?
25. Are you satisfied with the product? What do you think about your performances in the program?
26. What tip would you give to a new student who comes to the program?

2. Research Physics Program Folder (Description of Activities, Documents)

This appendix includes a description of activities in the “Research Physics” program, a list of projects of the students, and documents such as: document of intent (template for Research Horizon), guidelines and rubrics for the writing of the reports and the parents' approval.

2.1 Description of Activities in the Preparation Stage in the “Research Physics” Program

From the Collection of Research Physics Activities (Perl, 2019), developed, written, and edited by: Professor Edit Yerushalmi, Dr. Zvika Arica, Zeev Krakover, Dr. Zehorit Kapach, David Perl, Nancy Shalev, Haim Edri

Unit	Core of the Activity	Main Concepts & Principles	Main Skills	Scientific Ways of Thinking
10th grade-1: A trolley at a fixed speed	Bringing the system to a constant speed (not on the basis of theoretical analysis) and use of a ruler and time recorder to justify that the system indeed moves at a constant speed	<ul style="list-style-type: none"> * Definition the speed as the rate of change of place in a period of time * Momentary and mean speed * Friction, balance of powers aspires to zero, through reduction or balancing of the forces (in intuitive language) 	<ul style="list-style-type: none"> * Measurement error and its reduction: improvement of the precision of measurement using a ruler (placement of the ruler relative to the measured points, setting the origin, ...) * Resolution and repeatability of the measurement instrument: the time recorder, conversion of representations from a trace diagram to a table to a graph to a formula. * Drawing a graph on millimeter paper * Use of an electronic spreadsheet to build a linear graph * Use of the Excel function of a trend line 	<ul style="list-style-type: none"> * Experimental realization of a physical concept – open and creative process (reduction of friction, balance of forces) * Discovery of methodical behavior in the data, with reference to aspects of the limitations of the measurement in order to improve its precision, for example: to identify a trend I need more than 2 points, the number of measurements required to identify a trend depends on the resolution of the measurement instruments and the objective of the investigation. It is permissible to neglect data if they derive from an identified problem that is not essential to the phenomenon, but data whose appearance you do not know how to explain must not be ignored

Unit	Core of the Activity	Main Concepts & Principles	Main Skills	Scientific Ways of Thinking
10th grade-2: Falling of a magnet	Follow up after the falling of a magnet through analysis of its movement filmed in a video clip	<ul style="list-style-type: none"> * Concept of acceleration as the change of speed in a unit of time * Movement at a changing acceleration * Movement at a changing acceleration: it is recommended air resistance: force changing as a function of the speed, which increases until balance in which the balance of the forces is equal to zero 	<ul style="list-style-type: none"> * Setting a standard for the drawing of graphs in general and in particular in Excel (dispersion, titles, units, trend line) * Filming a video as a tool for the collection of findings and manner of performance of the experiment correctly (choice of background, setting the camera, angle of photography, distance from the camera, setting the ruler used as a calibration rod, beginning point of the filming) * Knowing to work with Tracker. The purpose of the settings in the stage in the initial definitions (calibration rod, definition of axis, starting time point, 'skipping' of primes) * Different configurations of the findings using the software (trace diagram, time/place and speed/time graphs) * Export of data from Tracker to Excel and drawing different graphs through Excel * Transition from place-time graph to speed-time in Excel * In the framework of the homework preparation of the work report (partial and initial) 	<ul style="list-style-type: none"> * Importance of the field of measurement – the students will understand that to draw as many conclusions as possible they must research “the entire motion” (from the start to the finish). * Presentation of a variety of graphs – graphical representation of the findings collected directly $x(t)$, intelligent choice of processing the findings through the choice of new variables $a(t)$, $v(t)$ and the understanding of additional representations, and the use of them to draw the most conclusions in the context of the inquiry question * Examination of the trend of the graph and drawing conclusions from the gap that is not linear * Reading theoretical material about the phenomenon and comparison to reality as obtained in the experiment * Commitment to repeat the measurements if we did not succeed in obtaining from them sufficient information. * Reporting on the research – from the stage of the description of the experiment. How are results presented and how are conclusions drawn from them.

Unit	Core of the Activity	Main Concepts & Principles	Main Skills	Scientific Ways of Thinking
10th grade-3: Atwood machine	Knowing the historical experiment in physics: examination of Newton's Second Law through an Atwood machine and knowing the work with different sensors in a computerized laboratory	<ul style="list-style-type: none"> * System of two bodies moving at constant acceleration. * The Second Law of Newton and one way of confirming it. * Development of a formula for acceleration of an Atwood machine * Direct relationship and inverse relationship between two variables (according to the formula 	<ul style="list-style-type: none"> * Getting to know the computerized laboratory – two sensors – sonar or optical gate along with smart pulley. * Correct work with sonar (minimal distance, verification of sonar reception, stability). * Construction of an experiment system according to a model – it is necessary to make certain of its stability, balance, etc. * Choice of the initial inquiry question (acceleration depends on ...) * Control of variables – it is necessary to examine that only the variable that we want to examine is being changed (how the sum of masses is changed without changing the difference and the reverse). * Planning an experiment comprised of a main inquiry question and a secondary inquiry question: to research the dependence of the acceleration for instance in the equivalent force first it is necessary to measure it through the investigation of the place-time dependence of a body for a certain equivalent force. * Linearization of the graph. 	<ul style="list-style-type: none"> * The students will differentiate between “good” and “less good” measurements and will understand the importance of the repetition of measurements. * The students will understand the importance of the choice of as broad a field of measurement as possible to obtain diverse results in every field of measurement. * Recognition of the limitations of the sensor that leads to the intelligent choices of the masses (the independent variable) used in the experiment – the choice needs to enable performance of at least 5 different measurements in the chosen field of measurement. It is necessary to add measurements if the field of the measurements is not adequate or if there are interesting areas. * When producing a graph, we are interested not only in its trend but we will always attempt to calculate the slope and see whether it is possible to give it meaning and connection to the theory. * Use and advantage of the linearization of the graph. * In the framework of the homework – preparation of work reports (intermediate and final) that include a more detailed and in-depth report of the experiment and advanced analyses of its results.

			<p>* Calculation / presentation of the slope of the graph and its fit with the theory.</p> <p>* Calculation of the relative error.</p>	
Unit	Core of the Activity	Main Concepts & Principles	Main Skills	Scientific Ways of Thinking
10th grade-4: Roemer experiment	Getting to know basic concepts in astronomy towards getting to know a historical experiment in physics and reconstruction of the method of measurement of Roemer for speed of light. Work through simulation.	<p>*Roemer experiment for the measurement of the speed of light.</p> <p>* Mention of historical experiments and classification of them according to categories.</p> <p>* Getting to know basic concepts in astronomy (planet, star, moon, eclipse)</p> <p>* The solar system – Jupiter – Earth. Movement and changes in it.</p> <p>* Cyclical phenomena.</p> <p>* Cycle time.</p> <p>* Measurement of time between two events from a moving system ("Doppler effect").</p>	<p>* Work through simulations 2. Jupiter</p> <p>* Methods for measurement of the cycle time in general (great number of cycles for the reduction of the error, setting as accurate as possible starting point and end point.</p> <p>* Considerations in the measurement of the cycle time in the astronomical context - use of the phenomenon such as 'entry into eclipse' as a starting point.</p> <p>* Conversion of the units for the accurate calculation of time between two dates in a year.</p> <p>* Reading article / material and processing information.</p>	<p>* Solving problems: the students were challenged in the calculation of the speed of light from the data produced using the reading of an article that presents the principle behind the measurement alone.</p> <p>* Carrying out a "class" experiment (collaborative) and taking responsibility for the accuracy in the measurements for the good of all.</p> <p>* The importance of determining an 'accurate' and uniform measurement method for the whole class.</p> <p>* Comparison between different graphs for the drawing of conclusions on the phenomenon (graph of distance versus graph of change of cycle time).</p> <p>* Differentiation between error of measurement and deviation that is exhibited by a trend that should be researched.</p>

Unit	Core of the Activity	Main Concepts & Principles	Main Skills	Scientific Ways of Thinking
10th grade-5: Investigation of springs	Discovery/proof of Hooke's Law for a single dependent spring. Performance of open inquiry in a system including springs..	* The constant of the spring, Hooke's Law. * Additional concepts arose in the different groups according to the inquiry questions (frequency, cycle time, kinetic energy, temperature, etc.)	* Getting to know a variety of mistakes of measurement and ways to minimize them: required number of measurements, mistake of a measurement device, relative and absolute error. * Judgment in the choice of the system components (which spring and which weight should be chosen) * Asking questions: formulating a good inquiry question. * Planning an experiment that suits the selected question (including appropriate measurement tools). * Ordering of equipment according to as precise planning as possible. Presentation of the work to the class for the first time and receiving feedback that promotes learning from the students and instructors.	* The students gained experience in inquiry of their own from its start to its end: during the work they implemented the ways of thinking and the skills they acquired throughout the previous activities, each one according to his level and the inquiry question he chose. *Choice of the inquiry question: To be interesting and challenging but also performable. *Coping with difficulties in building and measurements and finding solutions. * Calculation of the physical value (like the constant of a spring). * Examination of the hypothesis in light of the experiment findings – to focus on what is similar and different between the hypothesis and the findings and to propose an explanation for the differences between them.
Unit	Core of the Activity	Main Concepts & Principles	Main Skills	Scientific Ways of Thinking
10th grade-6: Mini-project (Four meetings)	The students will choose a phenomenon through a facility in the Science Park. The mini project will include an experimental aspect in addition to a limited aspect	* Different concepts arose in the different groups according to the inquiry questions, for example: power of sound, focus of a concave mirror, the angle of the arc cone, breakage	Experience in open inquiry: * Choice of the phenomenon * Observation of the phenomenon and finding the physical variables relevant to it.	* Modeling of the phenomenon – building a system similar to reality in the laboratory room. * Emphasis on the stage of the linkage to the theory: finding the trend of the measurements and search for the model and theoretical explanation.

	of independent learning of content.	coefficient of liquid, centrifugal force, frequency of coverage in beats, interference of sound waves, standing wave in a string, center of gravity of a physical pendulum, and so on.	<ul style="list-style-type: none"> * Raising questions, formulating an inquiry question and hypothesis. * Building a system for the carrying out of the experiment in the means at our disposal. * Analysis of the results and drawing sound conclusions on the analysis of the results. * Sharing with peers the inquiry, peer assessment through giving and receiving feedback that promotes learning. 	<ul style="list-style-type: none"> * Serious investment of thought and coping with difficulties in the building of a suitable system for the experiment. * Choice of appropriate devices of measurement, range of measurements, and coping with difficulties with accuracy and background noise. * Simplification of the system - it is not always possible to perform what was planned and in these cases (for the most part) it is desired to build a simpler parallel system.
Unit	Core of the Activity	Main Concepts & Principles	Main Skills	Scientific Ways of Thinking
<p>11th grade-1: Computational modeling</p> <p>11th grade-2: Summative task in computational modeling</p>	<p>Numerical solutions for physical models based on Newton's second law</p>	<p>Motion and interaction in 1 and 2 dimensions: Falling cupcake cups, spring pendulum and motion under the influence of a central force</p>	<ul style="list-style-type: none"> * Basic programming concepts that allow to solve kinematic equations in VPython via the Euler approximation: <ul style="list-style-type: none"> - creation of objects. - Assigning values to variables, in particular vector values. - updating values of variables within a loop. • Refining a numerical model to better match numerical prediction with experimental results (students were guided through worksheets to compare num. model and measurement of a falling cupcake-cup and refine the num. model to better match experiment) 	<ul style="list-style-type: none"> * Structuring basic programming concepts: Students ask to follow step by step directions to construct a program for constant motion. * Problematizing the concept of Euler approximation: Students were asked to manipulate an existing code for a cart to move in constant acceleration (constant force) through Euler's method. * Problematizing physical modeling of a real world phenomena: students were required to model on their own the motion of a mass on a spring and motion under a central force, while being coached by the instructor. * Structuring comparison between measurement and numerical models.

2.2 List of Projects of the Students in the “Research Physics” Program

Student (Number)	Gender	Project Name
02	M	Magnus power in a wind tunnel
03	F	
15	M	Water bubbles in oil
14	M	
23	M	Magnus power - flying cups
20	M	
34	F	Optics - from rays to waves – arc
28	M	
30	M	Incandescent light bulb as a light source and its spectrum
01	M	
05	M	On waves and strings - characterization of oscillations in the guitar string and the sound obtained from it
24	M	
16	M	Investigation of springs and slinky
21	M	
19	F	Movement of Brownian particles interacting with a glass surface
18	F	
06	M	Wilberforce pendulum movement
26	M	
25	M	Polarization
04	M	
33	M	The dispersion ratio of water waves in a tank
07	M	
17	F	Sound waves - the limits of sounds
29	M	
10	F	Spread of a kalium permanganate tincture stain in water
11	F	
31	F	Coupled carts
12	F	
09	M	Parametric resonance in pendulums
13	M	
27	F	Electron motion in electromagnetic fields
08	M	
22	F	Vibrations in the string
32	F	

2.3 Document of Intent: Template for Research Horizon, Progress Report and Forward Planning

The document of intent is a document that needs to be submitted to the supervision for teaching physics of the Ministry of Education (of Israel) about one month after the beginning of the work on the research project. The document of intent has two main components: a pair of documents, one written by the adviser and one written by the students.

Aims of the document of intent:

1. Formal – the supervision needs to ascertain that this is a real project that is being worked on
2. Educational – for the student – orderly phrasing of the proposal for the delineation of the research with the support of the adviser
3. Educational – for the teacher – presenting the safety net for the guided
 - A. Definition of a possible defined and feasible task
 - B. Management of negotiations of the students and the adviser on the task

Therefore, each one of the components of the document of intent will describe a picture of the current situation and the direction (or the directions) indicated in the project. As aforementioned, one from the adviser's viewpoint and one from the advised person's (the student). The description of the picture of the situation includes the direction and the goals of two points of time: 11th and 12th grades of work on the research project.

Eleventh grade: Description of the topics that the project will address and main means by which it will attack this topics, present status report, progress and forward planning report – research horizon for the near future (in the second half of 11th grade) and research horizon for the distant future (in the 12th grade) that it is expected will be presented in the presentation after the Passover holiday of 11th grade (submission date of the document of intent 1 is start of February 2018).

Twelfth grade: Presentation of the planned chapters of the summative report of the project and description of the contents of each chapter, organization of the relevant information of each chapter (what are the existing components, what remains to do about them, and which components are missing and planned to be performed), the tentative development of the research, the insertion of the planning into a Gantt chart according to the meeting dates (the submission date of the document of intent 2 is the start of January 2019).

The following is the template for the document of intent:

**Document of Intent 1: Template for Research Horizon, Progress Report and
Forward Planning (11th Grade)**

Name of students:

Name of adviser:

Name of project:

- A. Preface – Explain main concepts relevant to the engagement in the phenomenon of motivation
- B. Present status – What did the students do until now?
 - 1. Questions and goals defined until now
 - 2. Theoretical background acquired by the students
 - 3. Description of the experiments performed until now
 - a. Systems of experiment
 - b. Collection / analysis of data
 - i. Achievements – experimental skills
 - ii. Achievements – description of the findings of experiments until now
 - 4. Theoretical analytical calculations or calculations if performed
 - 5. Challenges, dilemmas, and present directions
- C. Research horizon for the continuation of the 11th grade (intentions for the near future)
 - 1. Questions and goals
 - 2. Theoretical background
 - 3. Experiments
 - a. Experiment system(s)
 - b. Collection/analysis of the data
 - i. Achievements – experimental skills
 - 4. Theoretical analytical calculations or calculations
- D. Research Horizon in the 12th Grade (intentions for the distance future)
 - 1. Questions and goals
 - 2. Theoretical background
 - 3. Experiments
 - 4. Theoretical analytical calculations or calculations
- E. Bibliography

**Document of Intent 2: Template for Research Horizon, Progress Report and
Forward Planning (12th Grade)**

Name of students:

Name of adviser:

Name of project:

1. Template for the Research Horizon Document

This document presents the planned chapters in the summative report of the project in the model that suits the specific project. Every chapter has:

A. The chapter title

B. A short paragraph describing its contents.

Chapter No.	Chapter Title	Description
1		
2		
3		
4		
5		

2 + 3. Template for the Progress Report + Template for Forward Planning

The organization of the relevant information that is in every chapter of the final report

Chapters of the Summative Report	Existing Components					Name of the Document File	What Remains to Do About the Existing Components	What Missing Components We Plan to Perform
	Theoretical Background	Theoretical Modeling	Collection & Analysis of Data	Findings	Conclusions			

Gantt Table - Introducing the Planning to the Schedule of Meetings

Date																			
Components to Be Performed for Each One of the Product Chapters																			
Rationale																			
Theoretical Background – It is necessary to write at home in parallel to the meetings																			
Theoretical Modeling																			
Experiment System																			
Findings																			
Conclusions																			

2.4 Guidelines and Rubrics for the Writing of the Reports of the Inquiry Project in the “Research Physics” Program

Guidelines for the Writing of the “Mini Project” / Intermediate / Summative Report of the Inquiry Project

Title (Project Name, Name of Presenters, Name of Instructor(s), Date)

Description of the Phenomenon

1. Description of the process of the focus on the researched phenomenon
2. The phenomenon that in the end we focused on, which aspects we chose to research in it, and why this is interesting (scientific or technological contexts in which the phenomenon is expressed)

Description of the Experimental Investigation

1. The physical variables relevant to the description of the phenomenon, and formulation of the inquiry question(s)
2. The experimental system(s) (Add a figure and/or pictures and/or video and/or system of experiment) and the course of the experiment(s) – the measurements performed
3. Description of the experimental challenges, their implications, and if necessary the answer found for them
4. Findings – appropriate representations (table or graph or algebraic expression, etc.)
5. Main conclusions and relative error calculations, if possible
6. Limitations of the experiment (such as assumptions made and possible error factors)

Comparison between Theoretical Prediction and Findings of the Experiment(s)

1. Physical principles (physical description) relevant to the explanation of the phenomenon
2. Assumptions and approximations
3. Theoretical model predicting the phenomenon
4. What is the relationship between the experimental findings and the predicted findings according to the theoretical model?

Summary

What are the main things you learned from the investigation (can be both in the field of the physical content and in the field of the performance of the inquiry) and what are the directions of the continuation that you propose for the investigation?

Reflection (for the Written Report)

1. What we learned: Note ideas that were focused or understood differently as a result of the project.
2. Manner of work: What things in your opinion should be retained in the manner of the work and what things should be changed?

Bibliography (for the Written Report)

It is necessary to note Internet information sources or others you used in the preparation of the work.

The following tables present assessment rubrics from the supervision: a rubric for the assessment of the preparation stage, a rubric for the assessment of the research process and its documentation, a rubric for the assessment of the final written work (at the end of 12th grade), and a rubric for the assessment of the presentation of the research. Use these rubrics to build your work.

Rubric: Evaluation of the Preparation Stage

Evaluation of the preliminary stage, including the activities performed in the 10th grade (and sometimes also at the start of the 11th grade), as a preparation before the transition to the main research.

Components	Aspects Evaluated	Weight
Acquisition of tools	Ways of measurement, computerized laboratory, computerized analysis of video films, setting up an experimental design, error evaluation, computational science.	40%
Towards the research	Coping with open-ended tasks, creativity, formulation of research questions, suggestion of ways of action, critical discussion, self-criticism, coping with difficulties, intelligent use of inferences	30%
Work practices	Orderly participation, work with peers, emphasis of well-written reports, meeting the time schedule, safety in the laboratory	30%

Rubric: Evaluation of the Research Process and Its Documentation

Evaluation of the preliminary stage, including the activities performed in the 10th grade (and sometimes also at the start of the 11th grade), as a preparation before the transition to the main research.

Topic	Description	Weight
The experimental work	Setting up a system, skilled use of the system, identification of failures and necessary improvement, planning additions and realization.	25%
The theoretical work	Intelligent use of theory, mathematical presentation of theory, analytical solution, numerical solutions, changes and updates of theory	25%
Data processing and drawing conclusions	Data processing, production of representations and transitions between them, evaluation of errors, comparison between theory and experiment, scientific criticism.	25%
Research conduct	Meeting the time schedule: submitting in time the reporting documents during the research, management and quality of the research journal Teamwork: cooperation, meeting the agreed upon division of tasks, mutual support, trend of development and improvement, initiative, independent background learning in fields of theory and experiment, creativity / innovation / originality, work beyond the designated hours in the school.	25%

Rubric: Evaluation of the Written Work

Components	Aspects Evaluated	Weight
Theoretical component	Theoretical background, independent/original discussion, independent mathematical development, approximations, research objectives, research questions	15-35%
Experimental component	Building a system, full description of the system, experiment considerations and ways of measurement, improvement of the system and adjustment to the research, description of the measurements (independent measurements), numerical solution and simulations	15-35%
Data processing and conclusions	Representations of measurements, ways of data processing and analysis, discussion of the accuracy of the measurement, comparison between theory and experiment, coping with gaps, drawing conclusions	40%
Presentation of the writing of the research	Quality of the written work, presentation that is clear, relevant, to the point, coherent, and inviting, coping with difficulties	10%

Rubric: Presentation of the Research

Components	Aspects Evaluated	Weight
Presentation of the theoretical component	Clear presentation of the research objectives and research questions, mastery of the theoretical background, the principles and the assumptions upon which the research is based, understanding of the meaning of every expression appearing in the written work	15-35%
Presentation of the experimental component	Full description of the experiment design, considerations of experiment and ways of measurement, explanation in order to improve the system and adjust to the research and the measurement process (reference to constraints), mastery of the stages of numerical solution and simulations	15-35%
Presentation of the data processing and conclusions	Explanations of representations of the measurements (and precision of the measurement) and of ways of data processing and analysis, presentation of the conclusions, comparison between the theory and the experiment, coping with gaps, likelihood of the results, reference to other researches	40%
Presentation of the research	General quality of the presentation: clear, relevant, coherent. Mastery of “physical language”.	10%

2.5 Parental approval letter

Dear Parents,

Re: Your Child’s Participation in a Research on the Topic of “Learning to Become a Physics Inquirer: Environment, Process, and Challenges”

The discussed research is carried out in the framework of my doctoral studies in the Department of Education at AMU University in Poznań, Poland, in cooperation with the heads of the Research Physics Program, Professor Edit Yerushalmi and Professor Bat Sheva Alon, the Division for the Teaching of the Sciences, Weizmann Institute for Science, and with the agreement of the current head of the School of Information at the Davidson Institute for Science Education, in the framework of which the program is held.

Lacking access to the identifying details of the students, which were necessary for the purpose of the dissemination of this letter by myself, the teacher was asked to distribute this letter to the parents of the students in the “Research Physics” Program that is held in the Davidson Institute for Science Education.

The objective of the research study is to examine how studies in the “Research Physics” Program influence the characteristics of the student’s scientific thinking, learning abilities (such as self-learning ability and teamwork ability), perceptions about inquiry work and its skills in the inquiry field.

This research study may contribute to the development of additional programs for teaching and learning in the path of inquiry in the fields of science in general and in the field of physics in particular.

During the period in which the program is deployed, the plan is to carry out these actions at two points in time for the research purposes:

A. Filling out Questionnaires

The researched students will be instructed to fill out, in a group framework, questionnaires that examine their attitudes towards scientific inquiry as a whole and inquiry activities that will be conducted in the program framework. In addition, the examined students will be asked to address in the questionnaires their degree of satisfaction with the program and will be asked to characterize their experience in practical work in the field of physics. The filling out of the questionnaires is planned to take about twenty minutes, each time.

B. Performing a Test in Writing for the Identification of Skills

In the test, which will also be held in a group framework, the students will describe experiments in the field of physics. At the end of every description, they need to note what are the main skills required to perform the experiment. The test is planned to last about twenty minutes.

C. Performing Observations

To meet all the learning processes occurring in the individualized work of the students examined in the framework of the program, I will ask to observe them during their work, while documenting the observation using video films.

D. Holding an Interview

The respondents will be asked to participate in a semi-open interview. In this type of interview, the phrasing of the main questions is performed ahead of time, but the series of their presentation is not determined, and as necessary it is also possible that during the interview questions will be added pertaining to the examined topic. The interviewees will be asked to tell about the way they chose to perform the stages of inquiry in the program framework, to describe how during the performance of the inquiry they encountered difficulties and how they dealt with these difficulties. They will be asked to address changes (if they occurred during the inquiry work) in the cognitive aspect (such as the understanding of the theoretical content), social aspect (such as learning and teamwork), and emotional aspect (like perception of self-efficacy to perform works of this type).

The interview will be carried out by me, alone (I am a physics teacher in a high school, but not in the school where your child studies) and will be held after the studies planned in the program framework (not at the expense of the lessons), in coordination with the contact people of the school where your child studies in the Davidson Institute. Every interview is planned to last about 30 minutes. The documenting of the interview will be held through a voice recording. During the interview, the right of every interviewee to privacy will be assured, without disturbing the institute staff from supervising the interviewee as required.

I would like to note a number of important points:

- The performance of the research was approved by the Office of the Chief Scientist in the Ministry of Education, subject to the conditions detailed in its permission document (a copy of the permission was given to the school management and the contact people of the school in Davidson Institute and can be viewed upon request).
- All the data will be correctly in a manner that identifies the subjects, for the purpose of the triangulation of the information that will be collected about every subject from the different information sources noted above, at the two points of time planned for collection.
- The video films, audio recordings, and all the rest of the data that will be collected will be used only for the purposes of the discussed research study.
- I will meticulously maintain the confidentiality of the video films, audio recordings, and all other identifiable data that will be collected, by storing them in password-protected computer files, when only I and my research adviser know this password (and access to the data will not be permitted to the school staff and the parents of the examined students).
- I will destroy the video films, and I will permanently eliminate the details that enable the identification of the respondents from the rest of the data, immediately at the end of the processing required for the research purposes, and in any event not later than 31.12.2020, at the earliest date of the two.
- The publication of the research findings will be performed in a way that will not allow the identification of the research respondents.
- Every parent has the right to decide that their child will not participate in the actions of the collection of the desired information (all or in part). In addition, the students who are candidates to be examined themselves have the right not to participate in these actions (even if their parents have given their consent) and the respondents have the right to end their participation in the collection of the information at any time they want. All this, without the students being harmed in any way following their decisions or their parents' decisions. The participation in the learning program in the Davidson Institute of the students who do not participate in the information collection actions for the research purposes will not be harmed. All this I will also clarify to the students themselves before the beginning of the information collection.

For any request for explanation or clarification of the research, it is possible to contact me:
Mobile phone: 0507476753 Email: michal131313@gmail.com.

If you agree for your child to participate in one or more of the above actions for the collection of information, I will thank you to fill out the consent form attached to this letter and to convey it as soon as possible to the contact people of the school in the Davidson Institute.

Sincerely,

Michal Sigron, researcher

Consent Form

To:

Mrs. Michal Sigron

Re: Participation of My Son/Daughter in a Research that Includes Video Films, Audio Recordings, and Collection of Other Identifiable Data about Him/Her

Since you are performing a research on the topic of “Learning through Inquiry in the Field of Physics: Environment, Processes, and Challenges”, performed at the Davidson Institute for Scientific Education, in the framework of the “Research Physics” Project, headed by Professor Yerushalmi and Professor Alon, from the Division of the Teaching of the Sciences in the Weizmann Institute for Science, and since you asked for my consent for the participation of my son/daughter _____ (please write the full name of the son/daughter) in video filming, audio recording, and collection of other data which will be performed by you for the purposes of this research study.

Therefore, I declare as follows:

- A. That you have explained to me about the aims of the research and the topics and issues that will be examined in its framework,
- B. That you have explained to me about all the acts, with their content, in which it is planned that my son/daughter will participate in the framework of this research,
- C. That you noted the data on which the video recordings will be destroyed and on which all details identifying the additional data that will be collected about my son/daughter will be destroyed,
- D. That you noted the means you will adopt to ensure confidentiality of the video films and all the rest of the identifying data that will be collected until the date they will destroyed / eliminated permanently,
- E. That you have obligated that the research findings will be published in a way that will not allow the identification of the respondents

After I have understood all the aforementioned statements, I hereby give my consent to participate to my son/daughter in this action / these actions (please check the box(es) beside the actions, according to your decision):

- Observations documented through video filing in the framework of the individualized sessions that will be held during the “Research Physics” Program at the Davidson Institute
- Filling out identified questionnaire
- Taking an identifying test
- Participation in an identified interview, documented with audio recording

In witness thereof I hereby sign

Date

Parent Name

Signature

3. Students' Citations for the first Research Question (from open-ended answers in the various questionnaires)

This appendix presents examples of students' quotes (from open-ended answers in the various questionnaires) that illustrate the aspects presented in the research in the various chapters, about the students' perception of their experience, their challenge and their development in performance different components in the inquiry work.

3.1 Students' Citations for Part A of the First Research Question: The Students' Perception of the Challenge in the Performance of the Different Inquiry Components

3.1.1 Students' Citations -Stage 1: Preparation Stage of the Inquiry Project – Detailed Description of the Students' Challenges in Each Inquiry Component

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 3.1.1.2 -Qualitative Analysis – Detailed Description of the Students' Challenges in Each Inquiry Component, from the students' responses in the Inquiry Skills Questionnaire (see appendix number 1.2, before the submission of the “Mini-Project” report, 10th grade, N=27) to questions: “Choose from the list of these skills (or others) two skills that are hardest to perform in your opinion. Explain your choice.”

Inquiry Component: Phrasing Questions/Goals

- 1. General difficulty with transferring the thought to the phrasing of the question/goal.** This difficulty arises from the students' quotes: “Phrasing the inquiry question since there are situations in which it is hard for me to express what is in my head and to put it into words” (student 29, M), “The inquiry question: it is hard in my opinion to describe your thoughts and to explain to a person the goal of the experiment, what is hiding in your head” (student 7, M), “To think about the inquiry question, since it is very hard to phrase your thoughts to be in one question and to include everything” (student 11, F).

2. **Difficulty with formulating the inquiry question**, when students are aware of the importance of the research question, which has a crucial impact on the design of the experiment and the entire research, so they want to ask right., for instance: “Difficulty with phrasing the inquiry question – planning of the entire experiment is based on the inquiry question since it must be phrased well and accurately” (student 10, F), “Great difficulty with asking and phrasing questions – you need to know how to ask question and how to phrase them since this influences the entire inquiry” (student 33, M), “Difficulty with phrasing an inquiry question: since in the question itself there is an answer, if you ask the inquiry question correctly or in the question itself there will already be a part of the answer and the question will show the way how to research” (student 29, M).
3. **Difficulty with choosing the inquiry question**, so that it will be interesting and in essence will lead the direction of the investigation. Two female students (3, 17) were not bothered by the phrasing but by the fact that the inquiry question represents the choice of the topic for the inquiry and by the freedom they have to research what interests them. The process of thinking and identifying what is the topic that is interesting to research is a process that takes a long time, for instance, “Phrasing the inquiry question – since it takes me a lot of time to think about what I want to research, and how” (student 17, F), “Phrasing an inquiry question, it takes me time to phrase a regular question that will interest me without deviating from the topic” (student 3, F).
4. **Difficulty with locating and identifying the factors that influence the phenomenon**, especially when there is no prior knowledge on the phenomenon. In the beginning stage, the student still does not have background on the phenomenon, and therefore it is hard for him to phrase a question without the required background. For instance, “the inquiry question is supposed to research a topic but asking the question without previous knowledge can be too simple or easy and sometimes the opposite, therefore there is difficulty identifying first the factors that influence the phenomenon” (student 10, F), “A difficulty with the skill of phrasing an inquiry question since it is slightly complicated, since it is required to understand all the factors that act so as to perform an experiment that will go smoothly” (student 7, M).

5. **Difficulty with deploying creative thinking in the asking of the questions.** One student (33, M) wrote about the difficulty in becoming unstuck and finding creative ways of asking questions. “I found it very difficult to ask questions and posit a hypothesis since they are the critical basis for the performance of research and the drawing of conclusions. And we generally are stuck on one routine way and asking questions required free and creative thinking, which is hard to do” (student 33, M).

Inquiry Component: Positing a Hypothesis

1. **Difficulty in finding the balance between free thought and reliance on a previous theory/ previous knowledge.** For instance, “Positing a hypothesis is correct understanding of the reality that requires of us to balance between free thought and routine thought (relies on previous theory/ knowledge) and this is hard to do” (student 33, M).

Inquiry component: Performing an Experiment

1. **Coping with the existence of random mistakes in the performance of an experiment, like human errors.** This difficulty arises from the students' quotes, for instance, “It was hardest to perform an experiment since there is room for human mistakes that cause the experiment to be less accurate and it is necessary to deal with this” (student 9, M).

Inquiry Component: Data Processing

1. **Difficulty with building graphs in a computerized environment.** Two students (23, 21, both M) explained the nature of the difficulty with the processing of the findings and indicated that the difficulty is especially with the creation of graphs on the computer. For instance, “Processing the findings on the computer – sometimes we get into a mess with the graphs and do not know exactly how to write the result on the computer and make a graph on the computer” (student 21, M) and “it is hard for me to perform processing of the findings since it is hard for me to work with the computer and I get messed up with this” (student 23, M).

Inquiry Component: Drawing Conclusions

1. **Difficulty with finding a relationship between two factors.** This difficulty arises from the students' quotes, for example, “difficulty with processing findings and drawing conclusions – after the findings are collected you need to draw conclusions and find a relationship between the factors and this was not easy to do” (student 26, M).
2. **Difficulty with implementing high level thinking strategies (like understanding, analysis, and synthesis) to reach conclusions.** More than one-half of them explained similarly that the difficulty in the component of drawing conclusions derives from the requirement to understand in-depth the findings and the processing of them and to perform high order thinking (like understanding, analysis, and synthesis) to reach conclusions that answer the inquiry question. For instance, “The most difficult skill in my opinion is drawing conclusions, since this is the summative stage, which includes in it what has been done until now and because of this is the most complicated and comprehensive that explains the research results” (student 7, M). “In my opinion, oral reporting and drawing conclusions are the two most difficult skills since they rely on understanding the findings and processing them” (student 15, M). “Drawing conclusions is also difficult since there are cases in which reaching a conclusion is complicated and requires high order thinking and many processes in addition to the processing of the results of the experiment” (student 8, M).
3. **Difficulty with comparing between theory and the experiment findings.** For example, “Considerable difficulty with drawing conclusions since this necessitates comparison between the theory and the results of the experiment and to give an explanation to the difference between them” (student 9, M).

Inquiry component: Written Reporting on the Inquiry

1. **General difficulty in verbal phrasing, which includes also the transition from graphical representation to verbal representation.** Two students (8, 21, both male) explained that the difficulty primarily in the writing of a verbal description of what is done in the research, like a description of the carrying out of the experiment.

For example, “A written report since sometimes it is difficult to explain in writing what we did or concluded from the experiment” (student 8, M) and “Sometimes you get tied up with the graphs and do not know how exactly to write the results that derive from the graph” (student 21, M).

Inquiry Component: Oral Reporting of the Inquiry

1. **General difficulty with conveying the thought into oral expression.** This difficulty arises from the students' quotes, for instance, “Oral reporting – since we do not always know how to explain in words what we are thinking” (student 21, F) and “Oral reporting – it is hard for me to explain my thoughts in words” (student 29, M).
2. **Difficulty during the time of the presentation with the mastery of the accumulated knowledge on the inquiry.** “Oral reporting – since you need confidence and mastery of the knowledge you accumulated on the experiment” (student 26, M) and “In my opinion, oral reporting and drawing conclusions are the two hardest skills since they depend on understanding the findings and processing them” (student 15, M) and “Oral reporting – it is hardtop remember all the experiment by heart” (student 33, M).
3. **The coping with stress and the embarrassment that exists when standing in front of an audience.** Two students (10, 29, both male) noted that the difficulty derives from the embarrassment and pressure existing in some of the students when standing in front of an audience, for instance: “oral reporting – I personally do not like talking in front of an audience and presenting findings and I am a little embarrassed and therefore this is the part I have difficulties with” (student 10, F) and “The second skill that is very hard for me to carry out is oral reporting since there is pressure in the transfer of the knowledge that I accumulated to the other members of the class in the presentation before them” (student 29, M).

3.1.2 **Students' Citations -Stage 2:** Intermediate Stage of the Inquiry Project – Detailed Description of the Students' Challenges in Each Inquiry Component

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 3.1.2.2 - Qualitative Analysis – Detailed Description of the Students' Challenges in Each Inquiry Component, from the students' responses in the Summative Questionnaire, (see appendix number 1.4, before the submission of the intermediate report of the project, 11th grade, N=33) to questions: “Choose at least two components in which you noted that you experienced considerable difficulty. Describe what was the difficulty in these components, how did you cope with these difficulties?” and question: “Regarding your satisfaction about the cooperation between the students and the teacher-mentors, if you are not satisfied, please describe what bothered you” and in question: “Note two-three aspects of the program that should be changed and explain”.

Inquiry Component: Choosing an Inquiry Topic

1. **Difficulty with choosing a topic that is not familiar and is new for the students.**
This difficulty arises from the students' quotes, for instance, “It was hard to choose a topic when they do not know it” (student 22, M).
2. **Deliberations on choosing a topic according to the degree of the challenge, interest, and complexity of the topics.** The student weighs questions such as to what extent is he interested in challenging himself, should he choose a complex topic or a less complex one. For instance, “Difficulty in the choice of a topic for the project, I greatly deliberated between going for a topic that really interest me personally, like topics in optics and/or chemistry such as Brownian movement, or a topic where I have no previous knowledge, like electricity ... and I want to challenge myself more and to choose a topic that I will need to learn from the beginning gradually and reach with it high levels” (student 1, M).
3. **The number of possibilities of choosing an inquiry topic is limited and the choice is from a database and is not free.** For example, “The choice of the topic for the project is not completely free, we could have chosen only from a number of possibilities, which makes the choice harder” (student 18, F). Some of the students proposed broadening the database of research topics in the program so that they

would have a greater selection of topics that interest them and greater chance of connecting to the topic. Examples: “The choice of the topic – although there are many possibilities perhaps it is preferable to let the students choose what topic they want, not from a database” (student 19, F) and “The broadening of the possible topics for the project since not everyone connects to the presented topics” (student 12, F).

Inquiry Component: Phrasing Questions/Goals

1. **Difficulty with the focusing of the inquiry question and prevention of dispersion to the different directions of investigation.** A number of students explained similarly that the difficulty with the phrasing of an inquiry question is primarily in the focusing of the inquiry question, because of the many findings or because of the extensive phenomenon, and that it is possible to deviate to all sorts of directions of investigation. For example, “Focusing the inquiry question – in our project we chose to engage in a totally new topic from what we knew (electricity) therefore a number of times it happened that I and my research partners deviated from the topic we investigated and were forced to go back and to focus on the topic we started with” (student 30, M), “It was hard to crystallize questions since in the material we engaged in and all our findings made it difficult to choose one inquiry question – we coped with the difficulty in that we focused the question and we chose the most important findings” (student 21, M).
2. **Difficulty with bringing up an inquiry question when there is no previous knowledge on the topic.** One student brought up this difficulty and proposed to first get to know the topic extensively. For instance, “Finding an inquiry question, we did not have since we did not have knowledge on the topic, we needed to first get to know the topic extensively” (student 6, M).

Inquiry component: Locating Information Sources

1. **Finding a low number of sources relevant to the researched phenomenon.** Students explain that the difficulty in this component arises when there are few sources relevant to the researched phenomenon, and in this case it is necessary to turn to and seek the help of the teacher-mentors in the search for sources in this

- topic. For example, “The locating of relevant information sources (such as content websites, textbooks, or articles) for the research topic – we did not find much research relating to our specific phenomenon. With the teacher-mentor’s help, we found articles on the topic and dealt with the difficulty” (student 9, M).
2. **Lack of knowledge and experience in finding evaluated, quality, and high level information sources.** One student (female) emphasized that it is not very difficult to find relevant sources for the research on the basic level; rather the difficulty begins when it is necessary to find a quality and evaluated information source to reach a high level of knowledge on the researched topic and especially when the topic is new and you do not know where to find what is needed. “The basic knowledge was not hard to find but to reach high level of knowledge it was very hard to locate quality sources of information and it is possible to rely on and especially because the topic is new I did not know which sources are relevant for the topic” (student 32, F).
 3. **Difficulty with the multiplicity of information sources when the phenomenon is composed of sub-phenomena and many components.** One student (female) tells that the performance of this component was hard for her because of the considerable quantity of the components related to the phenomenon and it is necessary to search and to find for every component sources separately. “The difficulty with locating relevant sources of information – the phenomenon that we researched is composed of a number of phenomena and of many components when for each one of them it was necessary to search separately” (student 10, F).

Inquiry Component: Planning an Experiment

1. **Difficulty with performing isolation of variables in the process of planning the experiment,** when in actuality, additional variables surface during the experiment. For instance, “Another difficulty was the isolation of variables since we used measurement units we did not know beforehand and the experiment focused for the most part on pictures composed of pixels and it was very hard to plan how to isolate the variables or the different materials that have a different structure, in addition it was hard to isolate their transparency and to examine whether the transparency is

different or similar” (student 28, M) and “As a part of my project we researched the field of optics and therefore we worked a lot with pixels and with a quantity of filters that the picture goes through when photographing the spectrum, all these caused great difficulty with isolating the variables in the planning of the experiment” (student 34, F). The students tell that using the consultation with the teacher-mentor they overcame this difficulty and a creative way was found to plan the building of the experiment system that enables isolation of variables and meets their needs. For example, “Planning the system was challenging to a certain extent since we needed to adjust the system to our needs and to the measurement of our variable. First we did not exactly know what we had to build. After consultation with our teacher-mentor we found a creative way to plan the system and measure our variable” (student 14, M).

2. **Coping with the dynamism of planning the experiment** to increase the effectiveness and improve the experiment system. The students describe coping with the dynamism of the planning of the experiment, which is not performed one time and remains constant but changes and they return and improve it during the inquiry, so as to increase the effectiveness and improve the experiment system as much as possible. The students overcame this difficulty through group thinking and teamwork with the partner in the project. For instance, “difficulty with planning the system since many times we tried to improve the system and increase its effectiveness as much as possible and in the end we overcame this through group thinking with the project partner, we suggested different ideas and different ways” (student 15, M).

Inquiry Component: Performing an Experiment

1. **Difficulty with independently finding the equipment required for an experiment in the laboratory.** This difficulty arises from the students' quotes, for example, “Another great difficulty we had was the assembly and finding of parts of the system so that we can measure and perform experiments in the field we chose” (student 7, M).

2. **Difficulty with building the experiment system independently**, which derives from the lack of familiarity with the topic and with the system components. For example, “Difficulty with building the system, since Alex and I, the group members, did not have preliminary knowledge in electricity, first it was very difficult to build the systems and to understand how to connect all the components, which we just now learned into one system, whether in a column or in parallel, adjustment of the voltage to what the light can receive so as to prevent too many shorts / loads. However, the teacher-mentor and the laboratory assistants helped us greatly understand the entire system and how to deal with it” (student 1, M).
3. **Difficulty with operating parts of the system independently**. This difficulty arises from the students' quotes, for instance, “In addition, I needed help from the laboratory assistants in the implementation of some of the research aids but in the end I managed and I learned to do it alone” (student 3, M). “In the work I frequently encountered difficulties with the deployment of the equipment” (student 21, M).

Inquiry Component: Using Technological Aids and a Computerized Laboratory

1. **Difficulty operating different technological instruments and in a computerized laboratory** (such as sensors, computerized programs), which derives from the lack of knowledge/experience in the use of these instruments. The students report that they were helped by the laboratory assistants, and it was necessary to have determination and to use trial and error until they surmounted these difficulties. This difficulty arises from the students' quotes, for instance, using a computerized laboratory – there was difficulty in operating and stabilizing the sensors from the PASCO software, we coped with the difficulty using determination, patience, and many attempts” (student 21, M). “Another difficulty was control of technical difficulties since we used the Tracker software that we had not learned beforehand and when performing the measurements we encountered technical difficulty in the operating of software that delayed the learning process and the research process” (student 28, M).

2. **Coping with lack of accuracy and sensitivity of the technological measurement devices.** This difficulty arises from the students' quotes, for instance, “difficulty performing accurate measurements with the technological instruments – it was difficult with Tracker since we noted the points the most accurately that the software could give, which created accuracy that was not maximum” (student 20, M). “When we (my project partner and I) took results directly from the computer software we used to analyze the phenomenon, there was lots of noise, and we did not obtain reliable results suited to the theory” (student 23, M). “Difficulty with the use of technological means for the research purposes, this was complicating and not accurate to work with an audio program and there were many noises. Therefore, we were helped by the laboratory assistants who helped us” (student 17, M). In addition, students brought up the need to see to more sophisticated equipment in the laboratory to build systems of experiment that will enable more accurate measurements. For instance, “you need more sophisticated equipment to build more accurate systems” (student, 31, F).

Inquiry Component: Data Processing

1. **Difficulty with classifying data relevant to the inquiry question.** For instance, “First it was hard to classify the data, not to take all the data from the software but only the basic data that is needed (since there was much noise) ...” (student 23, M).
2. **Difficulty with independently transitioning from raw data to complicated data.** For instance, “... then it was hard to alone reach through self-calculation more ‘complicated’ data (like acceleration. But we did this, we used thinking (I and my partner in the project), these are data that must be taken, and from these data we learned together how it is necessary to process them to reach more complicated data” (student 23, M). From the quote it is possible to see that the student overcame these difficulties using critical thinking and teamwork with the project partner.

Inquiry Component: Drawing Conclusions

1. **Difficulty when the results are not commensurate with the theory and it is necessary to find an explanation of this gap in the conclusions.** Most of the

students who chose this component as difficult to perform described that this difficulty appears mainly in the stage of the comparison between the theory and the experiment and finding a relationship between them and conclusions following the comparison. The difficulty arises especially when the results are not commensurate with the theory and it is necessary to find an explanation of this. The students overcame this difficulty following joint thinking of the team members. For instance, “Difficulty in linking between the project findings and the theory – the results were not commensurate with the theory and we needed to attempt to find for this an explanation, that this was difficult, we thought together as a team” (student 20, M) and “Difficulty with linking between the theory and the findings of the experiment and overcoming mistaken results” (student 27, M).

2. **Difficulty when a theory relevant to the research, upon which it will be possible to base the conclusions, is not found.** Students explained similarly that the difficulty with drawing conclusions arises when a similar experiment or research was not found on the chosen topic, upon which it is possible to base, for instance: “The great difficulty was the connection to the theoretical model since the topic I chose was not performed beforehand and there was not a previous research, thus making the experiment process and the finding of differences between theory and experiment difficult” (student 28, M), “As a part of the project we chose a question that was never researched and therefore it was hard for us to explain the results and we did not have a model or an experiment of other scientists to base upon” (student 34, F).
3. **Difficulty when the theory is very complicated mathematically (in the students’ opinion) to reach conclusions.** The students overcame this difficulty using the teacher-mentor’s support and finding creative ways, such as use of computational modeling to overcome complicated mathematical solution in the students’ view and to create a formula that links between the variables. For instance, “Difficulty with connecting between theory and the findings of the experiment: in our two large projects, the theory was very complicated mathematically and therefore we had to think about very creative ways to find the link (computerized model etc.)” (student 13, F). “In the beginning it was hard to find a formula because the mathematics was complicated, but in the end together with the teacher-mentor we wrote it...” (student 31, F).

Inquiry Component: Written Reporting on the Inquiry

1. Difficulty with summarizing the main points in the writing of the presentation.

The students brought up the difficulty during the writing of the presentation, since it is necessary to summarize the main points to manage to present the inquiry in an allotted period of time, especially when a large number of experiments were performed and there is considerable theoretical material on the topic. They overcame this difficulty with the help of teamwork and support from their teacher-mentor. For instance, “Difficulty with writing the presentation – we had a lot of theoretical material and experiments, the difficulty was the allotted time given to us to present in a summarized manner all the things in the presentation” (student 10, F), “The creation of the presentation constituted a certain difficulty primarily to choose and to write the important things but I and my partner succeeded in dealing with this difficulty in that we were helped by our teacher-mentor and by one another” (student 30, M).

- 2. Lack of time and resourcefulness for documenting the research work.** Some of the students described that in the encounters they work on the inquiry until the last moment so they have no time and resourcefulness for documenting. For example, “Difficulty with documenting, there was none. Until the end of the lesson we worked on the research and therefore there was no time or resourcefulness for documenting” (student 06, M). These students in this stage still do not understand the effectiveness and thinking of documenting the inquiry process. For instance: “The research journal had not benefit and did not help in anything, we barely referred to it” (student 2014, F). Another student (6, M) noted that although he did not succeed in documenting the inquiry process, he understands the importance of the documenting and its effectiveness and therefore he seeks to think how to cause students to document especially when the students do not have the motivation to document and they do not at the moment see the importance of the issue. “It is important to force the students (who do not have much motivation to document)” to document since the research journal is important and effective” (student 6, M).

Inquiry Component: Oral Reporting on the Inquiry

1. Fear and even anxiety about standing and presenting in front of an audience.

More than one-half of the students who noted that they had difficulty with the presentation before their peers explained that the difficulty derives from fear and even anxiety about standing and presenting in front of an audience. The students told that to overcome this fear they practiced at home their presentation before their family and friends and their self-confidence then increased. For instance, “The presentation before peers and teacher-mentors was a serious obstacle for me since I have stage fright but when I learned the presentation and practiced with peers and my partners I obtained confidence and overcame the fear” (student 29, M), “Presenting before teacher-mentors and teachers – it is a little difficult for me to speak before people, I am shy. I coped with this difficulty in that I practiced at home, in front of my family and friends with reading the presentation” (student 24, M). Some of them noted explicitly that they did not really succeed with the attempt to cope with this difficulty, for instance, “Presenting orally – it was hard for me to stand in front of people who are looking at me and to talk. I did not really succeed in coping, I do not really remember what happened there aside from the anxiety I felt” (student 9, M), “The oral presentation: I have difficulty with standing in front of an audience and presenting. The attempt at coping with this did not really succeed” (student 18, M). In addition, the students raised the need to carry out for intermediate presentations and peer assessment during the inquiry work, for two main reasons, first to improve the oral presentation and stand before an audience before the final presentation and second to report on the situation and to advance the project and thus it will be possible to carry out follow up and supervision for the entire team. Examples: “It is possible and preferable to do shorter presentations during the year to see where the entire staff is found. In addition, the presentation of things helps with the understanding of the material and of course experience with speaking in front of an audience, which is very important in the future to scientists and in general” (student 1, M). “To do every so often a lecture and report on the situation of the project, so that we can practice the reading and presenting and improve it before the final presentation” (student 25, M).

2. **Difficulty with keeping to the allotted time for the presentation of the inquiry.** Students suggested overcoming this difficulty by planning ahead of time the content of the presentation and the manner of the presentation. For instance: “The presentation of the project to teacher-mentors and peers, the difficulty was to present at an allotted time, but they planned ahead of time how to present and what” (student 16).
3. **Fear that the oral presentation may harm the image of the quality of the project work.** One student brought up the concern that the presentation to the peers may harm the image of the work if the presentation is not good and therefore he does not see the need to present the project in front of people. The quote: “I do not think there is a need to present the work since there are people who are afraid of presenting and this can harm the image of the work if they become confused” (student 29, M).

Inquiry Component: Building Content Knowledge

1. **Difficulty with learning and understanding in-depth the contents required for the project, especially when there is no prior knowledge about the inquiry topics** and the theoretical material is new for them. The students explain in a similar manner that they coped with the learning of topics that are new for them and they did not have prior knowledge on the inquiry topics. Students noted that to learn and understand the theoretical material in-depth it is necessary to locate sources that are relevant to the researched topic and to obtain the teacher-mentors’ help. For example: “Difficulty with the learning and understanding of the contents required for the project – we both came to the project without knowledge on its topic and we were helped by our teacher-mentor and by literary materials to understand and to learn it” (student 8, M), “Learning and understanding of contents in physics since we did not engage in optics in the past but we overcame this through the increase of the depth of the understanding and explanations on the part of the teacher-mentor” (student 15, M), “Another difficulty was understanding all the physical principles related to our new topic. With the help of our teacher-mentor’s patience, we succeeded in the end in understanding most of the material” (student 14, M).

2. **Difficulty with independent learning of the contents relevant to the inquiry.**
The previous difficulty especially grew when it was necessary to learn the new topic independently. For instance, “The topic on which the inquiry was based is a topic in which I did not have previous knowledge. Therefore I needed to learn it by myself, the self-learning was not simple. I experienced great difficulty with understanding the material, especially that this is a topic I needed to learn from the beginning” (student 32, F).
3. **Coping with the complexity of the theoretical material and its high level.** The students overcame this difficulty through the support of the teacher-mentors, who explained to them the things that were not understood or were complicated. For example, “Learning and understanding new topics in physics – at first it was hard to learn the new topics since they were on a higher academic level than we had learned until now and it was harder for us to understand, we solved this difficulty with the help of the teacher-mentor, who explained all that was not understood” (student 12, F), “The understanding of the theory – as aforementioned, the theory was complicated and understanding it was relatively difficult” (student 210, F), “We have until now been dealing with the theory since it is on a higher level than in the school” (student 11, F).

Inquiry Component: Building a Theoretical Model

1. **Difficulty with building a theoretical model, primarily through computational modeling,** both in the correct writing of the physical principles related to the researched phenomenon and in the correct writing of the programming language. The students reported that they had difficulties with this component mainly in the building of the theoretical model through the computational modeling of the phenomenon. The students explained that there is difficulty with writing according to the rules of the programming language and correct writing of the physical principals related to the phenomenon. They overcame these difficulties by observation of the modeling carried out in the past and were helped by the teacher-mentors or laboratory assistants who understand computational modeling. For instance, “I had difficulties with computational modeling, since it was necessary

to master the theoretical material and formula and also the programming language, but I received help from the teacher-mentors and in the end I managed” (student 3, F), “It was difficult to build a simulation on the computer, with correct writing of the physics related to the research and in general to write the language properly. But we asked the teachers who were there and they helped build the theoretical model correctly” (student 31, F), “Writing a computational model – at first it was hard to write the computational modeling since time had passed since we had learned the software and we did not remember everything. We looked at the software programs we wrote in the past and we were helped by the teacher-mentor to solve the difficulty” (student 12, F).

In addition, the students proposed similarly that it is necessary to emphasize in the program on the use of computational modeling in the inquiry work to build a good theoretical model, and it is necessary to increase the awareness of the students of the importance and effectiveness of this instrument. For instance: “To be exposed more to the computational modeling and its effectiveness so that it will be more understood what is the goal of the building of the model” (student 23, M), “Perhaps to attempt to bring more experiments that it is possible to model, I terribly wanted to use the computational modeling in the experiment” (student 25, M), “If they continue to teach computational modeling, to obligate the use of it in the research, since with it we can build a good theoretical model” (student 1, F). In contrast, one student (4, F) did not see the importance of this instrument and argued that it is not possible to dedicate considerable time to the computational modeling. “Computational models did not take part in most of the projects and it was possible to do something more useful in this time” (student 4, F). In addition, one student proposed to seek the advice of experts in the field of inquiry to improve the model. “To create a relationship with people who had researched this topic and to seek their counsel to reach a more accurate theoretical model” (student 28, M).

Inquiry Component: Self-Regulation

1. **Difficulty with the organization of the inquiry work**, because of the large and extensive scope that is required to carry out an inquiry project in this program, both in terms of the learning materials of the inquiry topic and in the many performances of inquiry carried out in the project. The students describe the ways of coping with this difficulty with the help of the understanding and the performance of the orderly documenting of the inquiry in a “research journal” in which the research processes were documented. For instance, “Difficulties with organizing the research work – we coped with these difficulties with the help of a notebook in which we organized and wrote all the research processes and results of our experiment” (student 17, F), “Difficulty with organizing the research work – we did not know from where to being on this giant topic, therefore we learned all the theory, and we performed experiments on all that we learned, and we documented everything” (student 24, M). Other students raised the need to plan the work ahead of time and to implement methodical thinking from the start of the inquiry to overcome the difficulty in organizing the research. For instance, “To be more certain about the continuation of the work and what is planned already from the beginning” (student 1, F), “To focus more on methodical thinking already from the beginning, to help with the order, the general organization, of the research process” (student 29, M).
2. **Difficulty with meeting the time schedule** because of the great load of the inquiry work beyond what was expected because of all sorts of problems that arose during the work. Other students explained that with them the difficulty in meeting the times derived from the considerable work on the project that was held beyond the expected time because of all sorts of problems that arose during the work. One of the copings to meet the time schedule is the choice of a simpler and less complex inquiry question. Quotes: “Difficulty meeting the time schedule – since the simplification of the phenomenon that we are researched took longer than expected, we got pressured in terms of the time schedule. To meet the schedule, we chose a rather trivial inquiry question” (student 9, M). In addition, so that there will be time for fuller and more in-depth investigation students proposed that the duration of the time of activity in every session will be longer or to begin the project at an earlier

- stage in the program. For example, “It is desirable to give more time in the program in every session so as to research in greater depth the entire phenomenon” (student 9, M), “To begin the project at an earlier stage in the program, so that we can manage to research what we want and if there will be problem then we will have time to resolve it and to meet the time schedules” (student 22, F).
3. **Difficulty with performance of an intelligent decision in the choice of directions of investigation of the project** during the inquiry work. The students overcome this difficulty with the help of intelligent and joint decisions with the partner and persistence to the investigation. For example: “The overcoming of the situation of uncertainty – in a certain stage of the project (relative to the percentage) I had considerable difficulty choosing the directions of investigation related to the phenomenon, something that takes time. But later on I chose together with my partner in the project a certain topic and persevered in it and thus we succeeded in understanding and researching number of aspects related to the phenomenon in a more effective manner” (student 23, M).
 4. **Reaching the fulfillment of the investigation in the middle of the process and lack of knowledge on the continuation of the direction of the investigation.** For instance, “Difficulty overcoming situations of uncertainty, after we finished a certain stage in the inquiry, we did not always know how and where to continue” (student 16, M).
 5. **Reaching the situation of lack of satisfaction with the inquiry performed and/or lack of confidence in the quality of the inquiry.** The students surmounted this difficulty with the help of the reinforcement and support from the project partner. For instance, “Difficulty being in a situation of uncertainty. I had a number of times deliberations whether to leave everything because the planning I hoped would work out did not work out for me but I received reinforcement and support from my partner and time did its part and everything worked out” (student 29, M), “Difficulty overcoming the situations of uncertainty: it is hard for me to continue onwards to the next stage in the project when I know that there is a chance that the previous stage is not precise and will result in mistakes in the continuation or I am not certain that what I did is good ...” (students 13, F).

3.1.3 **Students' Citations -Stage 3:** Final Stage of the Inquiry Project – Detailed Description of the Students' Challenges in Each Inquiry Component

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 3.1.3.2 -Qualitative Analysis – Detailed Description of the Students' Challenges in Each Inquiry Component, from the students' responses in the Summative Questionnaire (see appendix number 1.4, before the submission of a summative report of the project, 12th grade, N=34) to question: “They chose at least two components that you noted that they experienced considerable difficulty about them. Describe what was the difficulty in these components, how they coped with these difficulties?” and the question: “Regarding their satisfaction about the cooperation between students and teacher-mentors, if you are not satisfied, then please describe what bothered you” and in question: “Note two-three aspects of the program that should be changed and explain”.

Inquiry Component: Choosing an Inquiry Topic

1. **Difficulty with the focusing on the inquiry topic and avoidance of dispersion to other directions of investigation.** Students overcame this difficulty using direction from the teacher-mentor. For instance, “Difficulty with focusing on the inquiry topic – not to deviate to other directions that are interesting but distance you from the topic we chose to focus on, we acted according to the teacher-mentor’s advice” (student 30, M).
2. **It is impossible to change the topic in an advanced stage of the research** despite the great difficulty of the students in understanding the topic. This difficulty arises from the students' quotes, for instance, “I experienced considerable difficulty in terms of the change of the inquiry topic, we could not change the topic itself, which was very difficult to understand and it was hard on the research process. We could not change the topic (for example from optics to mechanics) since we investigated and we did the year before and we are in an advanced stage in the program” (student 28, M).

Inquiry Component: Phrasing Questions/Goals

1. **Difficulty with choosing an inquiry question, which will be interesting for all the team members.** Respondents are mentioning “We had difficulty choosing our inquiry question – to choose a question that we both want and are interested in, but after much thought we chose what we both wanted” (student 16, M).
2. **Difficulty focusing the inquiry question.** This difficulty arises from the students' quotes, for instance, “There was great difficulty with the focusing of a certain inquiry questionnaire on a topic we chose that is related to the cup of wine and its process of inquiry. We coped with the difficulty by changing the question, so as to investigate things that we could produce measured results” (student 17, F), “After last year we did not know what to focus on, which made it hard for us to plan the work and the direction of the investigation, we coped with this difficulty with the help of the teacher-mentor, who directed for us the inquiry questions so that we would work on this” (student 28, M).

Inquiry Component: Locating Information Sources

1. **Finding a low number of sources relevant to the inquiry topic,** primarily when the researched phenomenon is not widespread and because of their little experience in this component. This difficulty arises from the students' quotes, for instance, “It was very difficult to find information sources since there weren't many sources for the topic that I need to learn” (student 32, F), “Since our phenomenon is not widespread, and since we chose to go in-depth in the theoretical background, we encountered great difficulty in finding theoretical background” (student 33, M). The student 19 suggested adding experience in this component already in the first year of the program, in the stage of preparation, and not only in the work on the project: “In the first year we were supposed to learn inquiry skills...but in essence we did not practice finding theoretical material, we experienced this for the first time only after the beginning of the first inquiry work, I would attempt to add experience in these skills in the program already in the first year” (student 19, F).

Inquiry Component: Planning an Experiment

1. **Difficulty with planning a system that will meet the inquiry question**, especially when the existing system does not allow isolation and measurement of the desired variables, because of a number of reasons, such as a too simple system or the opposite, a too complicated, too sensitive system: For instance, “Difficulty in planning an experiment system that will answer the inquiry question – our first experiment system was too simple and not good enough, so we need to find and plan a more complicated way to build a system that will suit us and we can measure the variables without interfering factors” (student 14, M), “Planning a system – our system was very sensitive and composed of things we did not have and therefore it was hard for us to assemble the system and reach the required system, which will enable the measurement only of our variable” (student 25, M), “It was very difficult to plan and build an experiment system since our experiment system was complicated and needed considerable thinking on things we did not think about in the beginning” (student 32, F).
2. **Coping dynamically with the planning of the experiment system**, which changes according to the inquiry needs. The students describe many changes in the planning of the inquiry during the work to create a system that will provide a solution to the inquiry question. For instance, “The difficulty of the choice of the system and its planning – the difficulty was to produce reliable data through sensors and Wilberforce pendulum given to us. Therefore we had to plan and to create a system of our own. This system did not measure as we wanted from the beginning. We needed again to plan and to create a number of models (3) until it worked like we wanted” (student 26, M). It can be seen from the students’ answers that they overcame the difficulty because they persevered, they were determined, and they deployed considerable thinking in planning so as to reach as good and improved system as possible. For instance: “Difficulty with planning the experimental system. We coped with the difficulty with stubbornness and perseverance to improve the system for two years” (student 15, M).

3. **Difficulty with planning an experiment that will bring up quantitative data and not only qualitative data.** One student (17, F) brought up this difficulty so that in the inquiry process there will be quantitative data analysis and not only qualitative, which includes data processing in graphical representation. The student was forced to change her direction of investigation because of this requirement. For example, “The research in the project requires necessarily measurable findings from which graphs / certain results are produced (according to what I understood) and this is something that limited in a certain level the possibility of the research in my opinion. However, following this requirement I changed my direction of investigation and I planned additional experiments from which I could build graphs. Perhaps this was for the best since the new direction was more interesting and in-depth and in the end it very much connected to the initial research” (student 17, F). From the quote, it is possible to see that the student coped with the difficulty in the understanding of the goals of the requirement to perform a quantitative experiment and to recognize the dynamism of this component so as to create deeper and broader investigation and to create a connecting line between the initial experiments and the new direction of inquiry.

Inquiry Component: Performing an Experiment

1. **Difficulty with building an experiment system that will allow accurate measurements.** This is the main difficulty that students describe in this component, because of a number of reasons, such as factors of error in the experiment, limitation of the experiment system, and lack of equipment and means in the laboratory that will enable the system to be improved. For instance, “performance of accurate measurements – it was difficult to obtain the maximum accuracy in our measurements in the Tracker software but luckily we found the error factors of these sizes and we attempted to minimize them” (student 14, M), “Performance of accurate measurements – we did not have the means that allow more accurate measurements. We coped with this difficulty in that in the end we did not use the experiment findings from our experiment but the findings from an article that did an experiment like ours, and instead of performing the experiment we created a

computational model for the theoretical prediction of the phenomenon” (student 18, F), “The greatest challenge how to isolate the parameters in the composition of the experiment system to reach the most accurate results possible with the existing instruments” (student 29, M), “The difficulty is doing more accurate experiments since there isn’t enough equipment in the laboratory” (student 1, M).

As can be seen from the students’ responses, the students coped with this difficulty in different ways: the minimization of the error factors in the experiment system and the attempt to isolate the variables as much as possible, taking data from existing articles on an identical experiment to analyze more accurate data, and building a computational model for the phenomenon. In addition, in the question “note two-three aspects of the program that should be changed and explain”, some of the students sought to improve the laboratory, through the acquisition of more reliable and sophisticated measurement tools for performing more accurate measurements. For instance, the quote “The improvement of the laboratory – more sophisticated instruments that can help. Additional laboratory instruments for measurement – there weren’t enough devices to measure the power of the light and even if there were, they were not sufficiently calibrated and accurate” (student 28, M).

- 2. Coping with the dynamism of the experiment performance in the inquiry process**, which is expressed in the performance of repeated experiments and in the improvement of the experiment system, which requires abilities like perseverance, determination, and creative thinking. For instance, “there is additional difficulty in the coping with performance of repeated experiments a large number of times, in the change of the experiment system to improve it and to reach better results. We coped by not giving up, we persisted until this succeeded, and much creative thinking” (student 7, M), “The experiment system of the Faraday effect – we tried a number of different experiment systems and it was not easy to work each time with another system” (student 4, M). The students describe that they coped with this difficulty because of their ability of perseverance, determination, and creative thinking.

Inquiry component: Data Processing

1. **Difficulty with collecting and analyzing the data**, because of the large scope of data and especially when the action is monotonous it sometimes led to frustration. This required of the students considerable investment and proper time planning. For example, “During the investigation of the measurements I had to use the Tracker software to produce data from the films we took. This took many hours of monotonous action, which frequently repeated since it was necessary to ascertain the correctness of the produced data. This caused me great frustration frequently during the work. I coped with this difficulty through the correct division of time and considerable time investment” (student 7, M).

Inquiry Component: Drawing Conclusions

1. **Difficulty with the comparison between the theory and findings of the experiment and especially when there is a large gap between them**. This was the main difficulty in this component. The students overcame this difficulty through critical thinking and greater depth of investigation in order to reach believable conclusions. For instance, “There was a difficulty in the comparison between theory and experiment since there is a large gap between the theoretical world and the realistic world, and therefore we needed to think and to critique what we did and to investigate more to reach more correct conclusions” (student 29, M).

Inquiry Component: Written Reporting on the Inquiry

1. **Difficulty with persevering in the continuous and consistent documenting of the process of the investigation**. This difficulty arises from the students' quotes, for instance, “Documenting the inquiry process – it was difficult to collect the considerable information we worked on for an entire year, we overcame this with the help of the Drive program that concentrated everything for us” (student 28, M). Some of the students overcame this difficulty with the help of writing an inquiry journal, which includes the entire inquiry process and its products, while in contrast some students did not document their work consistently and it was difficult for them with the writing of the inquiry work. For instance, “We experienced considerable difficulty

- in documenting since we did not document almost anything. Much information vanished or was forgotten, thus making it hard to write the final work. What was not documented we tried to reconstruct, but if we did not succeed in reconstructing, then the topic simply entered the work in an uncertain manner” (student 6, M).
2. **Difficulty with verbal phrasing of the description of the work components** like description of the experiments, description of the conclusions, and description of the reflection, for instance, “Difficulty with writing the work – it was hard for us to write the work, to describe and to phrase the experiments, the difficulties, and the conclusions” (student 10, F).
 3. **Difficulty with the organization of the summative work**, ordering the work components in logical continuum that is interesting to the reader. This difficulty arises from the students' quotes, for instance, “Difficulty organizing the writing of the research work – it is much easier for me to order things in the order of events – chronologically but in the work they wanted according to a different order and therefore I simply wrote the entire work by chronological order and then I copied everything according to the desired order” (student 22, F), “... in addition, difficulty with ordering the continuum of the experiments so that this will be logical and interesting” (student 10, F), “I experienced considerable difficulty with the organization of things and findings in the writing of the work” (student 27, F).
 4. **Difficulty with the differentiation between the major and minor points and performing decisions** in the choice of things that will be presented in the presentation, so as to not wear out the tester / audience with unnecessary details and to increase the interest in the beauty of their investigation and to meet the time limits allotted for the presentation. For example, “Writing the presentation – it was hard to insert all the experiments into the presentation while maintaining its length. We removed certain parts so as to keep the audience focused and not to lose their attention and to manage to go through the entire presentation in the allotted time” (student 11, F), “Writing the presentation – it was hard for us to summarize all the experiments into a presentation of 15 minutes” (student 10, F), “Writing a presentation – it was hard to organize the presentation into a quarter of an hour and therefore we held practices with the presentation to remove less important contents” (student 28, M).

Inquiry Component: Oral Reporting on the Inquiry

1. **Coping with the fear and stress that exist in standing in front of an audience.** This is the main difficulty in this component for most of the students. The students relate that they overcame this difficulty through the repeated rehearsal of the presentation before family and peers, and the accumulation of experience in presentations during the program and the mastery of the content knowledge and the inquiry process before the summative presentation increased their self-confidence and self-efficacy in presenting before an audience. For instance, “Oral presentation – it is hard for me to present things orally in front of an audience. Therefore, I also had difficulties in this case. I coped with this difficulty in that we repeated the presentation many times and also my knowledge on the topic after two years of work on the project gave me the confidence and success in oral presentation” (student 18, F). “The difficulty I coped with was presentation in front of peers since I have a fear of speaking in front of an audience but I succeeded in dealing since I learned the material well and I knew all the material required for the presentation, this reduced the stress and helped me” (student 22, F), “The presentation of the work – I was pressured when we needed to submit and present the work in front of the teacher-mentors and examiners from the institute, but over time and with the many presentations we performed I began to overcome the fear” (student 13, F).

For the question “note two-three aspects of the program that should be changed and explain” the students held different opinions; some students sought to give frequent presentations in front of an audience in the program to improve the associated skills, for instance, “Evenings of student presentations should be held to improve in the skills related to oral presentation” (student 26, M) while some students wrote that despite the skills acquired in presenting in front of an audience they would have preferred not having this type of assessment. For instance, “In my opinion, it is necessary to change the standing in front of an audience despite the advantages of it to help shy students, there are some who cannot convey the general picture of the research and this harms their evaluation” (student 29, M), “In my opinion, if it were possible to examine the final project in a way that is not an oral presentation in front of an audience. Not everybody is suited for an oral presentation. However, I know that in any case this is something that I will need to learn to perform and I will encounter it in the future” (student 18, F).

Inquiry Component: Building Content Knowledge

1. **Coping with the learning of completely new theoretical material.** Students dealt with this difficulty with the help of teacher-mentors, referral to experts in the inquiry field, practice of the material, and reciprocal fertilization in learning with the partner. For instance, “Difficulty with learning the theory. The theory we received was based on new concepts and instruments, which were not understood by us. We needed to learn first the basis and to advance over time on the level of the theoretical background of the field we chose until a very high level. I dealt with the difficulty through work on the material and practice, we heard lectures of experts on the topic, I learned together with my project partner, and we helped one another better understand the material” (student 7, M), “The material of rotary motion was new to me, and therefore it presented a difficulty during the work. Using the teacher-mentor and the fact that rotary motion is parallel to linear motion, I overcame the difficulty” (student 6, M).
2. **Difficulty with in-depth understanding of the researched phenomenon, primarily learning of physical contents at a high level.** For example, “The topic was very hard for us to understand because the study material was on a very high level” (student 28, M), “It was hard for us to learn and to understand contents in physics required for the project since sometimes the information was hard to understand and on a high level” (student 31, F), “It was very difficult to learn the theory. We chose to go in-depth above what was required in the phenomenon we investigated and therefore the result was the understanding of it became complicated” (student 33, M). The students are helped by the teacher-mentors to overcome this difficulty and invested in learning to understand the investigated phenomenon. For example, “It was hard to understand the theoretical background but with the help of the teacher-mentors, who again and again taught until I understood, I overcame this difficulty” (student 12, F), “Difficulty in the learning and understanding of contents in physics. We coped with the difficulty by sitting a lot on the material and explanations from the teacher-mentor” (student 15, M).

3. **Difficulty with independent learning of the theory relevant to the inquiry.** This difficulty arises from the students' quotes, for instance, for instance, “For me personally it was hard in terms of the topic of learning the theory and different phenomena independently” (student 17, F). The student continues and says that she overcame this difficulty following a rise in her awareness and understanding an independent learning style in the performance of inquiry is essential and to advance in inquiry she needs to adopt this learning style. For instance, “... as we advanced with the different experiments and inquiry questions, the learning of the theory has already become something that it is still difficult to learn material independently, but there is no choice and it must be done to advance” (student 17, F).
4. **Difficulty with learning and understanding the theoretical background** because of the lack of finding relevant information sources to the investigated phenomenon. For example, “Our project is characterized by the fact that we posit hypotheses about the phenomena that occur, we do not have an accurate theory that can explain the phenomenon and the processes that occur. We attempted to ask professors but they also had difficulty. This made the learning and understanding of the theoretical background of the phenomenon hard” (student 11, F), “Although we attempted to turn to experts, we did not have a crystalized and clear theory at the end of the research” (student 10, F).
5. **Difficulty with good mastery of the mathematical tools at a high level** to advance in the learning of the theoretical material and to reach greater depth of understanding. For instance, “One of the greatest difficulties we encountered is to understand the mathematics (to use mathematical instruments at a high level, such as Taylor vector analysis, partial derivatives, etc.) to understand the phenomenon better” (student 13, M).

Inquiry component: Building a Theoretical Model

1. **Difficulty with building a theoretical model primarily in computational modeling**, both because of the need to master the theoretical background and because of the mastery of the new programming language. The students coped with this difficulty using the support of teacher-mentors and academic coordinators. For

instance, “The creation of the computational model – this was a long and complicated process that required considerable learning in terms of the theoretical content, very good knowledge of the laws of physics, and also in terms of mathematics, like knowing vector multiplication, which is not taught in high school, and in terms of the study of a new programming language, but the support around the help to deal with the difficulties” (student 8, M), “One of the biggest difficulties encountered is to understand the mathematics to build a physical model” (student 33, M).

Inquiry Component: Self-Regulation

1. **Difficulty with taking personal considerable responsibility of the student for the planning and organizing of the inquiry work** that requires discipline and self-management. According to the students’ reporting, the difficulty increases when the student is assigned great responsibility in performing the inquiry, is required to have self-discipline, and especially when the student must plan and organize the inquiry work independently. To overcome this difficulty, the students planned a work program for the following sessions. For instance, “Difficulty with self-management of the inquiry process – I and my research colleagues did most of the work alone, without great help from outside factors, most of the responsibility is on us, and we had to plan and organize the research work, what to do in the next sessions” (student 23, M).
2. **Difficulty with functioning of the logistics of the management and organization of the inquiry required in the afternoon hours**, after the day of studies in the school. For the question, “Note two-three aspects of the program that should be changed and explain”, the students described difficulty getting to the Weizmann Institute in the afternoon hours, after the day of studies in the school, which makes it harder to perform the inquiry and the logistics (managing and organizing the inquiry) that is required and they seek to have the program in the morning hours. For instance, “To hold the program in the school hours and not in the afternoon hours so that we can be more alert and initiating in the sessions, in the inquiry work, and in the managing and organizing of the inquiry” (student 15, M).

3. **Difficulty with meeting the considerable pressure and time schedule** both because of other commitments outside of the program, especially for students in the 12th grade who with the approach of the high school matriculation preparation tests and examinations, and because of the load of tasks to complete the inquiry project in the research physics program. This difficulty was prominent among the students. It is possible to see from the quotes that the students overcame this difficulty through the investment of considerable time on the project work also late at night, correct planning of the time schedule, feeling of commitment to their partner student in the project, which created the motivation to meet the schedule, so as not to be an inhibiting factor that may harm the partner.

For example, “Planning the work and the time schedule was a little difficult especially with the school and the preparation tests and high school matriculation exams we had” (student 25, M), “Because of the load outside of the program it was very hard for me to meet the time schedule, to submit things in time, and to find time to work on the topic outside of the Davidson Institute” (student 34, F), “Meeting the time schedule, the crowded time schedule of the 11th grade and 12th grade, we had to perform many things and to do a lot ... and therefore, I was forced to work far later at night to manage to submit the work in time” (student 13, M). “It was always hard for me to cope with the time schedule – especially in a period of the end of the year, in which there is stress from many directions what helped me was that I had a friend for the work whom I knew is also influenced by my actions and if I were not to meet the time schedule then she would have been hurt by this” (student 19, F), “Difficulty meeting the time schedule – they organized the time correctly to submit in the desired time” (student 28, M).

4. **Reaching a “dead end” and lack of knowledge how to advance in the inquiry,** which led sometimes to considerable frustration. For example, “... also sometimes we reached a dead end and we did not know how to continue this investigation and this greatly frustrated us” (student 17, F), “At the time of the work many uncertainties arose that made the work difficulty and even sometimes stopped the work process and led to frustration. With the help of the teacher-mentors I succeeded in understanding and in overcoming these difficulties” (student 12, F).

In the answers to the question “note two-three aspects of the program that should be changed and explain” the students suggest that it is necessary to have in the program greater follow-up after the progress of the inquiry in every project, to ascertain that the topic is investigable and that the student has the tools to investigate it and to locate the students who are ‘stuck’ and to help them in earlier stages.

For example, “It is necessary to do more checks of what the students did, since there are some who are not advancing while others are advancing greatly, and to help students who are stuck in the inquiry in the goal so they will succeed and will not get pressured at the last moment” (student 34, F), “To ascertain that students can do a comprehensive research from all aspects in a topic in which they are interested and not to reach a situation of being stuck” (student 10, F), “To examine ahead of time the topics for the project so as to prevent a situation in which the topic is not solvable or is too difficult for the student” (student 11, F). In addition, the students propose that the program introduce into the syllabus a lesson with the goal of teaching ways of coping with situations of uncertainty, management of inquiry work, and meeting a time schedule. For instance, “To hold a lesson regarding the coping with frustrations, time management, organization of the inquiry, and encouragement of work in the home” (student 7, M).

5. **Reaching a situation of dispersion in the inquiry work and/or lack of organization and there is no guideline throughout the entire work.** Students overcame this difficulty with the help of the teacher-mentors’ support and with the help of focus in the in-depth investigation of the topic (and lack of dispersion and superficial investigation of many topics).

For instance, “we reached a situation of lack of certainty in our work, we researched different phenomena when we did not finish with one phenomenon, everything appeared to be dispersed, until in the end with the help of my teacher we found a theme connecting between the experiments and it gave me the confidence that we did good work” (student 17, F), “I had a lot of difficulty with the organization of things, we did not have a clear line of thought throughout the work, we always scattered to new topics, and in contrast there were topics that we got stuck in and they prevented progress and this created frustration and a constant feeling of lack of progress” (student 34, F),

“Overcoming the uncertainty – in the 11th grade it was very hard for us since we advanced too fast in the work and we did not go enough in depth in what we did and what the meanings were. We drew lessons and in the 12th grade we worked in a more established manner. Supposedly we advanced less since we invested more time in every topic, but the opposite is true. The greater depth in the topic helped us know where we came from and where we are going to and not to be scattered” (student 26, M).

6. **Coping with many frustrations and feeling of powerlessness when reaching situations of uncertainty.** The students describe that when they reached such situations sometimes they felt powerless and experienced considerable frustration. The students report that to overcome these situations they were helped by teacher-mentors and academic advisors who encouraged them to continue to research. In addition, the students’ awareness of the lack of deterrence from these situations and that it is necessary to persist in investigation helped them overcome this difficulty. For instance, “The overcoming of situations of uncertainty, great frustration that you do not get what you want (we did not succeed in building a sound cannon and building a system that would succeed in breaking a wine glass). It is necessary not to be deterred by these situations and by the frustration and to pay attention to the statements of the teacher-mentors and others around since this helps overcome and to continue to research with what there is” (student 29, M).

Inquiry Component: Teamwork with the Project Partner

1. **Difficulty with the coordination of times between the team members.** This is the main difficulty that was prominent in the teamwork with the partner. The students overcame this difficulty with the help of correct time management. For instance, “Difficulty in work with the team partner – it was hard to meet during the sessions and during the studies, we coped with this difficulty with the help of correct time management” (student 28, M), “It was hard to meet with my partner because we are not from the same school” (student 31, F), “It was hard to coordination work times” (student 27, F), “It was hard to coordinate the meeting times between the team members” (student 21, M).

2. **Difficulty with the planning of the division of the inquiry work and the roles in the team**, so that it is fair and accepted by the team members. For example, “It was hard to plan the team work, who will do what and how much, we overcame this, we divided the work so that this would be acceptable and fair for both of us” (student 21, M). The students overcame these difficulties with the help of correct time management between the team members. One student proposed “to do already in the first year more works in a pair for a longer term so as to get more accustomed to teamwork” (student 19, F).

Inquiry Component: Teamwork with Peers in the Broader Group

1. **Lack of satisfaction with the social interaction with the rest of the peers in the broader group in the program.** The students are interested in increasing the social interaction with the rest of the peers and even doing group formation activities to create more opportunities for social interaction. For instance, “There are students and I do not get to talk to them much since there wasn’t an opportunity, I would recommend holding formation evenings of all the students in the project” (student 26, M). “To improve the lack of interaction with the rest of the class members” (student 14, M).
2. **Lack of satisfaction with the sparse activities that include peer assessment.** The students express desire for greater performance of peer assessment in the program, since, in their opinion, peer assessment can improve the project work and their self-confidence and especially because the peers are their age and therefore the peers’ critique is received in a more friendly and less critical manner than that of the teacher-mentors’ (which sometimes is fixated and less open). For instance, “The topic of peer assessment in the program should be improved. Students are an uncritical eye, therefore they can examine problems sometimes in a better way than the teacher-mentors, since the teacher-mentors are "biased" in their opinion on a particular topic (student 26, M), “To perform peer evaluation more frequently, to strengthen the confidence on the work and the project” (student 25, M).

3.2 Students' Citations for Part B of the First Research Question: The Students' Perception of Their Development in the Different Inquiry Components

3.2.1 Students' Citations -Stage 1: Preparation Stage of the Inquiry Project – Detailed Description of Aspects of the Students' Development in Each Inquiry Component

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 3.2.1.2 - Detailed Description of Aspects of the Students' Development in Each Inquiry Component, from the students' responses in the Inquiry Skills Questionnaire, (see appendix number 1.2, before the submission of the “Mini-Project” report, 10th grade, N=27) to question: “Choose from the above list of skills at least two skills that greatly developed in you during the inquiry work. Give examples that show this development.”

Inquiry Component: Phrasing Questions/Goals

- 1. Development in Phrasing an inquiry question**, knowing the structure of the inquiry questions, which is composed of dependence on two physical sizes. For instance, the students reported: “phrasing inquiry questions – I learned to phrase in a wonderful manner, from a simple question, to a question made correctly, how does something influence something else” (student 29, M), “I understood in a good way in my opinion how to ask an inquiry question correctly, to ask about a relationship between two things” (student 7, M). The students attribute this development to the many experiences in this aspect during the inquiry work. For instance, “The skill of phrasing an inquiry question developed in me. I feel that I improved in this because following the program I got to practice this skill” (student 23, M).

Inquiry component: Positing a Hypothesis

- 1. Knowing that the component of positing a hypothesis is a part of the inquiry process.** For example, one of the respondent wrote, “I developed in positing

hypotheses in the mini-project, when beforehand I did not know that it is a part of the process” (student 9, M).

2. **Creative thinking in the performance of the component of positing a hypothesis.** For instance, the students reported, “Every lesson they ask us to posit a hypothesis, and therefore my creativity slowly increases and I understand the process, in addition the teachers provide support and do not negate this hypothesis immediately and this gives more confidence” (student 29, M). In addition, it is possible to see from the previous quote that the student was satisfied with the teacher-mentors’ response, that they enable students to posit hypotheses and do not negate them even if they are mistaken and thus they give confidence to the students.

Inquiry Component: Planning an Experiment

1. **Choosing an appropriate way of investigation independently,** through the differentiation between what is important and what is less important during the planning. For example, one of the respondent wrote, “Planning an experiment – I learned how to differentiate between important things in the planning of an experiment and less important things, we did this during the project on springs, in which we chose by ourselves what we are researching and how” (student 21, M).
2. **Awareness of the importance of the component of planning an experiment,** which enables more orderly and organized work throughout the entire inquiry process. For instance, “The planning caused more orderly and organized work during the performance of an experiment and afterwards” (student 23, M), “I began to plan better and I stopped forgetting important things” (student 29, M).

Inquiry Component: Performing an Experiment

1. **Improvement of observations on the researched phenomenon.** For example, the respondents wrote, “Performing an observation and performing an experiment – since every experiment is accompanied by an observation of a certain phenomenon, this skill has improved in me. I am careful to observe well the phenomenon and to pay attention to details, if necessary a number of times so that the results will be more correct” (student 10, F). “Performing an observation and performing experiments – because of the many researches we learned to perform an observation

and experiments on the systems, what helps us greatly understand in-depth the task” (student 21, F).

2. **Performance of more complex experiments, which were not tried in the past.** This development arises from the students' quotes, for instance, “I developed in the performance of an experiment – since beforehand I did not attempt serious and complex experiments like we did in the past or with subjects in which we engaged in the program” (student 8, M). The students ascribe this development to the considerable experience in the component of the experiment in the program. For instance, “We performed many experiments and therefore I developed in this” (student 3, F).

Inquiry Component: Data Processing

1. **Familiarity with and accumulation of experience in the use of computer software** (like Excel), which enable the data processing in a better manner. For example, the respondents reported “Processing findings since beforehand I did not know how to work with Excel or what the trend line says and now I know and I use it also outside of the institute” (student 8, M), “The skills that most developed with me is the processing of the findings since before the program I did not know so well to use Excel” (student 15, M), “Processing the findings – almost in every lesson we did this action, and therefore largely this ability developed in me” (student 21, M), “I think that in me developed the skills of processing the findings since I feel I overcame the difficulties I had in this skill, although I still feel that this is hard for me” (student 23, M).
2. **Representation and graphical understanding.** This development arises from the students' quotes, for instance, “Processing of the findings – I learned to create graphs in Excel and to work with the software far better” (student 17, M), “I developed in data processing – I learned to create graphs in Excel and I developed how to look at the graph” (student 33, M), “I learned to process the findings through graphs and tables and to understand them better” (student 7, M).
3. **Recognition of the need first to understand the experiment performed and the logic behind it to process the data.** For example, one of the respondents wrote “Processing the data is a skill that has greatly developed in my opinion during this year following the considerable practice on the topic of these skills, and the fact that

I had to understand the logic behind the experiment so as to build graphs that explain and describe the experiment that was held” (student 5, M).

Inquiry Component: Drawing Conclusions

1. **Ability to draw conclusions from the graph and finding a relationship between two variables of the experiment.** For example, one of the respondent wrote, “Drawing conclusions – in the mini-project I succeeded in finding a relationship between the angle of entry of light into a drop to an angle between the entry ray and the red light ray in the exit and I succeeded in extracting from the graph the maximal angle of both of them” (student 15).
2. **Development of thinking, especially creative thinking and critical thinking in the process of drawing conclusions.** Students explain that the component of drawing conclusions caused them to implement creative thinking and critical thinking. For instance, “drawing conclusions caused to think outside of the box, and to know to prove things that are obtained and not to take them as a fact” (student 11).

Inquiry Component: Written Reporting on the Inquiry

1. **Familiarity with the correct structure of an experiment report** and accumulation of experience in writing laboratory reports. For instance, the respondents wrote: “Written reporting – we wrote many experiment reports and my writing improved, how to write an experiment report correctly” (student 10, F). The students explain that the development derives from the considerable practice in this component in the program and because of the feedback given by the teacher-mentors on their written work, for instance, “Written reporting improved, since in the submission of reports on experiments they are always fixed and emphasize to us what is correct, what helps us for the next times, the teachers of research physics are deserving of appreciation and admiration” (student 29, M).
2. **Familiarity and use of the Word program.** For example, one of the respondent wrote, “The skills that developed considerably in me is written reporting since before the program I did not know so much to use Word” (student 15, M).

3.2.2 Students' Citations -Stage 2: Intermediate Stage of the Inquiry Project – Detailed Description of Aspects of the Students' Development in Each Inquiry Component

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 3.2.2.2 - Detailed Description of Aspects of the Students' Development in Each Inquiry Component, from the students' responses in the Summative Questionnaire (see appendix number 1.4, before the submission of the intermediate report of the project, 11th grade, N=33) to question: “Choose from the above list two-three components that you think developed greatly during the program. Describe how you developed in these aspects.” And question: “Tell about the changes (at least two) that you performed during the research work, describe what caused the change and what you learned from it.” The description of the students' awareness of the things that it is important to them to preserve in the different inquiry components also arose from the responses to the following questions: “Give a ‘tip’ / lesson that you learned for a student beginning in this program” and question: “Note two-three strengths of the program that it is important to preserve.”

Inquiry Component: Choosing an Inquiry Topic

1. **Recognizing and coping dynamically with the inquiry topic and investigation directions**, which change during the performance of the inquiry. The students describe the deliberations in the choice of the inquiry topic and tell about the change of the inquiry topic for different reasons, for instance, not finding theoretical background on the phenomenon, lack of knowledge to build a system that will suit the topic of the investigation, lack of ability to measure the desired parameters in their experiment system, and interest in another phenomenon that arose from the investigation. For instance, “we wanted to change the inquiry topic since we discovered that we in essence do not have a theoretical model and previous theoretical material, therefore we deliberated and in the end we discovered interest to continue the experiment, but this change in essence delayed us during the inquiry” (student 28, M), “We changed the research topic since the planning was to build a sound cannon but we understood that we do not have at the moment the knowledge to do this” (student 29, M), “We changed the inquiry topic from the ‘decay of the wave’ after we received an explanation from the teacher-mentor that clarified for us that natural decay in the phenomenon we chose is not

- possible, and the measurement of the existing decay will be in essence the measurement of friction and therefore we gave up on this” (student 7, M). “We made this change since we expressed greater interest in the first part in motion” (student 23, M),
2. **Focusing the inquiry topic.** The students decided to research a topic in a more focused and specific manner than the broader topic chosen beforehand. For instance, “At the start of the work we wanted to research the movement of the bubbles of water in oil and we even reached certain conclusions. Nevertheless, we decided that we want to focus in the static part of the topic, which is the water bubbles stuck to the surface of the oil instead of sinking” (student 14, M). “In the beginning we wanted to research the third part in our movement since we were interested in the body reaches a speed that appears to be a constant speed but in the end we decided to research the first part of our movement in which the body rises upwards as a result of its self-rotation ...” (student 23, M). “I developed in the focus on one topic” (student 22, F).
 3. **Awareness of the importance of choosing an inquiry topic that interests the learner and was chosen by him,** so that the motivation will be preserved throughout the entire inquiry process. Most of the students recommend greatly in the question “Give a ‘tip’ / lesson that you learned to a student who is beginning in this program” to choose a topic that will interest the student so that the motivation will be retained throughout the entire inquiry process. For instance, “It is important to choose a topic that truly interests you” (student 10, F), “To choose only a thing that we are interested in researching and we chose to our satisfaction, since if we do not like this, then we will not want to do this inquiry, and the frustration will be greater in the students who did not choose what they wanted. During the research I chose what I loved at that time and I exhibited interest to learn more on this topic” (student 28, M), “It is important to like what you research” (student 8, M), “Choose a topic that interests you” (student 7, M). The students added that the program should retain the possibility of letting the students freely choose the inquiry topic (even if this is from a selection of topics). For instance, “To preserve in the program the free choice of the inquiry topic” (student 10, F).

4. **Recognizing that the choice of the topic is not obvious, it is necessary to use judgment.** The students understand the importance of the component of choosing the topic and recommend using judgment. For example, one of the students wrote, “To think deeply what topic he wants to research, and to think about the future implications and how much he will want to go in-depth in the topic” (student 17, F).

Inquiry Component: Phrasing Questions/Goals

1. **Recognizing and coping with the dynamism of the inquiry question,** which change following developments during the inquiry work. For instance, the respondents reported: “We changed our inquiry question since we preferred standing with the static system after we decided that it would be more interesting for us to research it, we learned that in the research work it is possible to turn to different and diverse directions during the investigation” (student 15, M), “Close to the ninth session the goal of our project was the linkage between the radiation from the lamp and the temperature but because we did not have the means to perform accurate measurement for this time we suspended the experiment and continued to research other ways of the lamp, such as behavior with alternating current” (student 1, M), “In the beginning the inquiry question was about how the viscosity of the liquid affects the movement of the particle, after we saw that particles stop and we understood that this is not because of the viscosity we changed our inquiry question to why the particles stop and how” (student 19, F).
2. **Focusing the inquiry question and avoiding dispersion to a wide range of directions.** For example, the respondents wrote, “In the beginning there was no clear direction of work and we performed general experiments on the phenomenon to research it in general. At a certain stage we focused on what we want to research in the context of the phenomenon” (student 12, F), “Our research questions were many and we need to decide on a main question and therefore to change the conditions of the system” (student 27, F), “Our first inquiry question was how the viscosity influences the Brownian motion but we encountered a phenomenon in which the particles in general halt and we chose to focus on it instead” (student 18, F).

In response to the question “Give a ‘tip’ / lesson that you learned to a student beginning in this program”, students also recommend to pay attention to this issue, to examine and critique actions, to focus and not to scatter. If there is dispersion to a different direction of investigation, it is necessary to see this as contributing to the main question, if not, to return to the main question. For instance, “Do not make haste. To organize well the inquiry question and to focus on one main topic and on one main question and not to get dispersed, and if we dispersed to see whether this contributes, and if not then to return to the main question” (student 24, M).

3. **Awareness of the importance of choosing a sufficiently interesting and open question** to reach an in-depth inquiry. For instance, one of the students wrote: “To start a good project it is necessary to choose an interesting question, one that can be developed in the continuation and that can reach an in-depth inquiry” (student 31, F).
4. **Improving the phrasing of the inquiry question compared to the past, which seeks dependence between two variables** (dependent variable and independent variable). For example, the respondents wrote, “Phrasing the inquiry question – this was especially hard for us as a team in the beginning but with time we phrased a large number of questions, we learned that it is necessary to assemble the question how a variable influence another variable and we improved in this skill, which will accompany us next year” (student 20, M). “We developed in the phrasing of inquiry questions compared to the past” (student 11, F).

Inquiry Component: Locating Information Sources

1. **Improvement in the technique of the search for information sources in the Internet.** For example, “The location of relevant information sources, I learned how to search optimally on the Internet” (student 3, F).

Inquiry Component: Planning an Experiment

1. **The level of planning rose, to detailed planning that includes identification and isolation of variables.** For instance the students reported, “The isolation of variables – I learned to disassemble the phenomenon into small components and to examine each one of them separately, as necessary” (student 10, F), “Change in the planning and in

the experiment system – in the beginning we used particles of fat (we mixed water and milk, fat particles are found in milk) and then we used silicon particles so that we can isolate and change more variables in the system and also since they are clearer when pictures are taken” (student 19, F), “We planned to choose different materials with the same acidity, which helped us isolate variables and examine whether they behave the same ... we wanted to examine whether the pixels are what influence the isolation of the variables and therefore we took two pictures that were taken at the same time again to examine the isolation of the variables on the most maximal level” (student 28, M), “Before we received the pendulum, we prepared an improvised Wilberforce pendulum of our own. For a long time, we tried to understand and plan how we can connect the sensors without harming the movement” (student 26, M).

2. **The recognition that the planning of the experiment is a dynamic process in the inquiry work and changes according to the need.** For example, the respondents wrote, “Another development is in the field of the planning and building of the system, it is necessary to plan according to the needs in the experiment, we changed the planning of the experiment accordingly. This ability developed over the last year and it certainly will help us in the future” (student 14, M), “We changed our experiment program each time according to the results that were obtained” (student 34, F), “Don’t be frustrated if what was planned or wanted does not work out, to come with an open mind to plan better” (student 32, F).
3. **Awareness of the importance of planning independently** (without preliminary briefing). The students sought to preserve the giving of the possibility to students to perform the component of planning an experiment independently (unlike the school, where generally they are given an experiment briefing that was prepared ahead of time) from the answers to the question “Note two-three strengths of the program that it is important to preserve”. For instance, “To preserve in the program the experience with planning a research system independently, causes us to think and to develop in this” (student 15, M), “The program teaches the students to plan to perform a scientific experiment, unlike the school that gives us the order of actions of the experiment ahead of time and it is important to maintain it” (student 34, F).

Inquiry Component: Performing an Experiment

1. **Building a better and more effective experiment system**, which enables isolation of variables, accuracy in measurements, and minimization of the factors of error as much as possible. For instance, the respondents wrote “We changed the experiment system since the experiment system did not maintain the isolation of the variables” (student 24, M). “A number of times we changed our system to more correctly and accurately examine the question we chose in the beginning” (student 31, F), “The change of the experiment system because of deviations in the measurements and therefore we minimize these deviations in the system” (student 2, M).
2. **Awareness of the importance of the accuracy of measurement during the performance of the experiment.** For example, one of the respondent wrote, “It is necessary to carry out the research in a slow and cautious manner and not to make haste to finish the research, this may cause a mistake in the results of the experiment and mistaken understanding” (student 30, M).
3. **The duration of the time of the building of the system and the time of the performing of the experiment shortened.** For instance, “Building the experiment system – as we built the system more times we improved in this, in the accuracy of the measurements and in a shorter time.” (student 10, F).
4. **Recognition that the performance of the experiment is a dynamic** and changing performance during the inquiry work. For example, the respondents wrote, “We changed our experiment system a number of times to reach the most effective system that we can obtain, we learned that the research work is very dynamic” (student 15, M). “During the year, we changed our system three times to adjust it to our needs” (student 14, M), “During the project we changed many systems of experiment – as we understood the phenomenon more, we understood that our experimental system is not adequate” (student 13, F).
5. **Creative thinking and activity so as to overcome the difficulties that arose during the performance of the experiment.** The changes in the experiment system and in the array of experiment performances developed the creative thinking and activity among the students. For instance, “I developed with creativity in the building of the system to overcome the problems that arose in the experiment” (student 2, M).

6. **Awareness of the importance of holding initial experiments to understand the phenomenon, to build the knowledge, and to specialize in basic inquiry practices.** For example, the respondents wrote: “Because we did not have previous knowledge, we need to perform many smaller experiments to reach first of all the level of performing a sufficiently serious experiment that will answer the inquiry question” (student 1, M). “We carried out a number of initial experiments to master the basis of the material” (student 4, F), “Small experiments help the understanding of the inquiry process” (student 22, F), “All the experiments and preparations helped and taught new things that are necessary and essential to the performance of the research” (student 23, M).
7. **Awareness of the importance of performing experiments independently.** The students note the importance of performing the experiment independently, in a way that allows developing this component more, and emphasized that this should be preserved in the program. For instance, “To preserve in the program the learning of research methods and the building of experiments independently in order to develop in this” (student 6, M). About one-quarter of the students (24.24%) report considerable development in the component of using technological aids and a computerized laboratory during the performance of the experiment.

Inquiry Component: Using Technological Aids and a Computerized Laboratory

1. **Knowing and using new technological aids and a computerized laboratory that they did not know beforehand.** For example, the respondents wrote, “I learned how to work with sensors and technological tools I did not know beforehand” (student 21, M), “I developed in the use of a computerized laboratory and technological tools (sensors, computer software, work with two cameras, etc.)” (student 9, M). The students want to preserve in the program that access to advanced equipment. For example, “To preserve the access to the new tools” (student 27, F), “Access to equipment is abundant” (student 09, M).
2. **Awareness of the importance of the use of technological tools and a computerized laboratory** that enables greater depth and breadth of horizons on the investigated phenomenon. For example, the respondents wrote, “Using advanced

tools for the purpose of the performance of the experiments since in this way it is possible to research more in-depth” (student 17, F), “Using sensors is another development since we used sensors I did not know about beforehand, we learned how to use with a light receiver and a light sensor and how to disassemble the light according to certain colors, which developed for us the horizons on the phenomenon and will help us even next year, in addition work with V Python broadened my horizons” (student 28, M). In addition, the students seek to retain the use of computerized and technological tools in the program. For example, “To retain the use of technology in the learning process”, “To retain the software and the modern and amazing means of measurements” (student 19, F).

Inquiry Component: Data Processing

1. **Ability to process data into graphical representation.** For example, the respondents wrote “I developed in the work with graphs and the analysis of graphs” (student 28, M), “I developed in the ability to process data into a graph” (student 4, M).
2. Awareness of the importance of data processing in a consistent and continuous manner after every experiment. For example, the respondents wrote “At first we would take measurements and only after all the measurements would we attempt to process and analyze them but we understood that this is not the right thing and therefore we changed the planning of the work and after every experiment we performed data processing and analysis for it” (student 32, M).
3. **Ability to calculate the value of the error.** Only one student addressed this aspect and wrote that he learned also to calculate the standard errors when he processed the data, to quote, “I developed in data processing, we learned greatly about standard errors and how to calculate them” (student 6, M).

Inquiry Component: Drawing Conclusions

1. **Good ability of drawing conclusions from comparison between the theory and the experiment findings, use of critical thinking** and examination of the gaps between the theory and the experiment findings and giving explanations for these discrepancies. For example, the respondents wrote, “I developed in drawing conclusions – after we

- learned the theory we began to carry out experiments that validate or examine it. From this comparison we needed to use critical thinking and thus we reached additional conclusions” (student 10, F). Development in drawing conclusions increased primarily when the results were not commensurate with the theory, and the students were required to give explanations of this and to use critical thinking.
2. **Understanding that when the experiment results are not commensurate with the theory they are not necessarily mistaken results**, but it is possible that they are true and correct results. (It is necessary to minimize the factors of the mistake or it is necessary to broaden the theory to understand the results.) For example, “The main change that we had during the work, that we had ‘mistaken’ results (that we thought were mistaken) that caused us to develop in drawing conclusions. First, we performed the experiment again and again, we expected to obtain similar results to the theory of the experiment, when we did not obtain what we expected, we understood that the results are not mistaken and we needed to draw conclusions why our experiment results are different from the theory, we found the factors of the mistake that greatly influenced the results and we reached additional conclusions that explain what came out for us” (student 27, F). This issue also came up in the question: “Give a ‘tip’ / lesson that you learned to a student beginning this program”. For instance, “Do not negate directly outcomes that are not exactly according to the theory” (student 20, M).
 3. **Good ability of drawing conclusions from comparison between the experiment findings and the findings of the computational modeling**. The students report that the computational modeling tool contributed to the development in this component when the students performed a comparison between the experiment findings and the computational modeling of the phenomenon (especially when the students did not succeed in solving equations analytically). For instance, “We added a comparison between computational modeling and the experiment and we developed the conclusions from this comparison” (student 18, F), “At the beginning of the comparison to the theory, we attempted to solve equations in an analytical manner but without success, and then we were forced to shift to the building of a computerized model that helps us reach conclusions” (student 13, F).

4. **Recognition that the component of drawing conclusions is a dynamic process in the inquiry work** and the conclusions can change following the continuation of the inquiry on the phenomenon. For example, the respondents wrote, “We changed the conclusions each time anew after obtaining another finding from another experiment that we performed following the preliminary experiment for which we were curious about the results” (student 34, F). “We changed the conclusions, we performed experiments with different variables intended to examine what the phenomenon depends on or does not depend on.” (student 10, F).

Inquiry Component: Written Reporting on the Inquiry

1. **Improvement in documenting the inquiry process in the research journal**, to more ordered, consistent, and flowing documenting during the inquiry work. For instance, “I developed in the documenting of the inquiry work – for two years in the project of Research Physics I learned a lot about the creating of a research journal, management and summarization of the research works, in an orderly and consistent manner, and this is something I would not have improved if I had not joined the program” (student 30, M), “The development in the documenting of the inquiry – writing follow up and progress reports in the laboratory journal in an ongoing manner” (student 7, M).
2. **Awareness of the importance of documenting the inquiry**, which helps keep in mind what was done from the start of the inquiry until now, for the purpose of the reconstruction of things as necessary during the investigation and writing of the work. Many students addressed this aspect. For example, the respondents wrote, “Documenting – I never would have written what I did and how I reach the conclusions ... I learned the importance of clear writing so that after much time I will understand what I did and also other people will understand what I am doing. And I improved in this” (student 19, F). “Documenting the work – as more lessons passed, we learned about the importance of documenting the work and we changed the manner of the work, we began to document more the inquiry in the laboratory” (student 10, F).

The issue of the importance of the documenting of the work also arose in the students’ responses to the question: “Give a ‘tip’/lesson that you learned to a student beginning in this program”. For instance, “To persevere in writing a laboratory journal, this can

greatly help in the summary of the project” (student 18, F), “To write a laboratory journal in a clear and orderly manner, it is easier to write the work when you remember all the stages clearly” (student 19, F), “To perform a laboratory journal” (student 24, F). students also seek to preserve the documenting method that was used in the program and to continue to encourage them to document. For instance, “To preserve the documenting of the project using the Google Drive and only towards the end of the project we understand its great importance” (student 10, M), “That the program will continue to teach and to encourage students to document a scientific experiment” (student 34, F).

3. **Improvement in the writing of experiment reports and writing of the summative work, to more detailed writing** that includes all the parts of the structure of an experiment report and structure of a scientific work. For instance, the students reported “I developed in the writing of the laboratory report in a detailed manner and it will include everything: goal, description of experiment, results, processing of the results, conclusions, and factors of error” (student 11, F), “To learn how to write a laboratory report” (student 28, M), “The program teaches to write a scientific work in an academic manner and I learned how to write and what needs to be in the work” (student 34, M), “We learned to write a scientific work on a high level” (student 27, F).
4. **Improvement in the writing of presentations, to organized, concise writing** (in which there are the main points) that is **clear to the audience**. For example, “Writing a presentation of the research – following the writing of the presentation of the project this year and the past year I think that I learned how to build a presentation that will explain the project and will see it in an organized and clear manner in the audience, which will include all the topics that are required and important and will be explained” (student 12, F). “I learned to write and to present scientific presentations in a better way” (student 8, M), “I developed in the building of presentations, since I more than once tried the building of the presentation, which helped me focus all the content of the experiment into a number of slides that can clearly explain the process of the experiment, what will help me in the coming year in the additional presentations in the studies” (student 28, M).

Inquiry Component: Oral Reporting on the Inquiry

1. **Overcoming the fear/shyness/pressure in the presentation in front of the audience more than in the past.** For example, the respondents wrote, “The presentation of the research results before an audience, at the beginning I was very pressured with these things but as I got more used to the presenting in front of people I succeeded in overcoming to a certain degree this pressure” (student 17, F). “I developed in the oral presentation – despite my shyness, I presented my work to the larger audience, and I felt that I am overcoming my stage fright and shyness. If you are afraid of an audience, shyness, then try to overcome it by presenting beforehand to your friends and families” (student 25, M).
2. **Improvement in the oral performance of the presentation, both in the content of the presentation** (presentation of the main things in the allotted time) **and in the improvement in standing in front of the audience** (rise in the self-confidence that includes body language and improvement in speaking clearly and in a way understood by the audience). For instance, the students wrote “Presenting to an audience – I think that following last year and this year I developed confidence in standing in front of an audience in presenting a research and I learned what to say and how to explain so that everybody will understand, what is important to explain and what can be skipped so that the time schedule can be met, how to stand in front of an audience, and so on” (student 12, F), “Presenting in front of peers, I improved in this and I know how to do this better and effectively” (student 16, M). The students explain that the development derives from the preparations for every oral presentation before friends and relatives, from repeated experiences of oral presentation in the program, and drawing conclusions from previous presentations. For instance, “Presenting before the peers like I noted developed in me greatly following the learning by heart and the actions I carried out before the presentation” (student 29, M), “When this year the time came to create the presentation we had to take into account many things that we did not think about previously such as the time of the presentation, the number of the slides, the amount of words ...” (student 30, M). In addition, the students seek to keep the presentations orally in the program to develop in this component. “To preserve in the program a presentation in front of the audience to develop in this” (student 7, M).

Inquiry Component: Building Content Knowledge

1. **In-depth and in-breadth understanding of the physical knowledge related to the researched phenomenon** (for the most part contents from outside of the high school curriculum). For example, the respondents wrote “The learning and understanding of the contents in physics developed in me. We learned much about harmonious and rotational movement” (student 6, M). “The learning contents and understanding of concepts in physics, I greatly extended my knowledge about physical phenomena” (student 3, F), “The program greatly broadens the physical knowledge of the students and increases the curiosity in the field of physics among the students” (student 34, M), “...aside from this, I extended my knowledge on the topic” (student 13, M). In addition, the students seek to retain in the program the possibility of learning contents beyond the curriculum and going into them in depth. For example, “To allow learning of topics that are not learned in the school” (student 12, F). “To preserve in the program the possibility of going into depth in the physics knowledge” (student 29, M).
2. **Awareness of the importance of building content knowledge to prepare a program of experiments and advance the inquiry.** For instance, the students wrote. “We learned all the theory, and this is important since later on we carried out experiments on everything we learned” (student 24, M), “Understanding the theory helps advance the inquiry” (student 22, F).
3. **Ability to develop formula that link between physical sizes independently.** For instance, the respondents wrote “In terms of the physics related to the experiment, we developed many different physics formulae and reached many formulae ourselves” (student 27, F). “Now we can write not only formulae that there are in books, now we can see how the system works and think alone how to build formulae” (student 31, F).
4. **Improvement of the independent learning ability in different topics.** For instance, the students reported “Learning and understanding of contents in physics required for a project, I improved my independent learning abilities of the different topics” (student 31, F). “I developed in my ability of understanding in the field of physics and ability of independent learning” (student 14, M).

Moreover, the students seek to preserve in the program the giving of the way in which they learn the contents, the way of inquiry and independent learning. For instance: “To maintain the learning and understanding of the theoretical material independently” (student 15, M), “To keep the learned contents and the way in which they are learned in the method of inquiry and in an independent manner” (student 18, F), “To preserve thinking and independent learning on topics not related to the school” (student 4, M). “To maintain independent learning” (student 2, student 21, both M). The students received the help of the teacher-mentors if they encountered a difficulty in this component, for example, “It is always worthwhile to attempt to understand alone and if you did not succeed then ask the teacher-mentor” (student 14, M).

5. **Quicker absorption of knowledge, understanding, and implementation of the knowledge acquired than in the past.** One student (M, 1) adds that following the engagement in the building of content of the project, in him more rapid absorption than in the past of the knowledge, understanding, and implementation of the acquired knowledge. For example: “I feel that before I began the project my ability to store information in a short time and to understand it was different from now, I began very quickly to absorb the information I read and to realize it in the project and to understand what in essence I am doing and where I am going to take this from here” (student 1, M).
6. **Awareness of the importance of taking responsibility for their learning and need to invest to build the content knowledge.** It is possible to see this in the answers to the question, “Give a ‘tip’/lesson you learned to a student who is beginning in this program”. The students recommend coming ready to learn, being serious and prepared to invest in learning. For instance, “To be serious, to invest, to be focused and willing to learn” (student 12, F), “to invest time and effort in projects and learning, to take things seriously” (student 16, M), “to be responsible for the learning of the self” (student 21, M).
7. **Recognition of the fact that there is a need for openness for learning new things, increasing curiosity, and self-challenge in building content knowledge.** For instance, one student wrote “I think that a student who is beginning in this program

needs to come with a mind open for learning, to be curious about processes that occur in the world, to be with great desire to succeed, to invest and to challenge the self to achieve great scientific knowledge.” (student 1, M).

Inquiry Component: Building a Theoretical Model

1. **Recognition and use of computational modeling for the purpose of building a theoretical model** they didn't know about beforehand (the students did not have previous experience in the past). For example, respondents indicated, “Computational modeling – I did not have experience at all and at the end of the project I succeeded in modeling random movement of one particle, of many particles, and of particles with interaction with glass” (student 19, F). “Computational modeling: I did not have previous experience in computational modeling or in programming at all...With the knowledge we acquired in the course we succeeded in modeling the phenomenon we engaged in” (student 18, F), “I greatly developed in computational modeling (writing a computer program that performs simulation) of a physical phenomenon – we learned how to “model” the phenomenon” (student 9, M).
2. **Awareness of the importance of the engagement in the building of a theoretical model** for the deeper understanding of the physical concepts and principles related to the investigated phenomenon. The students explain that this experience of building a theoretical computerized model led them to a more in-depth understanding of the physical concepts and principles associated with the investigated phenomenon and the drawing of conclusions from the modeling. For instance, “Adding computational modeling to the project to see the theory better and to better understand the phenomena we engaged in” (student 12, F). “Transition from an analytic way to computational modeling as a model for the theoretical material to understand the phenomenon” (student 9, M). In addition, the students seek to keep the learning of the course on computational modeling in the program so that they can also research using this instrument. For instance, “It is desirable to keep in the program the learning of computational modeling to research also through it” (student 7, M).

Inquiry Component: Self-Regulation

Improvement in planning and organizing the inquiry work:

1. **Planning the inquiry work in a more organized and effective manner than in the past.** For example, respondents reported “Unlike the project in last year in which the work was performed in a relatively short period of time, this year the work was performed in a very meticulous manner, there was an arranged program for how it was necessary to do the work” (student 1, M). “I developed in the organization of the inquiry work” (student 32, F), “I learned to plan my research in a smarter and wiser manner” (student 8, M). “We learned to be more organized in the inquiry work” (student 11, F), “I developed to know to make order in the research work” (student 2, M).
2. **Awareness of the importance of the planning and organization of the research work.** It is possible to see this in the students’ responses to the question: “Give a ‘tip’ / lesson that you learned to a student beginning in this program” their awareness of the importance of planning and organization of the research work. For instance, “It is important to perform the planning of the research” (student 23, M), “To be more organized in the inquiry work” (student 11, F).
3. **Improvement in the management of the inquiry work independently** and taking more personal responsibility for the advancement of the inquiry and the nature of the inquiry. The students describe that they perform the inquiry work more independently than in the past and take more responsibility for the performance of this task. For example, “Self-management of the inquiry process – another development of personal responsibility for the project, I had to make certain that the project would be ready in time and in the best way” (student 13, F), “I developed in self-management of the inquiry process, I did this more and more, therefore I learned how to do this better independently” (student 17, F), “I improved in the self-management of the process – before the project I was not accustomed to planning completely alone what and how to do and to research but after the practice during the year this became easier and simple” (student 23, M), “To be responsible for the advancement of the project” (student 21, M).

Improvement in meeting the time schedule:

4. **Improvement in the time schedule through the correct and orderly planning of the time** between the work on the inquiry project and the learning for tests and other commitments of the school. For instance, respondents indicated “Organizing the time schedule – I learned to combine the research work in the everyday life with all the load from the school, to come on time to the laboratory, and to organize the learning for tests” (student 25, M). “We learned how to plan the time and to find time especially in the period of the tests” (student 27, F), “Meeting the time schedule, we did an orderly time program and we rather quickly reached in the Passover holiday about two weeks before the date of the presentations the coverage of most of the content of the presentation and the written work, and very few things remained as expected for work of this type” (student 1, M), “I learned how to work better with a time schedule” (student 21, M), “Meeting the time schedule: I know to manage times better and more correctly” (student 24, M).
5. **Awareness of the importance of time planning and meeting the time schedule.** It is possible to see this in the answers to the question of “Give a ‘tip’ / lesson you learned to a student beginning in this program”. The students show their awareness of the importance of planning time and meeting the time schedule. For instance, “The planning of time and the meeting of times is an important part in research physics” (student 28, M), “Not to leave the work to the last moment” (student 8, M).

Improvement in dealing with situations of uncertainty:

6. **The recognition that situations of uncertainty during the inquiry work are a part of the inquiry process.** The students take into account that there may be situations of uncertainty in the inquiry work. For instance, “We learned to cope with mistaken results and not to despair and we even understood that the goal of research physics is that there will be different results and not necessarily according to the books since this is what happens generally when doing inquiry” (student 27, F).
7. **Stable standing versus situations of uncertainty during the inquiry work more than in the past** through the development of ability of perseverance, determination, and development of creative thinking. The students explain that, following coping with situations of uncertainty, the ability of perseverance, determination, and

creative thinking and doing developed to overcome these situations and to continue in the inquiry work. For instance, “Situations of uncertainty, when we do not know what to do and how to advance in the work, I now am more creative than in the past” (student 24, M), “I am with more creativity and desire because I coped with situations that I did not know how to continue” (student 2, M), “Withstanding situations of uncertainty, I improved in thinking in situations in which it is not clear what to do” (student 16, M).

In addition, the students provide ways of coping with situations of uncertainty in responses to the question “Give a ‘tip’ / lesson that you learned for a student beginning in this program” the students recommend to the new students to persevere, to research with considerable desire, not to give up when they reach a situation of uncertainty or powerlessness and to think creatively to overcome these situations. For instance, “To continue to persevere despite the difficulty and uncertainty” (student 9, M), “Not to get frustrated when they reach an unknown situation but to gather strength and to attempt to overcome the difficulty” (student 15, M), “To think creatively when you reach a dead end” (student 3, F). In addition, the students show interest in developing the creative thinking also in their responses to the question “Note two-three strengths of the program that it is important to preserve”. For instance, “Development of individual and creative thinking and giving a place for its expression in the program” (student 8, M), “To retain the creative thinking that the program gives to the student” (student 25, M).

In addition, students note that the teacher-mentors’ support helped them overcome the situations of uncertainty (the teacher-mentors gave them the tools for overcoming situations of uncertainty and the confidence to continue the inquiry). For instance, “In situations of uncertainty not to be afraid or not to give up, it is necessary to rely on the teacher-mentors’ statements. They will help you during the entire inquiry to show you that there is nothing to be afraid of and that you can continue” (student 29, M), “The program gives creative thinking and the teacher-mentors give tools for overcoming situations of uncertainty” (student 32, F).

Inquiry Component: Teamwork with the Partner in the Project

1. **Performance of the proper division of work between the partners and cooperation of each one of them** that led to the improvement in the teamwork and the work effectiveness. For example, the respondents reported, “In me the ability to work in a team developed, I generally tend to take over the work and tend to be disappointed in my group mates who dump all the work on me, in the inquiry work in the Weizmann Institute I could completely rely on my partner and we divided all the work and everything was done with amazing cooperation” (student 34, F), “Teamwork – my team mate and I had to work continuously and consistently, which was a little complicated for us at first but with time the coordination between us improved, we divided the work between us and we understood one another on the highest level” (student 20, M). “Sometimes during the year there were periods of trips/tests that made it difficult for me and my partner to set meetings outside of the Weizmann Institute. This made our progress difficult. But after a number of times we learned to deal with this problem and to work effectively even if this caused a division of the work” (student 23, M).
2. **Development of interpersonal skills** such as management of a respectful dialogue, giving place to another opinion, and each one will be expressed in the work, flexibility and compromise on the part of each one of them, openness and trust in the partner. For example, respondents indicated, “Group work required of me compromise and expression of an opinion in a correct and respectful manner” (student 33, M), “In this inquiry work, I developed openness and trust in my partner, giving a place to another opinion, and that each one will be expressed in the work” (student 34, F).
3. **Social responsibility** (to identify a situation of distress in the partner and to offer help), **with backup and mutual support between the project partners** primarily when encountering a certain difficulty or when they need to make a joint decision. For example, a quote from one of the students “Work with the partner was a development since during this research I understood the extent to which it is necessary and desirable to work with a research partner since they can be different investigation directions and it is necessary to decide. In addition, they

- can work on the topic that the other was not so certain and there was back-up for the other when it was hard for one in something” (student 28, M).
4. **Development of in-depth friendship relations with the partner** following the close teamwork throughout the inquiry work. For instance, one of the students wrote “Teamwork – the project helped me to know more my spouse, we became better friends, and we improved our teamwork over time” (student 26, M).
 5. **Awareness of the importance of good teamwork with the partner in the inquiry work because of its advantages**, like effectiveness in work following the division of work, reciprocal fertilization in learning and doing of the project, development in interpersonal skills and support in coping along with the partner (and not alone) with difficulties that arise in the inquiry work. It is possible to see this in the previous quotes and also in the students’ responses to the question “Note two-three strengths of the program that it is important to keep”. Many students sought to preserve in the program the teamwork with the partner because of the awareness of its importance. For instance: “To preserve in the program the teamwork because of all the advantages that I wrote in the previous question” (student 34, F), “To keep the teamwork – the learning with the partner nurtures and strengthens one another” (student 5, M), “Emphasis on group work while overcoming many obstacles” (student 1, M).

Inquiry Component: Teamwork with the Peers in the Broader Group

1. **Development of interpersonal skills** of openness and trust between friends, ability to ask help from the friends and giving help when needed. For instance, the students wrote “Teamwork – during the two years I learned how to work effectively in a group and how to be helped / help my friends during the research” (student 30, M), “Teamwork: I learned to work better with other people and to be helped by them” (student 18, F). The students seek to preserve the teamwork with the project partner and the rest of the peers in the broader group. For instance, “To keep the teamwork, the learning with the friends, the atmosphere of openness and trust between the friends” (student 5, M).

Inquiry Component: Identifying with the World of Scientific Inquiry

1. **Experience with the scientist's world, in which they learn and research through discovery and inquiry**, define a problem, and search for and are committed to finding a solution, which is accompanied by curiosity and creativity. The students attribute this to the atmosphere of the program in the institute, which is similar to the atmosphere of a scientist in his laboratory (and different from the atmosphere of the school), which awakens the student's curiosity, encourages inquiry, enables freedom of choice for research methods, allows access to diverse and considerable equipment found in a laboratory, puts emphasis on the practical side of the research and not only the theoretical side, and creates situations that require creative thinking. In the students' responses to the question of "Note two-three strengths of the program that it is important to preserve" it is possible to see that it is important to the students to maintain this atmosphere.

For instance, "To preserve in the program the form of investigation – to solve a problem and to search for a solution in diverse and very interesting methods such as that of the scientist, with much curiosity, interest, and creativity" (student 17, F), "Emphasis on the practical side of the research and not only the theoretical side, as done in the school" (student 8, M), "A non-binding or not too serious atmosphere but you are committed by your will – constitutes a very different feeling from the school, an atmosphere or a scientist" (student 18, F), "To preserve a practical inquiry environment" (student 2, M), "Work in a research environment" (student 3, F), "An atmosphere that encourages inquiry, curiosity, and interest" (student 10, F), "To preserve the curiosity that the program awakens in the student, the creative thinking that the program gives to the student" (student 25, M).

3.2.3 Students' Citations -Stage 3: Final Stage of the Inquiry Project – Detailed Description of Aspects of the Students' Development in Each Inquiry Component

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 3.2.3.2 - Detailed Description of Aspects of the Students' Development in Each Inquiry Component, from the students' responses in the Summative Questionnaire (see appendix number 1.4, before the submission of the summative report of the project, 12th grade, N=34) to question: "Choose from the above list two-three components that you think greatly developed in you during the program. Describe how you developed in these aspects." and question: "Tell about the changes (at least two) that you performed during the research work. Describe what caused the change and what you learned from it." The description of the students' awareness of things it is important to them to preserve in the different inquiry components arose also from the answers to the following questions: question: "Give a 'tip' / lesson you learned to a student beginning in this program" and question: "Note two-three strengths of the program that it is important to keep."

Inquiry Component: Choosing the Inquiry Topic

1. **Recognizing and coping dynamically with the inquiry topic and investigation directions**, which change during the performance of the inquiry, and they are a part of the inquiry process. The students describe changes in the topic and directions of investigation during the inquiry deriving from different reasons: shift to a more interesting topic that appeared during the investigation, difficulties during the inquiry that led to additional directions of investigation. For example, "The change of a topic – we changed the topic of the work since during the investigation of the initial topic we encountered a strange phenomenon that we did not expect and that interested us, especially to research and to focus on this phenomenon" (student 18, F), "We changed the topic following the transition to a topic with content that interested us more" (student 15, M), "Following the lack of ability to build the experiment system as desired, it caused me to understand that sometimes it is necessary to compromise and that such a change can cause additional directions of

investigation” (student 12, F), “When we understood that we do not have the ability to explode the cup of wine we shifted to the topic of inquiry of the volume of water and the density of the liquid as depending on self frequency” (student 29, M). In addition, the students describe how they were forced to change the work program following the dynamism in the topic of the inquiry. For instance, “Because we changed the topic in the middle of the year and we decided to also research waves, the entire work program changed for us, and we worked in parallel on two main topics” (student 34, F), “After we changed the topic, we changed the work program that caused many topics to surface” (student 28, M).

2. **Focusing the topic and investigating it in-depth** and avoiding going into different topics. For instance, a quote from one of the students “First we were scattered about with the choice of the new topic and then we formed a certain topic in optics and we researched it in-depth” (student 28, M).
3. **Ability to make decisions independently, to choose the inquiry topic, the directions of investigation, and the ways of investigation.** The students seek to retain this in the program. For example, “To keep the student’s independence in all that is connected to the choice of the topic and the research directions” (student 10, F), “To give the possibility to the students to choose alone the research they will engage in and how they will research” (student 15, M), “To let students choose and decide the inquiry topic” (student 22, F). Moreover, the students seek to preserve in the program the giving of a range of possibilities of inquiry topics and investigations ways to develop in this component. For example, “To preserve in the program the giving of broad possibilities regarding different topics and regarding the building of different systems” (student 14, M).

Inquiry Component: Phrasing Questions/Goals

1. **Recognition of and coping dynamically with the inquiry question**, which changes following developments during the inquiry work. For example, “Change of the inquiry question – during the inquiry, our first question changed and developed according to the development of the research and experiments” (student 10, F), “Change of the inquiry question – first we wanted to research about the

movement of water bubbles in oil, then we changed this to the height of the injection of the bubble that will stick to the surface of the oil and in the end we reached a question that describes the traits of the bubble with the change of its volume” (student 14, M), “Following the unexpected results we changed the inquiry question. What I learned from this change is that inquiry is something dynamic and it is necessary to adjust it to the results and to develop it” (student 19, F).

The students explain that changes in the inquiry question are made for different reasons, such as difficulty dealing with finding a way of solution to the question or following the lack of means in the laboratory. For instance, “We changed the inquiry question because we did not understand how it is possible to solve it” (student 31, F). “The inquiry question changed during the work because of the non-significant results last year” (student 28, M), “The change of the inquiry question following the lack of means and instruments in the laboratory” (student 1, M), “Change in the research question since the system did not work” (student 4, F).

2. **Focusing the inquiry question.** For example, the students described “Change of the inquiry question – we focused more the question to a certain direction because it was too general” (student 24, M), “The project we began without a research question, and after preliminary experiments and understanding of the theory we asked many questions and then we decided that we want to research and focus on one question that addresses the ration of dispersion in water waves” (student 34, M).
3. **Asking questions in the spirit of inquiry, which can develop into quantitative in-depth inquiry.** For example, the students described “we were forced to change inquiry questions so that they would suit the research requirements and have measurable results” (student 17, F), “We built an in-depth inquiry question that can be investigated” (student 28, M).

Inquiry Component: Planning an Experiment

1. **Identification of variables that influence the phenomenon and the separation of the variables in the planning of the experiment.** This development derives from the considerable experience in this component. For example, the students reported “The planning of experiments – we should have planned many experiments so as to

examine different factors that can influence the phenomenon and to make sure that the rest of the variables will be constant” (student 10, F). “To understand the system it is necessary to disassemble it into its factors and to learn it. Thus it is possible to plan the experiment – to examine the relationship between two factors you are interested in and thus it is possible to learn how they are related to one another” (student 26, M).

2. **Development of creativity and initiative so as to improve the planning of the experiment** and to overcome the difficulties encountered in the performance of the inquiry. The students note that the engagement in this topic developed in them creativity and initiative in order to improve the planning of the experiment. For instance, “The original planning did not meet the demands of reality (too weak engine, the form of stabilization of the system, incorrect implementation and planning of the experiment, etc.) Therefore, during the work I was required to display creativity and initiative in the new planning” (student 7, M), “Thinking outside of the box – over time I succeeded in broadening my thinking regarding the planning of future experiments that can be performed” (student 11, F).
3. **Recognition and coping dynamically with the planning of the experiment.** For instance, the students wrote “We changed the process of the experiment and the planning of the experiment a number of times because of the lack of success in reaching a conclusion” (student 23, M), “Change in the planning of the experiment since there weren’t the tools required for the experiment” (student 1, M), “Change of our planning time after time regarding the cup of wine to attempt to break it, which in the end did not break” (student 29, M). It is possible to see from these quotes that this development derives from the very coping with the dynamism and with the different difficulties that arose in the planning of the experiment.

Inquiry Component: Performing an Experiment

1. **Ability to improve the experiment system, in order to minimize the mistakes and achieve more accurate outcomes.** For instance, the students reported “We changed the system in the experiment to reach accurate results and a more accurate assessment, we learned extensive uses on the previous system that we

built and we upgraded it to other experiments” (student 28, M), “We made a change in the system (we were required to change parts from the system such as the engine, the crankshaft, and to add the optical fiber) in order to be accurate in our measurements as much as possible” (student 7, M), “We made a change in the system to improve the results” (student 3, F).

2. **Ability to perform an experiment more independently than in the past.** This development derives from giving freedom to students to deal with problems that arise during the experiment performance. For example, the students reported “We succeeded in improving and upgrading the system over the two years and overcoming the difficulties that arose during the building and solving the problems by ourselves” (student 15, M), “I developed in solving problems in the building of the system – during the experiment we accumulated great experience in the building of the system and such changes and other changes that we had, and we succeeded in solving alone the problems that arose in the building of the system far more than in the past” (student 14, M).

In addition, the students emphasized to keep in the program the access to laboratory equipment in the institute, to give great and various equipment for building different systems, which allows them to develop in this component and to transform into an independent and initiating researcher. For example, “To keep the access to equipment since this way we can be more independent and enables us to initiate more and to do new things” (student 19, F), “To keep the giving of broad possibilities about building different systems, since if we want to develop, to be independent and creative, we will have what is required” (student 14, M). We will note that some of the students mentioned that because of the support of the teacher-mentors and laboratory assistants they succeed in overcoming problems that surfaced during the inquiry work. For instance, “In the beginning of the experiment it was hard for us to build a system but in the end with the help of the teacher-mentors and equipment from another place we succeeded” (student 31, F). “The participation of the laboratory assistant and his great help encouraged us to succeed in the performance of the experiment” (student 17, F).

3. **Development of the ability to solve problems and to develop from creativity to providing an answer to problems observed in the experiment.** The students emphasize that following the attempt to solve problems during the performance of the experiment and the building of the system, in them developed the creativity and initiative to answer the problems that surface in the experiment. For example, “Change in the experiment system – following the lack of ability to build the experiment system as desired awakens creativity in the attempt to solve the problem” (student 12, F). “When we needed to assemble the system and correct it, the creativity and initiative developed” (student 7, M).
4. **Awareness of the importance of improvement of the constellation of the experiment** so as to provide a precise and focused response to the inquiry question. For example, The students noted “Building the experiment system, I understood that it is necessary to build a system of experiment that exactly suits the research objective and not to compromise on given systems” (student 6, M), “It is important to change the system – every change caused our system to be more accurate and stable” (student 11, F), “During the experiment we changed the system all the time since during the experiment additional requirements were created and we needed to improve it so it will answer our inquiry question” (student 24, M), “We changed our system a number of times because it was not suited to our inquiry question” (student 31, F).
5. **Recognition of the dynamism of the experiment performance,** that it is necessary to change the system of the experiment according to the directions of investigation that change during the inquiry work. The students understand that it is necessary to change the experiment system according to changes in the directions that develop in the investigation. For instance, “Change of the system – some of the experiments required to change the system, and to change it according to the next direction of investigation and the next planned experiment” (student 10, F).
6. **Awareness of the importance of mutual dependence between ownership of the inquiry and enjoyment of the research.** In the question, “Give a ‘tip’ / lesson you learned to a student beginning in this program”, one of the students noted the importance of enjoying the performance of the inquiry through making the

experiment and the inquiry in general owned by the student. For instance, one of the students wrote “Enjoy the experiment you are doing. If it is not fun for you, then make it your own, and be more independent, in that you create something new in the experiment system, which solve the problem, which make it better and in this way you will feel this is yours” (student 26, M).

Inquiry Component: Using Technological Aids and a Computerized Laboratory

1. **Familiarity with a range of technological and computerized tools for investigation and mastering the use of these tools.** The students became familiar with a range of technological and computerized tools for investigation, such as sensors, simulations, and computational modeling software, and later on the development was expressed in the learning how to use these tools. For instance, “I got to know and I became good in the use of the computerized laboratory and all that is related to sensors” (student 15, M), “I developed in the use of a computerized laboratory, simulations, and computational modeling, etc.” (student 13, M).

The students emphasize that this development derives from the approach of the Davidson Institute laboratory, which allows access to advanced and innovative equipment. In the students’ responses to the question of “Note two-three strengths of the program that it is important to keep”, it is possible to see that it is important to the students to retain this access in the program. Examples include, “The program should keep the use of diverse tools, including modern tools, for research purposes” (student 17, F), “In the institute there are many technological tools that allow the performance of different and diverse experiments during the inquiry, and it is important to preserve this” (student 34, F), “To keep the access to the laboratory and to technological instruments” (student 11, F).

2. **Deeper learning and inquiry of the researched phenomenon and giving ideas for additional directions of investigation following the experience with the computerized laboratory and technological aids.** Experience in a computerized laboratory awoke the students’ thought and led them to learning and deeper investigation of the physical phenomenon and giving ideas to additional directions of investigation. For instance, one of the students wrote “I learned that

- there are ways to research a phenomenon outside of the experiments, the computerized laboratory led me to think, to learn about the phenomenon and to research additional directions” (student 19, F).
3. **Awareness of the need and necessity of the use of technological aids and a computerized laboratory in the inquiry process**, when the use of these gave them an answer to the difficulties that arose during the performance of the inquiry (in the performance of the experiment, in the processing of the data, and in the solving of equations). For instance, “Change in the experiment system. The Wilberforce pendulum given to us did not allow measurement of its movement, and therefore we created a pendulum of our own that includes in it a telephone – because of the sensors in it. The new system suited us greatly and I learned that it is necessary to develop means if there is a need for them” (student 6, M), “We changed our system of experiment, and we moved to work in a computerized system instead of a physical system so as to solve questions that arose regarding the physical system and problems that we did not know how to address” (student 8, M), “... when we saw that the results that we would produce from the experiments did not help us in the answer to our inquiry questions we decided to focus on computational modeling that can answer the inquiry question (student 19, F). In addition, students describe that the computational modeling was necessary in the case that they encountered difficulty with solving equations analytically (since they were required to have high level mathematics that they still have not learned), and the computational modeling allowed them to cope with the equations numerically. For instance, “We did not succeed in solving equations analytically and we were forced to shift to the building of a computerized model, which enabled us to solve them” (student 13, M).
 4. **Recognition of the advantages of the use of technological aids and a computerized laboratory** that significantly makes the investigation method easier and increases the quality of the inquiry. For example, a quote from one of the students “The access to advanced equipment and a computerized laboratory made the research very easy, made it faster and more accurate, and the inquiry of higher quality and depth” (student 6 M).

Inquiry Component: Data Processing

1. **Specialization in the use of different tools that enable data processing in a professional manner** (such as Excel, Tracker, and PASCO). The students explain that this development derives from the many experiences with these instruments during the inquiry work. For instance, “We used a large number of tools such as Tracker and PASCO, which greatly helped us during the inquiry work. For instance, “We used a large number of tools, such as Tracker and PASCO, which helped us greatly produce data during the three years of the inquiry” (student 13, M). Processing results – I felt that I greatly improved in this entire part because of the experience I accumulated” (student 14, M), “Development in the field of the analysis of the data, we produced many tables and graphs from the data (from the films we filmed) which made us professional in it” (student 7, M). In addition, the students seek to preserve in the program the learning and the use of software for the analysis of data that helped them greatly develop in this inquiry component.
2. **Evaluation of the range of uncertainty of the measurement and its comparison to the range of mistake of the experiment that leads to critical thinking.** The students report that the development was expressed in the more professional performance of data processing, which includes calculation and evaluation of the range of uncertainty of the measurement and the comparison of the range of error of the experiment, which led to critical thinking (in other words, also development of critical thinking following the engagement in the data processing). Examples in quotes: “The control developed in me, I learned the importance of calculation of the error of every experiment and the comparison to the uncertainty that always is found in the experiments and then to critique what we did” (student 6, M). “Change in the form of the data analysis. Now the part of the evaluation of the uncertainty has been added, I learned to evaluate the range of uncertainty and accuracy of the measurements” (student 7, M).

Inquiry Component: Drawing Conclusions

1. **Ability to find a relationship between two variables that were measured in an experiment and describe in a conclusion the type of relationship.** For instance, one of the students wrote “I developed in drawing conclusions – to find a relationship between two actors in the measurements we made in the attempt to conclude how they link to one another” (student 26, M).
2. **Ability of comparison and linkage between the experiment findings and the theory and/or computational modeling to reach more focused conclusions.** For instance, the students wrote “I learned to represent the conclusions that are expressed from the data, as well as to link what is found to the theory” (student 7, M), “Improvement of the coordination between the theory and the findings of the experiment, which led to better conclusions” (student 2, M). “The comparison to the computational modeling so as to examine whether there are mistakes and to reach better conclusions” (student 33, M).
3. **Recognition and coping dynamically with drawing conclusions,** which can change following the development in the inquiry. For example, “Our conclusions changed when we received the results of the improved experiment” (student 27, F).
4. **Focusing of the conclusions, through control, examination, discussion of them, and filtering of some of the conclusions, when their correctness was doubted.** For instance, the respondents wrote “We focused our conclusions from comparison between the theory and the results of the practical experience, we examined and discussed the old conclusions, and we reached more accurate conclusions” (student 13, M), “Change of the conclusions – During the inquiry we discovered many conclusions that were not unequivocal then we filtered a number of them to present the best and most correct ones” (student 28, M).
5. **Understanding that when the experiment results do not suit the theory they are not necessarily mistaken results but it is likely that they are real and true results.** For example, a quote from one of the students “Change in the conclusions of a number of experiments – sometimes the results of the experiment appeared to be mistaken but after the researching in-depth it becomes clear that the results were correct, causing us to change the conclusions accordingly” (student 30, M).

Inquiry Component: Written Reporting on the Inquiry

1. **Improvement of the ability to document the inquiry process**, which is expressed in the meticulous and ongoing documenting during the inquiry more than in the past and detailed documenting in the work journal. Most of the students (from the students who chose that there is considerable development in the written reporting on the inquiry) report the development in this aspect. For example, “In my opinion the documenting of the processes of inquiry developed greatly when in the first lessons we did not dedicate to take pictures of systems that should be reconstructed in the future, to the point that we documented every lesson the experiment system and until the results and more” (student 29, M), “The documenting of the inquiry process – over the years we learned how to correctly document the research process, in a detailed and regular manner, so that I would have all the information towards the end when it is necessary to summarize it” (student 22, F).
2. **Awareness of the importance of documenting of the inquiry process and its advantages**, which helps recall the entire inquiry process and its products, especially when it lasts a long time and the investigation products accumulate and multiply, for the purpose of the reconstruction of things if needed during the investigation or towards the writing of the summative work at the end of the process.

It is possible to see this also in the quotes found in the previous aspect and also in additional quotes. “Documenting the inquiry work – I learned about the importance of documenting, I learned that it is necessary to document everything that is done and in the end they connect even if in the beginning it appears not connected and dispersed (student 34, F), “Documenting the research – because we conducted many experiments and the work process” (student 10, F), “Documenting the inquiry process – over the year we wrote on notes all sorts of points about our work and we sat down to write the work and we took out all the notes they greatly helped the writing of the work. I remember that last year we were less meticulous about this and it was really difficult to remember what we did at the start of the year” (student 19, F).

Regarding the question “Give a ‘tip’ / lesson that you learned to a student beginning in this program”, many students gave tips that show their awareness of the importance of documenting the inquiry process. For instance, “To document, to write, to take

pictures of every detail in the process” (student 13, M), “It is very important to document every action that you do” (student 26, M).

3. **Improvement in the level of the writing**, in the phrasing of the writing, in the correct use of scientific language, and in the organization of all components of the work summarizing the inquiry project. For instance, “Writing a summative work – I put forth effort to write the work with as high language and level as possible, for it to be organized, and in my opinion I improved greatly in my writing” (student 8, M), “Writing a work – my phrasing improved over time and became more professional and scientific” (student 11, F), “I developed in the writing of a summative work and in the organization of the experiments, the results, and all the parts we did in the inquiry” (student 9, M).
4. **Improvement in the abilities of control differentiation of important and less important points, and making decisions on the writing of the work**. What will go in, what will not go in, what is the level of detail required in the writing of the work, what parts of the work the student has mastered in the written content. For instance, “Writing an inquiry work – I learned what to pay attention to, how to write, in what language, what is the level of detailing required. This is a skill that I am certain will help me in the continuation” (student 34, F), “Following the lack of good enough knowledge of the theoretical background in one of the parts caused me to change in the writing of the work and the presentation. This change caused me to understand that it is preferable to present what is known well than to attempt to load on material and to be seen as having a lot to present” (student 12, F), “Now I know how the scientific research work needs to be and what needs to be written in it and what not” (student 4, M).
5. **Improvement of the skills associated with writing presentations**, in terms of the summarization of the main things, better visibility of the contents, agility and the time needed to write them and even enjoy the writing process. For instance, “Writing the presentation – I learned how to write a presentation, how it needs to look like, what are the main things that you need to present, and not to overload” (student 27, F), “Writing a presentation: sometimes this was a real tiring action for me that took hours. But from presentation to presentation I felt that it takes me less time to do it, I even began to enjoy the process” (student 17, F). In addition, the students note that

this development derives also from the peer assessment and giving feedback from the peers and teacher-mentors, which caused them to improve the presentation and helped them decide which main things will be written in it. For instance, “At first we did not know what to present in the presentation, what is good and what is trivial and after a number of attempts with the audience we knew what to add and what to improve so that the presentation will be interesting and meaningful” (student 28, M).

Inquiry Component: Oral Reporting on the Inquiry

1. **Improvement in the ability to present and stand in front of an audience compared to the past.** For instance, “Presenting the work to the teacher-mentors, I learned how to speak in front of an audience because of the project in physics and I improved in my standing, speaking, and presenting compared to the past” (student 27, F), “Standing in front of an audience – I feel that I developed in this aspect since during the research we were required to present the work and this required speaking in front of an audience” (student 10, F). “During the work we practiced a number of times standing and presenting in front of an audience, and this helped me improve my presentation” (student 12, F). From these quotes it is possible to see that the students explain that this development derives from the practices in the presentation before an audience during the program (as a part of the program requirements).
2. **Rise in the feeling of efficacy and self-confidence in giving a presentation in front of an audience and reducing stress and anxiety.** For example, the students wrote “Oral presenting in front of others, in my opinion, this really developed in me because I had a real fear of speaking before audience and pressure. From year to year, the pressure and anxiety have declined, and every additional presentation improved the feeling of confidence and ability of speaking in front of an audience” (student 17, F). “Standing in front of an audience – I feel more confident and able to lecture in front of an audience” (student 11, F). The students ask to keep in the program the students’ presentations in front of the teacher-mentors and peers to develop in this component. For example, “To keep in the program the presentations in front of an audience for building confidence and standing in front of an audience” (student 25, M).

Inquiry Component: Building Content Knowledge

1. **Learning and understanding of the relevant theoretical background to the inquiry and inquiry processes**, especially in students who did not have previous knowledge. For example, “Learning and understanding of the physical theory. We began to engage in the project without preliminary knowledge on the topic we investigated, over time we learned the mathematical basis, we met with professors who research the topic, we sought the counsel of the teacher-mentor, in the end we learned and we understood the theoretical background of the topic in-depth, we also understood in-depth the phenomenon that we investigated and how to research it” (student 33, M).
2. **Love and interest in inquiry and physics following the building of content knowledge**. Example in quotes, “The program broadened and deepened my knowledge and it gives an interesting aspect on the world of physics” (student 16, M), “Learning knowledge on a high level, learning on inquiry processes that caused me to understand and love what I do and to be interested in inquiry and physics” (student 12, F).
3. **Awareness of students of the importance of building content knowledge in the inquiry process**, which makes the practical inquiry into more in-depth and meaningful. For example, “I learned that it is important to understand the topic before diving into it in the research, since without the understanding of the topic in-depth the inquiry is less meaningful” (student 6, M), “We changed the work and learning method. From work that has the goal of advancing as much as possible in the project we changed to work that has the goal of understanding more in-depth and to bring about our outlook and the things that interest us into the project” (student 26, M).
4. **Development of formulae in an independent manner through experience and theoretical background** that is acquired during the inquiry. Unlike their school, most of the students get the formulae from the teacher or from the textbook. Example in quote, “The program is very interesting and relevant, it is different significantly from the school where they give formulae without background and explanation and hence you build the formulae from the understanding of the theoretical background” (student 27, F).

5. **Acquisition of learning style** (different from the school), **which integrates practical experience through theoretical learning** in the investigation of the phenomenon (unlike the school where they learn, where for the most part they teach frontally the theoretical material) and even the students seek to maintain this learning style. For instance, “The learning is meaningful and other, which is different from the learning in the schools, combines the experiments and theory and the opposite” (student 34, F). “To keep in the program the combination between theoretical learning and practical and experimental learning” (student 13, M).
6. **Independent learning of the researched phenomenon and ways of investigation.** It is possible to see that, despite the difficulties entailed in this learning, it is important to allow the students to cope with the building of content knowledge independently, in order to allow further development in this component. The students even seek to keep in the program the independent learning style of the theory and the ways of investigation alongside the support of the teacher-mentors.
For instance, the students reported "I found the situation of independent learning during the inquiry work to be difficult. Although there was support from the teacher-mentor, it was hard for me to understand the theory related to the phenomenon, since I did not have previous knowledge at all and I needed to learn a lot by myself and while performing the experiments. However, conversely this situation caused me to know how to learn alone, which I had not done in the past" (Student 17, F), “I developed in self-learning of the theoretical material and of inquiry” (student 32, F). Example in quotes: “It is necessary to keep in the program independent learning of the theory and freedom of action that is given to the students to choose the way of investigation, to experience it, and to learn this independently” (student 4, M). “To keep the independent manner of learning in combination with help and support from the teacher-mentors” (student 18, M).
7. **Recognition of the need for openness in learning** (to come with an ‘open mind’ and to be curious) **of new topics and adjustment ability to new and different learning abilities in the school.** The students are aware of the difference between the learning style in the school and the learning style in the program in the Davidson Institute. Therefore, they recommend in response to the question of “Give a ‘tip’ / lesson you

learned to a student beginning in this program” to come with an ‘open mind’, to be curious, and to adjust to the new learning styles and learning of new topics. For example, “To keep an open mind, to understand that there is a difference between physics in the classroom and research physics” (student 10, F). “To come with an open mind to new topics and a different method of learning from that of the school. To open the mind to something new and interesting” (student 28, M). “To be curious about the contents from the world of physics and especially new things” (student 1, M). “To come with an open mind and not to be fixated on one thing” (student 32, F).

Inquiry Component: Building a Theoretical Model

1. **Familiarity with and experience in building a theoretical model using computational modeling.** The students tell that this is the first time that they experience such an experience. For instance, “Computational modeling – I did not get to model physical systems beforehand and now I have experience in it” (student 8, M). In response to question “Note two-three strengths of the program that it is important to keep”, some of the students seek to keep the course “Computational Modeling”, which was taken before the start of the project as an activity of preparation for the project. For instance, “To keep in the program the learning of courses such as computational modeling” (student 3, M).
2. **Awareness of the importance of engagement in building a theoretical model** for the more in-depth understanding of the phenomenon and even prediction/discovery of additional phenomena. Example in quotes “The building of a model – I got to build a large number of computational models that helped us greatly in the inquiry to understand the phenomenon and to research it in-depth” (student 13, M). The building of a theoretical model using computational modeling – through learning and the project I experienced a new topic that I did not know beforehand that helped me understand the phenomenon and discover more things in my work” (student 12, F). “Although I did not want in the beginning to engage in computational modeling, I understood that building the computerized theoretical model is important and essential in our project, since through it we succeeded in seeing and researching what we could not do in the practical experimental system and we also discovered new things” (student 8, M).

- “Most of our work focused on the modeling and theoretical prediction of the phenomenon and therefore we developed in this” (student 18, F). “At the start of the project, we did not know where to begin the model, in the end we built a simulation that places the mathematical solution and in the end after considerable effort we built a computational model that predicts the experiment results (student 34, F).
3. **Development of a computer programming language following the building of a theoretical model in a computerized manner.** For example, the students wrote “Before the start of the project we did not have the knowledge in writing codes or in computer language. During the work on the computational model I learned a lot on the topic and I developed by abilities” (student 18, F). “Writing a computer program that performs simulation and builds a theoretical model of a physical phenomenon – once I did not know to write anything, today I know to write a computer program” (student 19, F).

Inquiry Component: Self-Regulation

Improvement in the planning and organization of inquiry work:

1. **Management of the inquiry work in a more organized and effective manner than in the past.** For example, the students reported “My ability of work management has increased, we changed the manner of work after we did not succeed in the beginning, to more orderly and organized work, with a plan what to do in the future” (student 16, M). “Self-management of the inquiry process – we learned how to manage the inquiry process in that we knew what to attempt and what to do during the inquiry process to reach good work” (student 28, M).
2. **Awareness of the importance of planning the inquiry, organization, and management of a work journal in the inquiry process.** Example in quotes from one of the students, “I developed in the organization of the research work – over time I understood the importance of this component and we invested in it thought and I invested in the planning of the research and in the management of the laboratory journal” (student 23, M).
3. **Increase of the work ethic and personal responsibility** over the progress of the work and success of the inquiry project. For example, the students noted “I think

that the project taught me something: work ethic, mainly focus on the management of time and responsibility for progress at work” (student 26, M). “I developed in self-management – responsibility towards the work that will be performed and towards the members of the large group” (student 9, M). In addition, they see the students’ awareness of the importance of perseverance, seriousness, and taking personal responsibility for the performance of inquiry from its beginning to its end – in other words, to reach results in the end the student must work, persevere, and invest time on the project, take responsibility, otherwise he will not succeed” (student 26, M). “It is necessary to address the research that is performed with seriousness” (student 15, M).

4. **Critical thinking on the performances and process of progress in the inquiry.**

For example, the students reported “I developed in the management and planning of the research, I learned to analyze my actions and to critique them” (student 20, M), “I developed in critical thinking and in creative thinking – I invested a number of hours a week in critical thinking on the learning process and on my progress” (student 25, M) and the student even recommends “to invest a number of hours a week in critical thinking about the learning process and your progress” (student 25, M). In addition, in responses to the question of “note two-three strengths of the program that it is important to keep” the students seek to keep in the program the development of critical thinking”.

5. **Taking more initiative and independent work in the management of the inquiry.**

For example, the students reported “I developed in taking more initiative and independence in the management of the inquiry, to learn beyond at home, not to rely only on the encounters and also not to waste time in the meetings” (student 34, F), “The independent work increased in all that is related to the management of the inquiry” (student 3, F). The students seek to preserve in the program the independent work in the management of the inquiry.

Improvement in meeting the time schedule:

6. **Improvement in meeting the time schedule through planning a better schedule than in the past.**

For example, the students wrote “I developed in meeting the time schedule – at first we did not really meet the times of the submission of the work

and then we saw this to be a supreme value and we planned our time to submit the works in time and on a satisfactory level” (student 28, M), “I developed in the management of a better time schedule for meeting the pressures” (student 24, M).

7. **Awareness of the importance of meeting times in the inquiry process**, to meet the work required in the inquiry process and to finish the project in a respectable and appropriate manner. For example, a quote from one of the students “At the start of the program I would procrastinate, I did not understand the meaning of writing an entire work at a large scale, larger by far than what we were accustomed to doing in the school. During the final project I was struck by the understanding that if I do not sit to advance at work frequently it will not advance” (student 26, M). Also in the responses to the question “Give a ‘tip’ / lesson you learned to a student beginning in this program” it is possible to see the students’ awareness of this issue. For example, “To do everything in time and to focus more on work” (student 31, F), “It is important to keep meeting the time schedule despite the pressures” (student 29, M).

Improvement in dealing with situations of uncertainty:

8. **Recognition that the situation of failure/frustration is a temporary situation and a situation from which it is possible to develop** and grow to additional directions of investigation and to further the depth of the investigation. For example, From the words of the students “Coping with situations of uncertainty and failure – during the program I experienced many failures of building the experimental systems and of the experiment itself and I learned during the project how to accept the failure and grow from it- like how to improve the experiment the next time. In all of these Coping I turned in new directions and deepened the inquiry, and I evolved to be a better researcher, to put in place a good experimental system that would be able to bring more accurate measurements”(student 25, M). “I think that the coping with frustrations at first I had many unplanned and undesired things in the project but in the end this is what made the project for us” (student 32, F).

Also from the students’ responses to the question “Give a ‘tip’ / lesson that you learned to a student beginning the program”, it is possible to see the students’ awareness to obtaining a situation of a failure/despair/frustration as an inseparable part of the inquiry process and to make it into a challenge and an opportunity for

growth. For example, “Do not despair, research physics is not a program based on certain material that you need to learn for the test but on a way of inquiry work when the failures are a part of it and it is possible to grow from them” (student 11, F). In addition, the students note that the development in this component derives also from the receiving of help and advice from the teacher-mentors, academic counselors. For instance, in the quote “The overcoming of situations of uncertainty – we learned to approach teacher-mentors and other people to seek their advice about these situations and we reached better results” (student 28, M).

9. **Awareness of the importance of the development of character traits such as perseverance, determination,** not giving up, and optimism, so as to advance in the inquiry, which are needed especially to overcome situations of uncertainty and powerlessness during the inquiry process. For example, the students wrote “To understand that this is a lengthy process and not to despair easily, to continue to research and to persevere to leave the despairing situation” (student 9, M), “Also when it appears that there is no chance to leave the situation there always is a solution and new investigation and a new direction to try” (student 22, F), “To know that everything is possible, even if we are with lack of knowledge about what is going to happen in the results of the experiments” (student 28, M), “Not to despair, you do not see results in the short term. This project is a continuum of successes that builds a story towards some end point” (student 26, M).
10. **Development of creative thinking and awareness of the need for it to overcome situations of uncertainty and powerlessness during the inquiry work.** For example, from the words of the students “I developed also in the creative thinking – to answer the questions and doubts that arose during the program, my creative thinking developed” (student 25, M), “Creative thinking developed to overcome all sorts of barriers that it had in the work process” (student 3, F).
11. **Feeling of ownership and leadership of the students over their inquiry project** following the overcoming of situations of uncertainty and powerlessness during the inquiry work. For example, one of the students wrote “Do not despair, be persistent, stand up for yourself and what you believe in. In the end, when you overcome frustrations, you feel that the project is yours and that you have led it” (student 33, M).

Inquiry Component: Teamwork with the Partner in the Project

1. **Correct division of the roles and work between the partners.** For example in quotes, “Teamwork – we acquired skills of teamwork and we worked correctly in terms of the work division” (student 28, M), “We performed a division of work in which each one “led” in its more prominent fields of interest, so that each one could contribute according to his ability” (student 13, M), “We succeeded very much in dividing the roles in the group” (student 31, M). The students report that they prefer to work with the spouse in the performance of the inquiry work that increases the work effectiveness and lessens the load because of the division of the roles and the division of the work. For instance, it is preferable to work with the partner since there is division of the work load between the partners” (student 8, M), “In my opinion, it is preferable to work the partner than alone since when you work in pairs you divide the work and the roles and then you manage more together” (student 17, F).
2. **Sharing ideas and mutual fertilization with one another.** For example in quotes, “During the research we exhibited teamwork between me and the research partner, we worked together and we shared ideas with one another and we displayed caring and understanding when one did not understand something and explained better” (student 28, M), “When you work with a partner there is another look at the phenomenon that comes from another person. In other words, the partner interprets the theory or the observations differently and this contributes greatly to the progress of the project. In addition, there are always ideas for the progress of the work even if you think they are finished (student 11, F), “When talking about such a difficult and complex project, when the material in it is on a very high level it is difficult to understand the material alone and the learning and the work with somebody else can help understand” (student 12, F).

The students report that they prefer to work with a partner in the performance of inquiry work because of the sharing of the ideas and the mutual fertilization with one another. For example, “In my opinion, it is preferable to work with the partner, since it is possible to hear ideas that I had not necessarily thought about. Aside from this, it is possible to get new directions how to solve problems or different research

- questions that I had not thought about” (student 8, M). “I think that it is preferable to work with a partner in inquiry work, when they learn together it is always possible to correct one another and/or to receive constructive criticism. In addition, and mainly in the performance of the inquiry, when working with a partner each one can bring up ideas and in this way it is possible to form together a work plan or a series of better experiments, like brainstorming” (student 10, F).
3. **Recognition of the strengths and weaknesses of the partners** and consequently the complementing of the partners’ weaknesses through the other partner’s strengths. For example, the students described, “In teamwork – over the years we learned what each one does better and to work together in a more effective manner” (student 22, F). “Work in pairs – each one has sides that he is better in more or less and the work in pairs can reduce gaps in certain things. For instance, if I have difficulties with something then my work partner is good in it, and in this way he contributes to me and the other way around ...” (student 17, F). The students note they prefer to work with a partner in the performing of inquiry work also for this aspect. For example, “In my opinion, every person has strong and weak sides and work with a partner can allow each one to overcome his weak sides through his other partner in the team” (student 12, F). In my opinion, it is preferable to work together since every person / student has his strengths and weaknesses. In essence, when working in a pair then one student can compensate for the weaknesses of the other student and thus create better and quality work” (student 29, M). “Of course it is preferable to work with a partner who compensates for your flaws, it is preferable to work with somebody who will bridge over the things in which you are weak” (student 33, M).
 4. **Development of interpersonal skills** such as showing empathy, consideration, giving space and respect to one another, providing support and backup for the partner as needed, especially when the partner is found in a situation of frustration/despair or has encountered another difficulty. For example in quotes, “We understood that we are on the same boat, we learned to take one another into account, to divide the work, to know when it is necessary to let loose, not to trip over one another’s feet, and to protect one another” (student 26, M), “Another

development is cooperation with the partner when together we performed joint work (on the writing of the work, presentation, and organization), and because of the support of one another we reached this point” (student 29, M). The students note that they prefer to work in teamwork because of the receiving of support and reinforcement from the partner. For instance, “Teamwork, since this encourages more that there is somebody else who performs the research with you and you do not feel alone in the entire busy process. Aside from this, work in pairs is also more fun since there is somebody to laugh with / somebody to support you in moments when something is not working” (student 17, F), “In my opinion, it is preferable to work with a partner, since it is possible to receive support from one another” (student 8, M). “It is preferable to work with a partner since this helps morally, when it is hard for you” (student 31, F).

5. **Creation of relations of in-depth friendship.** For example, a quote from one of the students “Friendship (focus on teamwork), I and my partner in the project we went through ups and downs in the program – many successes and difficulties. “This “train of emotions” matured us and crystallized us greatly” (student 26. M).
6. **Awareness of the importance of teamwork** and its many advantages mentioned above, which lead to effective, quality, and enjoyable work. It is possible to see this from the quotes that were written in the above aspects and also in the students’ responses to the question of “Note two-three strengths of the program that it is important that is kept” the awareness of the importance of teamwork. Many students sought to keep in the program the style of work in pairs (in a team) for different reasons that were mentioned above, which leads to effective, quality, crystallized, and enjoyable work. For instance, “It is important to keep the teamwork so as to do higher quality and more effective work” (student 99, M). “The research work will be far more serious and in-depth if they work in teamwork, and this contributes to knowledge and development of all the group members. In addition, if they work in pairs, each one has parts that he is good in and can go in-depth in the parts that he likes and can receive backup from his partner and help in areas in which he less understands” (student 7, M). “The work develops more rapidly and better in teamwork, even if one does not understand something, then the other can help. In addition, each one has other thoughts

and thus there are different solutions and there is choice” (student 31, F). “It is important to also preserve the work in pairs. This program very much crystallizes the pair who works on the project together” (student 26, M). “... of course, working in pairs makes the work more effective and also more fun” (student 10, F).

Inquiry component: Teamwork with the Peers in the Broader Group

1. **Awareness of the importance of teamwork with the peers in the broader group**, which is another source for receiving constructive criticism, support, help, and encouragement if needed. For instance, a quote from one of the students “Peers in the group should be approached and they should be explained about what you are going through and if necessary you should ask for help, they can encourage you, give you good advice and constructive criticism” (student 7, M).
2. **Creation of a relationship with students from different places in the country**. For instance, one of the students wrote “I go to know and formed a relationship with students from different places in the country” (student 12, F).

Inquiry Component: Identifying with the World of Scientific Inquiry

1. **Recognizing what the world of the researcher / scientists looks like and identifying with the way that the scientist goes through in the inquiry process**, which includes also difficult situations he must overcome, simultaneous with the discovery of the beauty of doing inquiry itself and its products. Some of the students express the desire to be in this world in the future, “In my opinion, the program contributed to the view to the future and the understanding what is the scientist’s career, understanding of the difficulties on the way, that everything is not fame and new discoveries. The program helped make the scientific world into something more realistic and in my opinion help to decide better if science is our direction in the future or not” (student 34, F), “The program gives tools for research that do not exist in the school framework like in a scientist’s laboratory and in this way you are exposed to the beauty of the research world, and this caused the thinking about this occupation in the future” (student 33, M).

4. Students' Citations for the Second Research Question (from open-ended answers in the various questionnaires and from the Interviews)

This appendix presents examples of students' quotes (from open-ended answers in the various questionnaires and from the Interviews) that illustrate the aspects presented in the research in the various subchapters, about the students' perception of the "Research Physics" learning environment, (particularly, the teacher's roles, the student's roles, and the learning resources).

4.1. Students' Citations – Description of Main Differences between the Research Physics Framework and Laboratory Activity in the School Framework

4.1.1 Students' Citations -Stage 2 – Intermediate Stage of the Inquiry Work (11th Grade) – Description of Main Differences between the Research Physics Framework and Laboratory Activity in the School Framework

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 4.1.2.1, from the students' responses (N=33) in the Attitudes Questionnaire (see appendix number 1.3). The students were asked to describe two main differences between the activities in the laboratory in the school framework and the Research Physics framework.

1. In the Research Physics framework, the choice of the researched topic was undertaken by the student and not by the teacher, as generally done in the school. The students report that in the Research Physics framework, the students are given the possibility of choosing the researched topic. For example from the quotes, "I can perform in the laboratory in the Research Physics program experiments as I like and according to my desire to choose and to research any phenomenon" (student 21, M), "We decide the research topic in contrast to the laboratory in the school" (student 22, F), "In the program it is necessary to make decisions, in the school the teachers choose a topic and the type of experiment" (student 19, M), "In the Weizmann Institute there is the freedom to choose what to do and what to address, this increases the motivation to research..." (student 7, M).

2. In the Research Physics framework, the students carry out laboratory activity more independently throughout the entire inquiry process, from asking the question to choosing the way of the investigation (planning and performing an experiment) to collecting and analyzing the findings, with the accompaniment and direction of the teacher-mentors. In contrast, in the school it is customary to give a full laboratory briefing from the teacher, from the giving of the experiment aim and performance instructions to the writing of the experiment conclusions.

For instance, from the quotes, “In the program we perform the research independently using short direction of the teacher-mentor and in the school there is one way of doing the experiment, according to the teacher’s instructions” (student 22, F), “In the school there is less freedom for trial and error for the students, and you perform an experiment according to the instructions. In contrast, in Research Physics it is possible to make a mistake and again to try and to improve since you are given the independence over the experiment” (student 8, M), “The additional difference is skill of choice of experiments and planning of experiments during the entire project independently, when in the school the teacher gives instructions how to perform the experiment” (student 28, M), “In the studies of research physics we worked for the most part independently, as opposed to the work in the class that is performed by the teachers” (student 3, F), “In the program, we, the students, think about the experiment and we are not dictated like in the school. In addition, the method of instruction does not give us the answers but rather gives us a different perspective and tools so that we will make the work more effective and we will answer our question” (student 29, M), “We (the students) are the ones who perform the experiments in “Research Physics” that is not like in the school. In research physics, we are the ones who ask questions and research them by ourselves and in the school this does not happen” (student 23, M).

3. In the Research Physics framework, the practical experience in most of the cases precedes the learning of the theory or is in parallel to it, in the school framework for the most part the laboratory activity after the learning of the theory. In other words, in research physics the building of the knowledge of the students is based on the experiments they perform and in parallel on the learning of theoretical content (for the most part, the experiments precede the theory). The students tell that in this way they achieve a deeper understanding of the physical phenomenon.

For example, “when we learn through experiments before we learn the theory – we see the relationship between the different factors, we learn to characterize the relationship through logic and through observation of the natural phenomena. I believe that we begin to understand better how physics works and how the processes that occur work than when learning first the theory and only afterwards performing an experiment, like we do in my school” (student 7, M), “Another difference, in the school greater emphasis is placed on the theory more than the practice (the physical experiment) and if an experiment is done then it is done after we learned the topic. In research physics the emphasis is on the experience (we did experiments almost every session), and in parallel we learned the theory related to the experiment” (student 8, M), “For the most part, the learning of the material is performed in experiments and not through written material” (student 1, M).

4. In the research physics framework, there is active learning, in which the students are more involved and active in the lessons and in the building of the content knowledge than in the school. For example from the quotes, “In the school we listen to the teacher when she teaches the material, in the Weizmann Institute we have the possibility of planning all the experiment ourselves and being active in the lesson, we teach ourselves while we plan the experiment and perform it, when the teacher of the institute instructs us and gives us a place for self-learning” (student 10, F). “The difference is that in research physics that student is more involved in what is done in the lesson than in the school, during the lesson we think what we need to learn and what to research so as to understand the phenomenon better and compose the knowledge during the lesson. In the school the teacher explains to you everything, from A to Z, and you do not need to assemble the theoretical material” (student 6, M).

5. In the research physics framework, the students reach the in-depth understanding of the physical phenomenon and broaden the horizons (contents beyond the curriculum), as opposed to in the school there is no time to go in-depth beyond the curriculum and beyond the material required for the high school matriculation certificates. For example from the quotes, “In the class we learn the specific material that will appear in the high school matriculation examination and of course the pace of the learning is intensive, this creates a situation that there isn’t time to broaden the horizons and to learn beyond the required material and also there isn’t time to go in-depth in the topic. In contrast, the research physics program enables us to be free, to ask questions, to be curious, and to reach additional places,

to understand that to carry out an experiment is not so simple and in the end to understand in-depth the topic” (student 11, F), “In the school they teach the theory without really understanding it – what in the program is not done. In the program they let you alone to understand the material and truly to understand it in-depth and not only to learn it” (student 32, F), “In the program there is more meaningful and in-depth learning than in the school” (student 25, M).

6. In the research physics framework, there is more independent learning than in the school, where the student learns theoretical material that is new for him. For instance, from the quotes, “In research physics there is self-learning and very great independence relative to the lesson in the school” (student 18, F), “In the framework of the research physics program, I learn more independently without the teacher’s teaching. Thus I learn how to learn alone and how to work and also broaden my area of knowledge in physics” (student 21, M), “In my opinion, the fact that we are researching and learning by ourselves and reach insights with the accompaniment of the teacher-mentors empowers and gives us independent learning and meaningful learning” (student 34, F), “The difference is in the independent learning – we learn alone the material in the research physics program” (student 24, M), “We learn alone and perform alone. The independent learning is important since you do not have a teacher who will teach you all the material, from A to Z, and the teacher-mentors do not give you the answer” (student 5, M).

7. In the Research Physics framework, self-management of the investigation and independent organization of the schedule and the work journal are possible, as opposed to in the school framework, in which the teacher manages the lesson and the pace of the learning. For example from the quotes, “The difference is in the fact that we manage the lesson as a team. And the fact is that there is no regular structure for the lesson, and we decide who to manage the lesson and the continuation of the investigation, what to do and when?” (student 20, M), “Planning the time – in the program we plan the time we research and learn and not the teacher (like in the school)” (student 9, M).

8. The research physics framework offers many more opportunities for teamwork among the students (work in pairs) than in the school, thus leading to cooperative learning with the partner and mutual fertilization, brainstorming, acceptance of support from the partner, and

development of interpersonal skills, such as giving help, consideration of the pace of learning of the project partner, and listening and accepting the opinions of the other person.

For example from the quotes, “The work was performed mostly with a team member, and this challenges you to learn to work in a team and helps you with the finding of solutions in the continuation, since we talk about the problems and each one suggests solutions and receives comments of one another and in this way there is more thought and motivation to find the solution” (student 1, M), “The difference – work in pairs, when generally in the school I am accustomed to learning alone. I would need to take into consideration the pace of learning of my partner, to teach my partner things I understood that he did not understand. In parallel, he helps me with things that I had difficulties with, and we complemented one another” (student 9, M), “The additional difference is in the group work – in the program we learn with other people and work together and it is necessary to listen and to accept the opinions of other people, in the school generally you learn alone” (student 24, M).

9. Receiving support and a personal attitude between the teacher-mentor and the student (every research team has a close teacher-mentor for the duration of the entire inquiry work) more than with a teacher in the regular class. For example from the quotes, “When there is a personal teacher-mentor, there is a more personal reference than with the teacher in the school, it is also far easier to understand the theoretical material that is sometimes difficult to understand, since you can approach the teacher-mentor and ask for an explanation exactly on what was not understood to you and in general to ask for his help in everything related to the investigation” (student 14, M), “In the program there is great personal reference from your teacher-mentor, since he is always close to you and follows up after what we are doing, and always wants to help or direct if we have difficulties, in the school it is hard for the teacher to reach all the students and the teacher does not always care like the personal teacher-mentor does” (student 8, M).

10. In the Research Physics framework, they are exposed to the world of the scientist/researcher more than in the school framework, mainly since they understand the nature of the inquiry process and there is also considerable practical experience.

For example from the quotes, “I gained experience in doing researches. I learned by myself the meaning of inquiry and its difficulty and its contribution to the researcher” (student 34, F), “In the program all the time we can see how the physics works in life and how the

scientist works, we understand the process that the scientist undergoes and the inquiry process. In the school too we barely do any experiments, here we do many experiments and this lets us feel like a researcher in a laboratory of a scientist” (student 31, F), “A different learning style, we research the topic and do not work like a parrot, we work in the manner of a research that increases the curiosity, like a researcher in the university” (student 27, F).

11. In the research physics framework, the results of the experiment are not known ahead of time and are not necessarily commensurate with the expected theory and it is necessary to provide explanations of the gap between the experiment findings and the theory. In contrast, in the school framework the results are known beforehand to the teacher/student, and mainly the goal of the experiment is to confirm the theory learned in the classroom. For example from the quotes, “when an experiment is held in the classroom, not everyone has the opportunity play an active part and in most cases the results are known ahead of time, since we learned about the theory before the experiment and the results were expected. In the Weizmann Institute, this is double; not only that you are independent and play a more active part in the laboratory but also the results are unexpected and many times are not commensurate with the classic theory and you need to explain why there is a gap, and you need to explain why there is a gap, and in my opinion more encouraging self-thinking, critical thinking and deepening in the experiment (student 10, F), “In the school when activities are performed in the laboratory they say what to do and the results are known ahead of time. In the program you are allowed to choose the topic that you want to research and there are not necessarily answer that are known ahead of time” (student 32, F), “In research physics, we perform experiments, without knowing what is supposed to be obtained in the end. Truly an inquiry is performed” (student 17, M).

12. There is a higher level of experimentation in the research physics framework than in the school, for different reasons. The first reason is a long-term experiment, which raises the level of the experiment – in research physics it is necessary to carry out repeated experiments and to constantly improve the experimentation system, in order to reach as accurate results as possible, to differentiate from the school, where generally it is customary to perform a one-time experiment during the year. A second reason is the complexity of the theoretical content relevant to the experiment – the content of the researched topic in research physics is beyond

the curriculum and its level is high relative to the school. A third reason is the complexity of the equipment – more use of technological instruments and a computerized laboratory that increase the level of the inquiry.

For instance from the quotes, “The level of the experiments is far higher, also because we need to improve our measurements and this is not one-time like the school and also because of the high level of the theoretical material, and therefore they go in-depth far more in research and in experiment” (student 12, F), “In the program the experiments are of a better level than in the school, because you are supplied better quality equipment, more diverse and sophisticated instruments and objects that are used for an accurate and real experiment” (student 10, F), “In research physics they use more diverse and sophisticated instrument than in the school, which increases the level of the inquiry” (student 17, F), “In the laboratory in the school the number of means is very limited and defined, without too many possibilities, and therefore the experiments are simpler and less complicated” (student 18, F), “In research physics we do the experiments ourselves and work with new computer software programs, in the school there is no use of computer software and the experiment is simpler” (student 16, M). The fourth reason is the performance of an experiment independently increases the difficulty and complexity of the experiment. For instance, “The difference is primarily in that we work far more by ourselves and therefore the experiments themselves are more complicated and complex since it is harder to perform this independently, but this way the experiments are more interesting” (student 16, M).

4.1.2 **Students' Citations - Stage 3** – Final Stage of the Inquiry Work (12th Grade) – Description of Main Differences between the Research Physics Framework and the Laboratory Activity in the School Framework

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 4.1.2.2, from the students' responses (N=34) in the Attitudes Questionnaire (see appendix number 1.3). The students were asked to describe two main differences between the activities in the laboratory in the school framework and the Research Physics framework.

1. In research physics, the student is allowed to propose and to choose the directions of investigation, when, to differentiate, in the school the teacher (the education system) decides upon the objectives. For example from the quotes, “A difference in the teaching style – in research physics we research by ourselves and offer directions of investigation, in the school the teacher decides and we do not at all have a thought about this” (student 23, M), “In the laboratory here we decide what to research and do everything alone and they do not do for us” (student 22, F), “Another difference, in the laboratory in the school you do not have the freedom to research, but you are told exactly what to research even if this does not necessarily interest you. In the program you can choose what to research and to take it in your direction” (student 32, F).

2. The research physics framework enables a change in the objectives of the investigation and reaching unexpected places because of the dynamism of the inquiry process and field of interest, while in the school the objectives are pre-defined and unchangeable. For example from the quotes, “In the school there is a predefined objective; in contrast in the program it is possible to change objective and reach unexpected places that popped up in the investigation” (student 8, M), “In the program the student has a broader place to express himself and his research desires, we can change the investigation in the direction that interests us – what cannot be done in the school” (student 13, M), “In the school in the laboratory it is set ahead of time what we are doing, how we are doing, without freedom of action, things are set. In research physics nothing is predetermined, we choose the way in which we want to act and the direction in which to continue according to what is obtained from the investigation. Accordingly, we think about changes that should be done in the investigation” (student 18, F).

3. Research physics enables freedom of action and independence throughout the entire inquiry work and leading of the inquiry project. In contrast, in the school generally the teacher is the one to lead the laboratory activity and the student works according to the teacher’s instructions and there is no real room for the student’s independent thinking and doing. For example from the quotes, “Freedom of research and ability of independent leading are expressed in the research in the inquiry questions and in the planning of experiments – in the program we lead and decide independently what to ask, we plan and build the experiment system, while in the school we perform an experiment according to

the teacher's instructions" (student 33, M), "In the laboratory activities in the schools they dictate the entire course of the experiment, the teacher instructs and almost does the experiment by himself while I observe or follow instructions. In the activities of "research physics" I create by myself the system, plan the research, choose the research question, and carry out the experiment" (student 7, M), "In the school we are guided exactly how to do the experiment and there is no room for independent thinking, in the program we can take the experiment in our direction and we have more freedom in its performance" (student 8, M), "One difference is that we have far more freedom of action and we for the most part determine by ourselves what to do and how" (student 16, M), "The students build by themselves the system of experimentation with the minimal intervention of the teacher-mentors" (student 32, F), "In the program we plan the experiment in the project, build alone the experiment system" (student 4, M), "The first difference – there are no instructions ahead of time in research physics, unlike the school" (student 6, M).

4. In research physics, the building of the knowledge is based first on practical experience and relying on this the students learn the theory. To differentiate, in the school, generally, the building of the knowledge is based first on the theory and relying on it they perform experiments. In general, there is more practical experience in the research physics program than in the school, and in the school greater emphasis is placed on the learning of the theory. For example from the quotes, "In the school we acquire knowledge and with it we perform experiments when we can already hypothesize what the result will be, while here we perform different experiments to build the knowledge with their help" (student 17, F), "In the research physics framework, we learn about the theory, by ourselves, sometimes even after the investigation of the phenomenon, as opposed to the school framework, in which we learn theory before performing the experiments" (student 15, M), "In the program we based our studies on experiments" (student 30, M), "In the school we engage primarily in theoretical learning as opposed to the research here, there is more experimental learning" (student 12, F), "The teaching methods are different, in the program they teach us how to research more than theoretical physics" (student 10, F), "We barely do inquiry and experiments in the school, we learn primarily theory" (student 31, F).

5. In research physics the student's degree of responsibility for learning and advancement of the inquiry project is greater than in the school. For example from the quotes, "Another difference is the different level of responsibility we have, in the program you are more responsible for your progress and your learning on the topic, there is no teacher who will teach the material, the teacher-mentor only supports and directs and most of the responsibility is on you" (student 16, M), "First difference, in the curriculum they are more responsible for the form of measurement of the inquiry, the learned materials, and in general the pace of progress. In the school the student is less responsible for the pace of learning, the teacher is responsible for this, of course the student is also responsible for his learning but there is somebody who gives him the pace" (student 29, M).

6. In research physics the student is more involved and active in learning and in investigation than in the school, where the student builds the knowledge and the understanding. For example from the quotes, "In the program there is the maximum involvement of the student in the process of inquiry and learning, since you in essence create the content and build your understanding as opposed to the school, where the teacher creates the content" (student 25, M). "In research physics the student's involvement in the learning is far greater, there is room for independent thinking, you learn by yourself the concepts and all the parameters that influence the phenomenon during the activity and think about the continuation of the learning, in the school you do not do this but the teacher tells you everything" (student 10, F), "The learning style is far more active, the skills are far more practical for inquiry work, the student's involvement is far more meaningful" (student 14, M), "The difference in the learning style and student involvement – more experiential and independent in research physics" (student 9, M).

7. In research physics the contents are broader than in the school and more complex. For example from the quotes, "We learn material that is not learned in the school and broadens horizons and also material on a high level" (student 30, M), "The content in research physics is different from the material learned in the school and engages in topics that are not focused on in the high school, such as, for example, Brownian movement, which in my opinion is more complex" (student 18, F), "The contents learned are far broader in the program than in the school" (student 12, F), "In research physics the theoretical material is more complex than in the school" (student 4, M).

8. In research physics there is greater depth in the topic than in the school. For example, “The difference in contents – the learning of the material in research physics is far more in-depth, in the school we learn only the theory without going into little things” (student 34, F), “The program caused me to go more in-depth in topics, to understand more in-depth the topics” (student 26, M), “In the program the contents are on a higher level than in the school and therefore greater depth is required” (student 14, M).

9. Research physics enables more independent learning than in the school. For instance from the quotes, “In the research physics framework we learn about the theory independently. We search by ourselves the material that belonged to the phenomenon and sit to learn alone without the teacher’s help, as opposed to in the school framework in which we learn the prepared theory (submitted to us by the teacher and the book)” (student 15, M), “The difference is in the manner of learning – the fact that the learning is independent” (student 20, M), “The learning is more independent in the program than in the school” (student 21, M), “The difference in the learning style – independent and free versus the school framework” (student 24, M).

10. In research physics the handling of formulas is different than in the school. In the program we attempt to understand the aim of the formula, how it is created, prove or compose the formula, the relevance to the inquiry, as opposed to the school, where the formulas are given and generally do not show the proof. For example from the quotes, “In the school, they teach us specific formulas and let us learn them by heart, in the Davidson Institute I feel that I am leaving the norm, researching what is interesting to me and what makes me curious and proving or composing the formulas that are related to inquiry and understanding them in depth” (student 27, F), “The program caused me to understand what the goal of the formulas is, how to reach them, the teacher-mentors give the time to develop the formulas by ourselves” (student 26, M).

11. The research physics framework enables the student to manage the work and to organize the time schedule, while in the school the teacher is the one to manage the lesson and what happens in it. For example from the quotes, “In the activities of research physics I create by myself the inquiry process and even change it during. I manage myself and organize the work that should be done and when and not the teacher. In the school the teacher leads the activity in the laboratory” (student 7, M), “In the program we learn how

to write a work journal, organization, and order” (student 11, F), “In the program the skills are acquired – how to perform inquiry on a high level, to organize the schedule, and to manage the work independently” (student 20, M), “The program caused me to withstand greater pressure and to know to manage time correctly” (student 26, M).

12. In the research physics framework, the students face more complex challenges than in the school of making decisions, learning from mistakes and failures, coping with situations of powerlessness and uncertainty (as expected in the inquiry process). For example from the quotes, “The difference in the difficulties – in research physics we encounter far more difficulties from the basis of the choice of the research topic, building the system, and manner of progress, especially when we encounter a dead end. In the school the experiments are very clear, less of the form of trial and error, with a certain objective they reach relatively immediately, without especial difficulties. In research physics there is room for more mistakes, there is lots of challenges, and we learn to overcome, and this is part of the process of scientific inquiry” (student 34, F). “The program in research physics enables us more to cope with challenges when the findings are not commensurate with the theory or when we reach a dead end” (student 15, M), “In the school if you get stuck at an obstacle many times the teacher explains to you the answer and shows you where you made a mistake. But here they let you research and cope with the mistakes and understand alone where we erred” (student 17, F), “The challenges are far more complicated in the program than in the school, for instance, when you cope with situations of powerlessness and even frustration ,when you do not know how to advance or to overcome an experiment that failed and to think how to improve it” (student 29, M), “In the program there is more independent coping with difficulties, failures, and lack of success” (student 25, M).

13. In the research physics framework, they are exposed to cooperative learning with the partner and to teamwork for the long term and discover its importance (such as mutual fertilization, joint decisions, division of labor and responsibility, and support of the partner), to differentiate when in the school the work is generally personal. For example from the quotes, “Additional skill that is acquired in the program is how to work in the team, we need to make shared decisions, to take one another into consideration, and also we help one another and divide the work between us, for the most part in the school I work alone” (student 20, M), “Another difference – teamwork with the group, in the program

there is more group responsibility and dependence on one another than laboratory activity of the school” (student 28, M), “Difference – the program enables teamwork and caused me to understand its importance – the learning in a group helps in the continuation of the way, we learn to listen to one another, to support and even to correct as necessary” (student 27, F), “Teamwork is more important in the program than in the school, since here in the program there is a regular project partner and the work in the team for a considerable period of time (we are at least two years together working on the project)” (student 14, M), “In the learning program there is more partnership with the partner for a long period of time of two years, there is no such thing in the school, infrequently in the school we work in a group for a lesson or two and submit a joint laboratory report” (student 21, M), “In the framework of the research physics program we work in teamwork as opposed to work in the school which is personal” (student 15, M).

14. In the research physics framework, a more personal relationship is created between the student and the teacher-mentor than between the student and the teacher of the school, which is expressed also in personal follow up after the team of students and the teacher-mentor is more available than the teacher in the school. For example from the quotes, “A difference in the teacher’s involvement – there is far more room for personal attitude and help in difficulties, the teacher-mentor follows up after the students and can know always what their situation is. In contrast to the school, where the teacher knows the situation of the class only after a test and is not always available for every little problem of every student because of the load of children in the class” (student 34, F), “The difference in the learning environment – in the program the groups are small (a pair of students and a teacher-mentor) as opposed to a big class in the school, therefore there is a more personal attitude from the teacher-mentor and the teacher-mentor is a part of the team” (student 24, M), “There is a more personal attitude between the students and the teacher-mentor than with the teacher in the school because of the close work with the teacher-mentor for a long period of time” (student 28, M).

15. In research physics the teacher-mentors are partners in the investigation since for the most part they do not know the answer as opposed to the teacher in the school, who for the most part knows the answers ahead of time. For example from the quotes, “The participation of the teacher-mentors – in research physics the involvement of the teacher-mentors is

greater and they learn the material together with us since they do not know the answer like we do, therefore they are partners with us in the inquiry, in contrast the teacher in the school knows the answers ahead of time and he does not research with us.” (student 23, M)

16. In research physics there is room for the experiment results that are not expected (which are not commensurate with the theory) and constitute investigation, to differentiate the results of experiments performed in the school are known ahead of time and generally their goal is to confirm the theory. For example from the quotes, “Another difference, in the school you know what are the answers to the experiment report even before you conducted the experiment, since they are supposed to come out according to the theory that the teacher taught, in the program the results of the experiment are not expected” (student 18, F), “In research physics the experiment can lead to learning of new material, since you obtain unexpected results and you research this. In contrast to the school, in which the experiment is specifically built for the material that the Ministry of Education set” (student 6, M), “In the school the answer is known ahead of time, and in research physics you do not necessarily know what the results will be” (student 32, F).

17. In research physics there are more means to perform inquiry than in the school: an abundance of equipment, modern and sophisticated equipment, time for performing the inquiry, and expertise of the teachers to guide the inquiry. “In the laboratory of research physics there are instruments and devices that are more improved and higher quality than in the school, which enable a broader research horizon” (student 13, M), “In the school we do not have so much equipment and time to carry out inquiry like in the institute, there is greater emphasis on learning the theory than giving the students time to research and carry out experiments” (student 31, F), “The teacher-mentors of the program are more experienced in guidance of inquiry and in the researched material and therefore in the school they less do inquiry” (student 28, M), “The difference in the teaching style – the teacher-mentors are more expert in the style of the teaching for inquiry” (student 34, F).

4.2 Students' Citations from the Interviews – The Students' Attitudes on the Inquiry Process and on the "Research Physics" Learning Environment

4.2.1 Students' Citations from the Interviews – The Students' Perception of the Student's and Teacher-Mentor's Responsibility in the Inquiry Work

The following section presents students' citations from the Interviews (performed after the submission of the intermediate report at the end of the eleventh grade) that illustrate the aspects presented in the research in the Chapter 4.2.1.1.4

A. Interview with Student 13, M

Interviewer: What did you learn from the program about yourself?

Student 13, M: "... And I also learned about myself responsibility and also to take responsibility for this project, in other words, to work with full force that we will have a prepared project and that it will meet the highest level that there is."

Interviewer: The responsibility that you spoke about, can you describe how this is expressed?

Student 13, M: "We had many moments when it seemed as if the project would not be ready, but we decided that there is no situation in which we do not have a project. In other words, we have something we are working on for two years, we must be as serious as possible. So yes, we had this personal responsibility, each one works at home alone, or we meet, we worked to finish this, and we had many times meetings during the inquiry itself. Each one knew to take responsibility and to do something better, or to channel it for the good of the project. Totally I feel that I improved my learning responsibility following the inquiry work."

B. Interview with Student 32, F

Interviewer: Is there a change in the degree of responsibility for your learning following the performance of the inquiry in the program?

Student 32, F: "Yes."

Interviewer: Why do you think this way?

Student 32, F: "Because you need to cope here with things beyond, which are new to cope with, like to take upon yourself very great responsibility. This required lots of responsibility

and meeting the time schedule, since you had a task to do and you need to submit it by a certain time.”

C. Interview with Student 14, M

Interviewer: Is there a change in the degree of responsibility for your learning following the performance of inquiry in the program?

Student 14, M: “No. I would say, the responsibility for my learning and my quality of learning always were high. I have high self-discipline, I know to organize time correctly, also for learning for tests. I always knew from a young age to plan my time and to be responsible for my learning and this is what helped me also in this inquiry work.”

4.2.2 Students' Citations from the Interviews – The Students' Perception of the Student's Degree of Independence and the Teacher-Mentor's Degree of Involvement in the Inquiry Work

The following section presents students' citations from the Interviews (performed after the submission of the intermediate report at the end of the eleventh grade) that illustrate the aspects presented in the research in the subchapter 4.2.1.2.2

A. Interview with Student 9, M

Interviewer: What in your opinion is the uniqueness of the research physics program?

Student 9, M: “I think that they gave us an interval of action and not somebody dictates to us the pace, gives instructions, and this gave me experience in the leading. David is a teacher-mentor and not a teacher. The teacher-mentor does not determine for you what to do.”

Interviewer: Did you feel comfortable with this?

Student 9, M: “Yes, I was comfortable with this, since I had my interval of action and I had the freedom to choose where to navigate the ship of the project and this was fun. In essence, they threw me into the water in a good part, I needed to cope alone, this in the future will contribute to me to academic studies. I did not have a teacher who will dictate to me and I need only to learn by rote.”

Interviewer: Describe the degree of involvement of the teacher-mentor in the work.

Student 9, M: “The teacher-mentor helped us greatly, also in the theoretical material, also in the experiment, his ideas advanced us in the understanding of the phenomenon. He offered to us experiments, to research them, so that from them we will understand the

relationship to the topic, but the teacher-mentor left us the freedom to discover things alone, he did not give us the solution, and this advanced us in the theoretical learning and in the investigation of the topic.”

B. Interview with Student 13, M

Interviewer: Describe how your teamwork with the teacher-mentor was.

Student 13, M: “Because the teacher-mentor was also the homeroom teacher, then he was busier, and we were with him less time than the teacher-mentors of other staffs, therefore we also had time that only I and my project partner work without a teacher-mentor. But we, I and my partner, think together what to do without the teacher-mentor, and if he is needed then he is called and he comes every time, I am very satisfied with how we worked. The relationship with the teacher-mentor was really good, first of all we enjoyed with the teacher-mentor ... For all that we need we can call him, SMS him, email him, then we had a very open system with the teacher-mentor ... and he also gave us the space to research by ourselves.”

Interviewer: What are you satisfied with?

Student 13, M: “We succeeded in thinking in a rather coordinated manner with the teacher-mentor, we had a bit of disagreements, but we also solved them in a nice way, in other if I said something and the teacher-mentor thought something else, then not that he is a teacher-mentor and he is a doctor and you do accordingly, we really sat and examine the two theories and we went with what everyone agreed.”

Interviewer: What are you satisfied with in the program?

Student 13, M: “It was very nice that they gave us a free hand, in other words, in the laboratory there was the equipment that we wanted, and the laboratory technicians always helped and they did not let us deal alone, and nevertheless they gave us a free hand to do what we really wanted and did not limit us. Every planning of an experiment that we wanted to do we performed, already in the first meetings we built the experiment system alone, without the teacher-mentor’s help. In other words, we could do exactly what we wanted, and we were not limited in terms of the idea or in terms of the topic or in terms of the instruments, this was truly cooperation on the part of the teacher-mentors and on the part of the laboratory technicians. I think that in general the program greatly succeeded.”

C. Interview with Student 10, F

Interviewer: Describe your teamwork with the teacher-mentor.

Student 10, F: “It was really nice, he helped us but he gave us a large interval for what we think is correct, he even let us be confused alone and to think alone. This was nice that we had this place to be independent in the research. For the most part we planned the meetings ahead of time, but there were times that we came to think what the teacher-mentor will tell us but generally we knew which topics we want to research and how to research them. He really guided us, literally. He did not take too much control over the research and only counseled us here and there and I really liked this approach.”

Interviewer: Did the program improve your self-efficacy (to believe in yourself) to do things independently/alone?

Student 10, F: I think that I had the efficacy to do things independently before the program, but this is something that it is possible to say that I used in the program, the program does require doing this.

D. Interview with Student 8, M

Interviewer: What do you think about the degree of involvement of the teacher-mentor?

Student 8, M: “It was on a good level, on the one hand, the instruction advanced us and gave us directions of thought and on the other hand this did not prevent us from researching alone and performing our role as researchers. This was a good integration, the teacher-mentor gave us our place to do what we think, to express our ideas and thoughts. This was balanced as necessary.”

E. Interview with Student 12, F

Interviewer: Describe your teamwork with the teacher-mentor. Describe what the teacher-mentor’s degree of involvement in the work is.

Student 12, F: “There was not so much to exert judgment and we did not need to plan, since the teacher-mentor would tell us what to do and how to build the system and what to measure, he asked the inquiry questions and suggested the planning of the experiments, and he also explained the theory. While without him we would not have advanced so much in the project work and we would not have reached an in-depth understanding of the theory since it was complicated and we found it difficult to solve equations on a high level of mathematics, but nevertheless I was interested in him giving us a little more independence.”

The satisfaction in the project was in the continuation, when I succeeded in the end to do the computational modeling independently, since the teacher-mentor did not understand this, and I needed to do everything alone, I needed to be creative, and I learned a new instrument with which I could research, which led to a project on a very high level.

Interviewer: Did the program improve your self-efficacy (to believe in yourself) to do things independently/alone?

My feeling of efficacy did not change, since I always knew, this is how they educated me, that if I want – I can achieve. But the program constituted for me proof of this, since until now I did not have meaningful challenges in order to see this.

F. Interview with Student 17, F

Interviewer: Describe your teamwork with the teacher-mentor.

Student 17, F: “We performed the measurements and understood the variables, we reached conclusions for the inquiry question, but we did not plan the experiment, the teacher-mentor tells us how to perform the experiment. The teacher-mentor was very involved, 70% , he told us which experiments to perform, he greatly attempted to help, but I developed the creativity and independence since like I said, the teacher-mentor planned everything. If I would move the wheel back, I would change the teacher-mentor since I would want to attempt to plan experiments alone, that we would think which experiments we must do in order to promote the project and to reach what interests us.”

G. Interview with Student 33, M

Interviewer: Describe your teamwork with the teacher-mentor.

Student 33, M: “With the teacher-mentor Aryeh it was a little more complicated, Aryeh is not in the same mindset with me and with student 7 in terms of the time schedule. We tried to explain to him to let us work in our time schedule. He maintains that we just postpone everything and in the end we will not submit the work, but in the end we did this in our time schedule and it came out a very good work. Sometimes there is with Aryeh also many disagreements, like which experiments, how to research the experiment, how to perform the experiment, but in the end we succeeded in resolving everything, with all the arguments and all the discussions and despite all the disagreements, we have cooperation with the teacher-mentor.

Interviewer: What are you not satisfied with?

Student 33, M: “I would like that the teacher-mentors will help in a basic manner, in other words only to direct and to enable more freedom for students.”

H. Interview from Student 23, M

Interviewer: Describe your teamwork with the teacher-mentor.

Student 23, M: “The truth is we did not really understand the teacher-mentor’s role. We did not have a relationship with him, our teacher-mentor was a mentor-teacher for three groups. So he wasn’t really with us. This caused us a bit of frustration, why do other groups have a close teacher-mentor and we share with another three groups. Perhaps this was good for us, since we learned to cope by ourselves and not to be dependent on the teacher-mentor. We learned to get along in general. But nevertheless the relationship with the teacher-mentor was good, he answered for us every question we asked also by email. He instructed us and referred to us, but I would recommend that he instruct fewer than three groups so that each group will receive more personal reference.””

4.2.3 Students' Citations from the Interviews – The Students' Perception of the Planning and Organization of the Inquiry Work

The following section presents students' citations from the Interviews (performed after the submission of the intermediate report at the end of the eleventh grade) that illustrate the aspects presented in the research in the subchapter 4.2.1.3.2

A. Interview with Student 13, M

Interviewer: What were your difficulties in the program, how did you cope with them?

Student 13, M: “Yes, we had the difficulty like everyone, this was the pressure of the time, since there was lots of stress of the high school matriculation examinations and tests. Especially, for me it was very difficult, since I also am an instructor in a youth movement and play handball three times a week, so this was serious pressure. In addition, our stage of exploration in the beginning was very meaningful and was very important, but it also was very long, took a lot of time of the project. Time pressure was created for us to perform the main experiment for the inquiry question, for the theory, because of this we did not have time.”

Interviewer: How did you cope with this difficulty?

Student 13, M: “We needed to think how we get along with our time, how we channel our time correctly. We used rather much the laboratory journal, at the end of every encounter, we wrote what we did, which findings we had, and what we plan to do for the following meeting and the coming meetings. Also many times we met, I and Or, in the afternoon and we finished works and we finished things at home and we dedicated time to this, since it was very important to us to meet the time frames and to prepare the project in the best way there is.”

Interviewer: What did you learn from the program about yourself?

Student 13, M: “First of all, I learned about myself, that I can cope with challenges of time and pressure. I succeeded in coping with challenges that I did not go to cope with outside of the framework of research physics, in other words to submit works with such a pressuring deadline with such load.”

Interviewer: What tip would you give to a new student who comes to the program?

Student 13, M: “To invest from your time, in other words, not to wait only for the meetings, this means to read in the home if there are materials to read, to come ready to every meeting and not to leave ends open during the inquiry ... to examine one hundred percent that there will not be anything that will come up suddenly and you will need to go back in all your progress. In other words, to be very thorough, to be very orderly, and to invest your time for this.”

B. Interview with Student 8, M

Interviewer: Tell me about the challenges you experienced in the project?

Student 8, M: “The great difficulty that I had is a day loaded with studies, and it is simply difficult to remain focused over time. And especially in the period of the tests I had to plan the time in order to get everything done, to learn and to research and to organize everything so that it would come out good like I wanted.”

Interviewer: How did you cope with this?

Student 8, M: “For the most part, I did not sleep much ... I gave up many things to focus on the research and on the studies since this was important to me to invest and to succeed ... also at the end of every meeting we set together with the teacher-mentor general goals for the coming meeting, what we plan to do, and indeed we would begin from the planning and this definitely helped.”

Interviewer: What did you learn from the program about yourself?

Student 8, M: “...I also learned how to manage my time properly ...”

Interviewer: What tip would you give a new student who comes to the program?

Student 8, M: “To plan well the work you are going to do and to invest, the more you invest, the better quality the research.”

C. Interview with Student 17, F

Interviewer: What did you learn from the program about yourself?

Student 17, F: “I learned from the program personally, that it is important to be ordered and organized in the work since this lets you see the continuation of the way. When we made order, sometimes together with the teacher-mentor – we found the line connecting between the experiments, we saw that we did many things and we learned many concepts and we acquired confidence that our work is good. However, we saw what is missing, where we need now to invest, and what we must do to continue the inquiry.”

D. Interview with Student 23, M

Interviewer: What would you like to improve or strengthen next year?

Student 23, M: “There are skills that I need to improve, such as planning, planning before every meeting so that it is possible to get more done. Most of the meetings we did not plan ahead of time what we do. Simply we came to Weizmann Institute for a meeting and planned what to do today ... this is one of the things that we wrote for us to improve. That we must plan more our meetings ahead of time to advance. I want to improve the work planning. Already in the vacation to read, to work on the research, to focus and to plan things already for the first year, that we will not be delayed during the next year.”

Interviewer: What did you learn from the program about yourself?

Student 23, M: “We found it difficult to plan the work and the time and nevertheless the program improved for me the self-conduct – to manage myself the inquiry work, my ability to meet a time schedule, to make order and organization in the work regularly and continuously.”

E. Interview with Student 10, F

Interviewer: What did you learn about yourself from the program?

Student 10, F: “I think that order is terribly important to me because every time that I and my project partner we attempted to remember things from the experiments in a non-orderly”

manner, we forgot them. And this is something that I learned that I need to document things more in the work journal and to be more orderly, to organize the time and the work in a good way.

F. Interview with Student 32, F

Interviewer: Tell me about other challenges you experienced in the project.

Student 32, F: “I think that in the beginning this was meeting a time schedule but this improved. The program required of me first planning of time, since it is necessary to invest our day in every week in the afternoon and also to invest at home to make a transition to what you do there, if this is to do works or to write the reports. This also required much responsibility. You need to submit reports at a certain time that they determined for you.”

G. Interview with Student 14, M

Interviewer: How did you cope with the planning of the research work?

Student 14, M: Before every meeting we would plan and seek the advice of the teacher-mentor what we will do in the next meeting, what we will learn for the next meeting so as to come ready to the meeting. Everything was in coordination with the teacher-mentor and through correspondence on the WhatsApp group. The instruction was of the right dose, not close but guiding. In my opinion, there was good instruction, on the one hand we had somebody to rely on, we were given tools when we needed this, on the other hand it enabled us to cope and to manage independently.”

Interviewer: What did you learn from the inquiry work?

Student 14, M: “To teach myself to meet time schedules, to initiate meetings with student 15 each time outside of the sessions, and to know to manage and organize the work.”

4.2.4 Students' Citations from the Interviews – The Students' Perception of the Coping with the Dynamism of the Inquiry and with Situations of Uncertainty in the Inquiry Work

The following section presents students' citations from the Interviews (performed after the submission of the intermediate report at the end of the eleventh grade) that illustrate the aspects presented in the research in the subchapter 4.2.1.4.2

A. Interview with Student 15, M

Interviewer: Tell me about the challenges you experienced in the project. How did you cope with them?

Student 15, M: “Many times when we would not receive the exact results we would need to begin again, this was to get up from the disappointment and each time to do better and better until you succeed.”

Interviewer: Did you experience a breaking point / frustration during the project? Or a situation of powerlessness / uncertainty? And how did you overcome it?

Student 15, M: “Not really, but we changed the inquiry question many times. Then until the end I did not know what we are focusing on. There was a very general focus until we decided to really sit on one topic that we wasted the most time on. Perhaps in this stage there was a little confusion but this was not really the breaking point ... also we always had the teacher-mentor who would advance us. There was never a moment of stopping. The teacher-mentor would propose way of progress. So we were never under a feeling that there is nothing to do. We would sit at the end for a conversation with the teacher-mentor on what we would do in the next stage and always when we would come we would see how the situation had changed, because of this we also changed many times the investigation and in the end we based on something that we wanted to research.”

Interviewer: What did you learn from the program about yourself?

Student 15, M: “I learned that I can succeed when I want ... I learned that also sometimes when you do not succeed it is not always a failure and it is always possible to find a way to advance.”

Interviewer: What did the program require of you?

Student 15, M: “First of all, thinking a little out of the box. Time. Hard work. Investment. Creativity.”

Interviewer: Did you develop in you the creativity in the program? If so, how was this expressed?

Student 15, M: “The creativity was always when you did not understand and you try until you succeed. We had, for instance, one field of inquiry of the speed of light, I remember that I and student 14 had a little difficulty with it and we sat on it a lot of time but in the

end we succeeded in reaching in our way an accurate result. Then it was thinking not only 'what the teacher says, you do' but creative thinking and independent understanding."

Towards the end of the interview:

Interviewer: What tip would you give a new student who comes to the program?

Student 15, M: "That you try to invest your time as much as possible. Try. Do not give up the moment you do not succeed since in the end it will pay off."

Interviewer: What did the program contribute to you in the personal aspect?

Student 15, M: "Like I said in the beginning, to know also after failure you need to get up and persevere and succeed, that failure is not always the end and it is impossible to continue from the moment you did not succeed in something. And in any event, not related to physics, to do the best. To invest the most time and to work the hardest in order to succeed. ... Also not to be closed to things, to be open, in the end it is worth it, you know far more worlds and topics and everything."

B. Interview with Student 10, F

Interviewer: What challenges did you have in the inquiry work? And how did you cope with them?

Student 10, F: "I think that the greatest challenge was in essence that we reached a dead end and we did not know how to continue, and there truly the teacher-mentor helped us greatly since we needed more professional help ..."

Interviewer: "Did you experience a breaking point / frustration during the project? Or a situation of powerlessness / uncertainty? And how did you overcome this?"

Student 10, F: "There were times when we a bit despaired, at first we did all sorts of experiments to examine how it is possible in essence to influence the system and to see what influences and what does not. In the end, we reached a dead end. But we knew that there is a solution and the teacher-mentor helped us a lot then we succeeded in dealing."

Interviewer: What is the intention 'we reached a dead end'?

Student 10, F: "In the beginning we hypothesized that there are all sorts of factors that can influence, such as, for example, the size of the drop, the volume of the drop, the volume of the water ... then we did all sorts of experiments in which we changed some of the parameters and some we left constant, and we saw that this does not truly influence the manner of spread of the stain."

Interviewer: From your perspective, if you received a result that you did not expect, is this failure?

Student 10, F: “In the beginning from my perspective this was indeed the case, but the teacher-mentor made sure to explain to us that part of the process of inquiry is also not to succeed and there are experiments that you don’t reach results and if we discovered a parameter that does not influence this system it is still a type of progress even if it appears that it does not advance us to any place.”

Interviewer: And you were convinced?

Student 10, F: “Yes, the truth is yes. Following this, I changed my opinion that it is a part of the inquiry process.”

Towards the end of the interview:

Interviewer: What tip would you give to a new student who comes to the program?

Student 10, F: “To come ready for this that it is something else, to come ready with an open head, to be ready to learn also things you didn’t learn beforehand, even if these are totally new topics, not to be afraid to begin a new topic and to cope with new things...”

Interviewer: Do you feel that you can do further inquiry work?

Student 10, F: “Yes, I have the self-belief that I can, since they gave me this experience and I see that I know how to perform inquiry work from the beginning to the end, can cope with difficulties that generally arise in the inquiry works and to do work in a good manner.”

C. Interview with Student 9, M

Interviewer: Did you experience a breaking point / frustration during the project? Or a situation of powerlessness / uncertainty?

Student 9, M: “I was at such a point of powerlessness in the home before we presented the final project before the audience. We wanted to improve the software program and to attempt to adjust it as much as possible to reality, to the outcomes of the experiment, and we did not so understand why there are gaps between the software and the experiment results. There were very large gaps, this is a point that really frustrated us, the gap between the results of the software and the results of the experiment, but in the end, we were brilliant, and we played with the parameters of friction, friction of air coefficient, and thus we succeeded somehow in getting close to the values of the experiment results. Today as well the gap was reduced but not perfect, I believe that next year we will advance to the reduction of the gaps between the theory and the reality.”

Interviewer: Did you develop your creativity in the program?

Student 9, M: “Yes, last year there were topics in which there were inquiry questions. This year, we needed to build the inquiry question according to the phenomenon and according to the theoretical knowledge and this necessitates from you creative thinking, to create something from nothing.”

Interviewer: How was creative thinking expressed?

Student 9, M: “For example, when we got stuck with the results of the software, the results did not come out according to what was expected from the theory, we could throw our hands up in the topic, in the end we got an idea that the parameter of the friction of the air influences the results. Therefore, we added a parameter in the software, the friction coefficient, we played with the parameter in order to adjust the software to the reality, and this necessitated from us creative thinking, to think outside of the box like they say.”

Interviewer: What did you learn from the program about yourself?

Student 9, M: “I learned not be afraid of coping with new things. The ability to cope with new topics, with questions that I did not know at all, with frustrations if something does not work or does not work out, with situations that you do not know where the inquiry will lead and how it will end.”

Interviewer: Do you feel that you can do another inquiry work?

Student 9, M: “Yes, the experience I accumulated in the program gave me the confidence for this.”

D. Interview with Student 13, M

Interviewer: Did you experience a breaking point / frustration during the project? Or a situation of powerlessness / uncertainty?

Student 13, M: “There were additional difficult parts, that we did not know what we are doing, that the modeling did not work and we did not have an idea what we are doing, why we compare, we were helped by the teacher-mentor and we worked on this more until we succeeded. But still the modeling did not suit the reality – the graph of the experiment. Again we worked on this, we added friction to the modeling and this significantly improved but still not completely, since in reality mass also has movement on the Z axis, and we in the modeling did not attribute to this importance. So we corrected and another time we

succeeded in improving the similarity between the two graphs. In other words, because we did not despair and we persevered in improving, we succeeded in achieving a good result.

Interviewer: Did you develop your creativity in the program? If so, then how was this expressed?

Student 13, M: “We used things that we did not use regularly. We had problems how to hang the mass on the spring in such a way that it will be as spherical as possible, volume as small as possible, in other words, that it will be close to a dot, we used the help of a carpentry shop – we soldered things, we broke things, and we succeeded in reaching some shape and engineered all sorts of things. In the inquiry process itself, it was necessary to think differently. This is a bit different from solving an exercise, this is to think that if I do this it will influence this. Or when I began something and I see that this does not work and does not go anywhere, I think differently, about something else that could work for me, bring up new ideas. The same thing on the matter of the modeling, as if you enter a world of programming and computers, and it is necessary to have creativity and a thought a bit beyond, then we had many things that necessitated creative thinking.”

E. Interview with Student 8, M

Interviewer: Tell me about other challenges you experienced in the project.

Student 8, M: “Much time we didn’t know what to research, we performed many experiments this year to examine exactly what we want to research. We searched always what was the main research question and we took much time, at least a good number of months, until at last we encountered an interesting phenomenon and we decided to focus on it. It is necessary to understand that this inquiry work takes time until the discovery. There was one matter that made it difficult for us, our last experiment. We needed to get three times to the institute to repeat the experiment again and again, since every time we got different results and not like we expected according to the theory and we need to understand to search for the reason for these results.”

Interviewer: How did you cope with this?

Student 8, M: “There were many situations in which we need to think outside of the box, sometimes we had results from the experiments that we did not expect and we needed to understand and to explain why this happens and how to neutralize the factor that influences the experiment, and this necessitates creative thinking. In addition, in the comparison to

the other groups, we had a non-trivial relationship from the teacher-mentor. The teacher-mentor was there for us throughout, we had personal treatment, we received a response to every request, and in essence she coped together with us in the entire process.”

Interviewer: What did you learn from the program about yourself?

Student 8, M: “... How to overcome all the obstacles in your way and the overcoming of the obstacle makes the work more successful and interesting and to be creative and to think outside of the box”

F. Interview with Student 33, M

Interviewer: Did you experience a breaking point / frustration during the project? Or a situation of powerlessness / uncertainty?

Student 33, M: “In the building of the system, we were not sure whether it will work or will not work out, and whether there will be or will not be very great uncertainty.”

Interviewer: How was the feeling of being in this place?

Student 33, M: “We said that it does not matter what happens, we will give the maximum and what will be will be, we will find a solution and not despair.”

Interviewer: And you did not despair?

Student 33, M: “No. We needed to think creatively.”

Interviewer: Did you develop your creativity in the program?

Student 33, M: “Yes, this develops them.”

Interviewer: Tell me how this was expressed with you in the work.

Student 33, M: “The program develops lots of creativity, this was expressed in building the system, planning experiments, sometimes the research demands from you to think in a way that is outside of the box, to propose original solutions. If you think outside of the box, you will obtain a different outcome, and very not banal, and for this I came to the Weizmann Institute.”

Interviewer: What did you learn from the program about yourself?

Student 33, M: “... not to give up, even if there are difficulties, it is necessary to know also to cope with them.”

G. Interview with Student 14, M

Interviewer: Did you experience a breaking point during the project? And how did you cope?

Student 14, M: “I do not think, we did not reach frustration. Perhaps small frustration, not something serious, when we reached a place where we did not know what to do, how to

continue. The teacher-mentor gave us a hint, a direction of investigation, and then we continued from there.”

Interviewer: Did you develop your creativity in the program? If so, how was this expressed?

Student 14, M: “We had creative thinking in the work, especially in the building of the complicated system, we need to find creative solutions for all the problems that appeared for us in the building of the measurement system.”

Interview: Do you feel that you can do another inquiry work?

Student 14, M: “I think that my level of efficacy rose throughout the inquiry. I discovered that in the work process I succeeded in understanding alone without help and can reach conclusions alone. I succeeded in bringing ideas and all sorts of things to research by myself. Then I believe in myself more, that I can cope with more research works.”

H. Interview with Student 23, M

Interview: Did you experience a breaking point / frustration during the project? Or a situation of powerlessness / uncertainty? And how did you overcome this?

Student 23, M: “Sometimes we found ourselves that we do not exactly what to do, and what is the next stage. However, we always found a way out. We thought at home, we read many materials at home that helped us understand the phenomenon. And if we do not reach something, then we were helped by the teacher-mentor Zeev or Idan and they directed us.”

Interviewer: Did you develop your creativity in the program? If so, how was this expressed?

Student 23, M: “Yes, the program developed in me the creative thinking, it is necessary to understand that there is more than one way to do something, especially when we were stuck then it is necessary to think differently. For example, we got stuck in the calculation of the Tracker, and then we had the idea how to address results differently and we reached better results.”

I. Interview with Student 32, F

Interviewer: Did you experience a breaking point during the project? And how did you cope?

Student 32, F: “... when we got stuck at some stage that we did not know how to advance and how to move from it. We got stuck in the beginning stage of the learning and we did

not know how to leave this. We were frustrated since the previous teacher-mentor did not give us the support we needed to leave this situation. Truly what helped us overcome this is simply to change the teacher-mentor. Since then in essence already everything worked for us, we still continued with small experiments but more the inquiry developed for us.”

Interview: Did you develop your creativity in the program? If so, how was this expressed?

Student 32, F: “Thinking about inquiry question is something that necessitates a lot of creativity, to think about something satisfactorily interesting that we did not research before ... and also this truly developed my level of thinking than to be stuck on things, this opened the mind.”

Interview: What tip would you give a new student who comes to the program?

Student 32, F: “Not to be afraid of the situation of powerlessness. When something does not work out, this is part of the issue, not to despair.”

J. Interview with Student 17, F

Interviewer: Did you experience a breaking point during the project? If so, how did they cope?

Student 17, F: “Yes, at those moments that we were frustrated. There were many such moments, especially when you did not understand the theory or that you do not know where you turn to, how to advance in the inquiry, or that the teacher-mentor gives you ideas that you are not interested in researching, you do not understand his way of action.”

Interviewer: How did you cope?

Student 17, F: “We always insisted that we would find the way to research what interests us – how to break a glass cup. We tried many ways, and on the way you learn a lot, even if you did not succeed in breaking the cup, we still continue to work on this.”

Interviewer: What did you learn from the program about yourself?

Student 17, F: “... that I do not give up, that I am stubborn that I have the willpower to persevere and not to despair, and that I can succeed and achieve what I want.”

4.2.5 Students' Citations from the Interviews – The Students' Perception of the Aspect: Building Content Knowledge in the Inquiry Work (in Stage 2 and Stage 3 of the Inquiry Work)

The following section presents students' citations from the Interviews (performed after the submission of the intermediate report at the end of the eleventh grade) that illustrate the aspects presented in the research in the subchapter 4.2.2.2

A. Interview with Student 8, M

Interviewer: In your opinion, what was the uniqueness of the Research Physics Program?

Student 8, M: “In the school they rather feed us material, there is a phenomenon and they give us an explanation of this and formulas. Here we need to research the phenomenon, we need to give an explanation for the phenomenon, we need to discover the formula for the phenomenon and to use the acquired knowledge. When you see with your eyes and do with your hands, this fits well. This is far more logical in the mind. In the school you remember the formulas by heart and here you discover the formulas by yourself or how to use formulas to discover new things.”

Interviewer: How did you learn the theoretical material relevant to your inquiry?

Student 8, M: “First thing our teacher-mentor gave us articles and writings related to the topic, this is a starting point, and from there we searched for more theoretical material on the topic and we learned at home. In the beginning, we learned about the theoretical material behind every phenomenon since we did not know the field of electricity and magnetism and therefore we learned the basic knowledge behind this. Then we went into greater depth, which phenomena to research from the phenomenon we saw ... we performed many experiments to understand the theory, experiments of trial and error, through the experiments we understood the theory. Every experiment we examined the reason for the result and how this is commensurate with theory if at all. In essence, in the continuation of the work the entire process was based on building our knowledge on the topic from our investigation.”

Interviewer: Do you understand the theoretical material relevant to your inquiry? Do you feel you have mastered the material?

Student 8, M: “I think that I rather mastered the theoretical material and understood it, learned it in-depth, and used it throughout the entire research.”

B. Interview with Student 13, M

Interviewer: In your opinion, what is the uniqueness of the research physics program?

Student 13, M: "... Here, the way we learned in the program, you learn the theoretical material better than in the school, since we did experiments, and we proved things through experiments and the theoretical material is better absorbed. We found an expression for the ideal mass, with which I am really satisfied, from which I know what the mass is that will cause the movement to be performed in the best way there is given a spring with a constant and length. As if we succeeded in reaching an algebraic expression that as if does not exist. And this sits far better in the head than what I would have understood, if I were to learn this in the school then only frontally."

Interviewer: Was there independent learning? Did you improve the ability to learn by yourself?

Student 13, M: "Yes, since we had much need for this, because of a lack of time. We had many times to read material alone, about friction or harmonious movement, a spring, about the time of a cycle, also to read articles alone, to find articles. Then we had many times to learn independently at home or in the institute that this is totally improved me in my ability to learn by yourself."

Interviewer: Do you understand the theoretical material relevant to your inquiry? Do you feel you have mastered the material?

Student 13, M: "Yes, totally, yes, I feel that I have mastered the theoretical material, all the issue of harmonious movement, I understood far more, because we found the algebraic expression from the experiments that we did and learned much independently at home on this."

C. Interview with Student 14, M

Interviewer: Which challenges did you have in the inquiry work and how did you cope with them?

Student 14, M: "The great challenge was to learn and to understand the theoretical material, we did not understand at first. We sat at home and we learned the theoretical material independently. It should be noted that this is new material for us and it is complicated."

Interviewer: How did you learn the theoretical material relevant to your inquiry?

Student 14, M: “We began to ask questions of one another on WhatsApp, and what we did not understand we asked the teacher-mentor for explanations and we received from him an answer to the questions we asked. The teacher-mentor explained to us a little about the theoretical material, and what it is necessary to look for in researches. He gave us a starting point, we asked questions together, we searched for answers in research studies, we learned independently, we learned together, it took us time but in the end we understood.”

Interviewer: Did you improve the ability to learn by yourself? If so, describe

Student 14, M: “We need to learn the theoretical material for the next session and to know what influences the force inside the liquid to come prepared for the next session. Hence, in the research I coped, learned new material, to read different research studies and to understand them alone. In the research we had much theoretical material to tackle alone, some I succeeded in understanding by myself and some I was helped in by project partner and by the teacher-mentor.”

Interviewer: Do you understand the theoretical material relevant to your inquiry? Do you feel you have mastered the material?

Student 14, M: “I can say that today I have mastered the theoretical material especially after the presentation of the research in a presentation for the parents and the teachers and after all the lessons with the teacher-mentor.”

Interviewer: What did you learn about yourself from the program?

Student 14, M: “I learned that I can sit to learn alone, to handle the theoretical material that is not familiar to me, to understand it in-depth, and to reach conclusions by myself related to the phenomenon that I researched.”

D. Interview with Student 9, M

Interviewer: In your opinion, what is the uniqueness of the research physics program?

Student 9, M: “In the school we learn not in an in-depth manner and here in the program we did a whole project, with the experiments and the observation of phenomena, analysis of the results, and we learn more in-depth the theory. Second, generally in the school the theory is given by the teacher or is from the textbooks. And here you need to search for the theoretical material, how to organize the new information, to get into academic articles, and to learn independently, and this is something new.”

Interviewer: What did you learn from the program?

Student 9, M: "... In the program I learned how to turn to theoretical materials that you did not know. The search for the materials that were relevant and reliable. In the program I experienced something new, independent learning, learning new material alone. This was most significant in my opinion."

Interviewer: Do you understand the theoretical material relevant to your inquiry? Do you feel you have mastered the material?

Student 9, M: "I feel that I have mastered more and am more confident. And this really contributes to the material of the school. I understood the topic of harmonious movement better and this prepared me for the matriculation examination."

E. Interview with Student 17, F

Interviewer: In your opinion, what is the uniqueness of the Research Physics Program?

Student 17, F: "In the school they teach me the material and here I would need to do this alone."

Interviewer: How did you learn the theoretical material relevant to your inquiry?

Student 17, F: "We received theoretical material related to the experiments from the teacher-mentor, like articles and a book in English. It was still very difficult to learn this alone, since we did not have any background on waves, we encountered many new concepts, and it was necessary to also learn them. But the experiments helped to understand the theory, since in parallel we carried out experiments. Every meeting we did an experiment, to understand the theory."

"The teacher-mentor also tried hard to help us, but we did not really understand him And his way of action was very frustrating. At some stage we understood that it is necessary to accept the situation with the teacher-mentor, we learned independently and the experiments helped us to understand the theory, but he tried greatly to help us, he answered us on WhatsApp, and he would send us articles."

Interviewer: Which challenges did you have in the inquiry work and how did you cope with them?

Student 17, F: "It was very difficult for us to understand the theory related to the phenomenon we researched. I feel that they threw us into the water, we learned independently, but there was support on the part of the teacher-mentor. The stage of the

independent learning of the theory was difficult for me, but on the other hand, this let me know to learn alone, what I did not do in the past.”

Interviewer: Did you improve your ability to learn by yourself? If so, describe

Student 17, F: “The program improved greatly my independent learning – I did not know this beforehand. I learned that I can learn by myself, since the teacher-mentor gave us much material to learn alone.”

F. Interview with Student 15, M

Interviewer: In your opinion, what is the uniqueness of the Research Physics Program?

Student 15, M: “The school and the atmosphere of the program are completely different things. In the school if you do not understand the material then they immediately explain to you and here they give you the opportunity to tackle it yourself, this gives you more self-confidence that you can also learn alone, when you do not understand the first time they give you time and then you see that you can still succeed.”

Interviewer: What challenges did you have in the inquiry work?

Student 15, M: “When we researched the topic of bubbles in liquid we needed to use optics there. Optics is a topic that we never learned about in the school and it was a bit hard for me to understand it. I am a person of logic and it was very hard for me to understand the stages that we need to do to reach an outcome. It took me time to digest the material. This is a topic that I had never encountered at all, not in terms of formulas and not in terms of theory, nothing.”

Interviewer: How did you cope with this?

Student 15, M: “I would ask the teacher-mentor to explain to us the material that we did not succeed in understanding, after we sat to learn much at home ... the teacher-mentor always would help us, always was on top of things, and never was there a moment that we felt that he does not know something. When we reached new materials, the teacher-mentor would send us articles to read, so that instead of reading things in a scattered manner he would explain to us in a simpler manner that was suited to our learning level. In the end the teacher-mentor always would interest us with materials to advance us.”

Interviewer: Do you understand the theoretical material relevant to your inquiry? Do you feel you have mastered the material?

Student 15, M: “I have not mastered it one hundred percent since this is not material I have learned fully and comprehensively. But regarding what we did for the most part I have mastered relatively well.”

Interviewer: Did you improve the ability to learn by yourself? If so, describe

Student 15, M: “Yes, it is clear. Many times I and student 14 (M) needed to learn by ourselves. The teacher-mentor would explain to us about the material in general. In the first time it is very difficult to absorb it, so I and student 14, M always would sit in front of the computer and search for explanations to learn this ourselves.”

Interviewer: What did you learn about yourself following the inquiry work?

Student 15, M: “That I can open myself to new ideas, to new material, to learn also something that is not familiar to me, to broaden also to other topics.”

Interviewer: What did the program contribute to you?

Student 15, M: “This caused me to know more to learn independently, to understand things that I do not understand far more rapidly and far more in-depth. In the school you always learn something according to the book or your teacher, and not in other forms, such as learning from the Internet and different sources. Even if only when they talk with you, you need to analyze what they tell you and understand it.”

G. Interview with Student 32, F

Interviewer: What should be kept in the program?

Student 32, F: “I think that the self-learning. Independent learning is something that it is hard to get along with in the beginning but I think that this is very important also to try to understand by yourself the material.”

Interviewer: What did the program contribute to you?

Student 32, F: “... In terms of the theoretical material, this enriched my knowledge greatly since I learned topics that I will not learn in the school. In terms of the level of theoretical material that increased in me, I reached a high level of the understanding of the material more than what would be if I had learned in the school.”

H. Interview with Student 10, F

Interviewer: What challenges did you have in the inquiry work and how did you cope with them?

Student 10, F: “I think that the difficult part was to understand truly the theory, since most of the material was in English and there were also many new topics for me, some of them from the field of chemistry so it took a little time to understand. I and Diana sat on this a lot together and we helped one another, and also the teacher-mentor would answer us about the questions we did not understand by ourselves.”

Interviewer: How did you learn the theoretical material relevant to your inquiry?

Student 10, F: “The teacher-mentor gave us a list of concepts that you need to sit and learn at home through the Internet. We needed to sit on this a lot, so this way we learned alone these topics, I and my partner in the project read a lot, each one alone, and we summarized in our words, and then we told one another what we are thinking, until we felt that we understand, and what we did not know we asked Haim, he would answer in the meetings or through Internet conversations about the questions that we did not understand on our own, until we understood in essence the theory.”

Interviewer: Did you improve the ability to learn by yourself? If so, describe

Student 10, F: “I think that me specifically no, since I was already a little accustomed to this, but I believe that in general the program does strengthen the self-learning.”

Interviewer: Do you understand the theoretical material relevant to your inquiry? Do you feel you have mastered the material?

Student 10, F: “I know all that leads to the theory, but of course there are many materials that we did not touch on them yet, but from what we did learn I know well. In other words, I still have not mastered, since there are many new concepts that I need to learn but what we have reached until now I do understand.”

Interviewer: Tell me about any moment during the work in which you felt a sense of satisfaction or enjoyment.

Student 10, F: “... I was terribly enthusiastic by the experiments that we did at first after we understood the theory, that in essence we verified the theory since we learned many things theoretically but when we see this then it is more understood.”

I. Interview with Student 23, M

Interviewer: In your opinion, what is the uniqueness of the research physics program?

Student 23, M: “In my opinion this is completely different. In the school you receive the information from the teacher, there are formulas and most of the questions are based on

formulas. There is thinking but less thinking than the research work ... In the Weizmann Institute the learning is independent and the search for the information are the students'. There is a teacher-mentor but the student needs to do the most and to plan his learning."

Interviewer: Do you understand the theoretical material relevant to your inquiry? Do you feel that you have mastered the material?

Student 23, M: "I have rather mastered the theoretical material. The phenomenon is related to one main topic, which is the Magnus effect. I know the topic from beforehand and this is not difficult to understand. In general, the material is understood, known to us, and we read also at home about the topic."

Interviewer: Did you improve the ability to learn by yourself? If so, describe

Student 23, M: "In my opinion, independent learning was not a problem, since I think that I had the ability earlier and also we did not have difficulties with theory, but I think that this is strengthening since it was necessary to have much independent learning in the inquiry work and mainly the ability developed to think alone how to organize the theoretical material."

4.2.6 Students' Citations from the Interviews – The Students' Perception of the Aspect: Teamwork with the Partner in the Inquiry Project

The following section presents students' citations from the Interviews (performed after the submission of the intermediate report at the end of the eleventh grade) that illustrate the aspects presented in the research in the subchapter 4.2.3.2

A. Interview with Student 13, M

Interviewer: Tell me about the teamwork between you and your partner in the inquiry project.

Student 13, M: "First of all, I know him (student 9, M) really well and he knows me really well, we are from the seventh grade, and the program caused the relationship to grow stronger. I think that this really helps the teamwork, and we work well together."

Interviewer: Was there a division of roles between you? If so, describe.

Student 13, M: "In the stage of explorations, in the initial stages there was no clear division, we simply did this together and each one did what he thought was right to do. The meaningful issue of the division came in the stage after we decided about the inquiry

question, each one knew to do the part in which he is better, and we succeeded each one to bring himself I think in the best possible way. In other words, generally student 9 took upon himself the part of the performance of the experiment, built the system, and changed the masses and other variables, and filmed the experiments. Of course I helped him with measurements, but I was more in the part of the analysis of the findings, I would download the films and work with Tracker, and also he helped me finish the work on the data. In the part of the theory, I was very enthusiastic with the issue of doing modeling on the computer, and he less wanted this. The idea of modeling was mine, the idea of formulas and equations was his, then we said that we will attempt both of them. He will attempt to find something with the equations and forces, and I will attempt to write a software program of the simulation. In the end, he was stuck in the equations and we both shifted to do this issue (the modeling), but the programming was more my issue, in other words, I took more command on this issue, since he less connected to the model”.

Interviewer: In your opinion, what is preferable to perform inquiry work in a pair or alone? Why?

Student 13, M: “In research physics it is preferable to work in pairs, if learning for a test, or solving exercises, according to my opinion, this is less comfortable in pairs, but because this is work that requires splitting up, to work also with the computational modeling, both to film and to operate the system, so this is good that there is two. Each one can bring what he is better in, to help when the other one is having difficulties, and also you have somebody to ask, somebody to ask advice from. Since this is not an exercise, this is a bit above the exercise.”

Interviewer: What did you learn about yourself from the work in the team with the partner?

Student 13, M: “First of all, I learned about myself that I can work in a team, teamwork is good, but still there are disadvantages of this, in other words to compromise on things, and not to do only what I think is correct, that there is another side, then to see that I can deal with this. I learned that I can accept and give criticism, that I do something and he thinks it is not right, then he can be free and to tell me exactly what he thinks and I will not be insulted or something like this. Our relationship became very open, in other words, I can come and critique or give a good comment, and this is as if very natural and comfortable.”

B. Interview with Student 208, M

Interviewer: Tell me about the teamwork between you and your partner in the inquiry project.

Student 8, M: “I and student 7, F, we worked closely together. We did not have too many differences of opinion, after every meeting we shared the work between us at home and then we learned from one another. We helped one another in the understanding of the theoretical material and in the understanding of the conclusions from the experiment. We rather accepted this, we were a good team. Each one took upon himself a role according to his strength. I think that I brought much of my abilities, such as laboratory in a computer and knowledge in software programs. Aside from this, I invested much time, I tried to give all that I could so that we would succeed and it would be a quality research. But in general we worked equally and we tried together to understand things.”

Interviewer: What is preferable, to perform inquiry works in a pair or separately? Why?

Student 8, M: “I like in works generally to work alone, since I rely on myself. But when we began in the work of the project I understood that it is preferable in a pair, since each one fertilizes the other, each one has another perspective and then you do not miss a new idea or a new direction. The synchronization of minds is a good thing.”

Interviewer: What did you learn about yourself from the teamwork?

Student 8, M: “I learned that I do not totally rely on others. I always went over the work of the partner. I learned that I cannot control everything and I need to learn to be freer and to depend on my partner.”

C. Interview with Student 23, M

Interviewer: Tell me about your teamwork with your partner?

Student 23, M: “My partner in the project is one of my good friends, we know each other from the seventh grade and this is not the first work we do together, but this inquiry work strengthened the relationship between us. We know one another and what our expectations of one another are. We know to be considerate and this is important.”

Interviewer: Was there a division of roles between you. If so, describe.

Student 23, M: “For the most part, the work together in the sessions, we learned together since we had a lot to document the work, to film, and to collect data and this necessitates

teamwork together. Only in the last stage in the writing did each one write and then we combined the contents.”

Interviewer: What is preferable to perform inquiry work in a pair or alone? Why?

Student 23, M: “In a pair, when each one did not understand something, we explained to one another, we divided the work between us, and this made it easier on both of us. In addition, we learned from one another the way of thinking, how to research, what to research, in other words, we proposed ideas especially when we got stuck and we needed to think about another way.”

Interviewer: Tell me what you learned about yourself in the teamwork with your partner?

Student 23, M: “Improvement of the relationship with people, in other words, to pay attention to the needs of others, listening to one another, compromise. When there was disagreement sometimes, we did both, we tried the two possibilities or one person gave in.”

D. Interview with Student 33, M

Interviewer: Tell me about your teamwork with your partner.

Student 33, M: “The partner in my inquiry work, is also my friend in reality, regardless of the work in the Weizmann Institute, we always divide the roles clearly, set hours – and learn. I did not have a problem with him in terms of the work, sometimes I did not agree with him and we got along using a conversation, speaking, understanding that there is no room for nerves and lack of agreement and research truly demands to speak with the partner and together to reach decisions and sometimes also to compromise, like in every system of relations.”

Interviewer: Did you have a division of roles between you? If so, describe.

Student 33, M: “Yes, although I am 70% blind and lack coordination in my hands, then I did things that I can do and he did what he could do and I did not. For example, in Excel I was responsible, he was responsible in Tracker. We shared in the writing of the experiment reports – there are things he would write since he was good in it, and there are things that he had difficulties and I would write, such as drawing conclusions, analysis, and so on. In the end, we always would listen to one another and correct until the result is good ... each one contributed equally, although I have things that I do not see, and there are things that student 7 (M) is not good in them, we are just people and each one has a flaw and somebody that he is less good, then we cover up for one another for the flaws of the other.”

Interviewer: What is preferable to perform the inquiry work, in a pair or alone? Why?

Student 33, M: “In a pair, since alone you do not cope with all the difficulties that can disrupt your progress. That you in the pair have two minds that work, that think perhaps a little differently, and in the end from both minds you extract the juice that will give you the best result and the best learning.”

Interviewer: What did you learn about yourself from the teamwork?

Student 33, M: “I learned that I know to deal with people in a group, or in any system of relationships. In other words, to understand the interaction with people, to understand that you are in a team and you need to speak and to compromise, together, and that the teamwork is something very important that it is impossible to ignore.”

Interviewer: What did you learn in social terms from the program?

Student 33, M: “I understood that all the issue of teamwork is important.”

Interviewer: When I tell you ‘inquiry’ what is the first thing that comes to your mind?

Student 33, M: “It is impossible without teamwork.”

E. Interview with Student 17, F

Interviewer: Tell me about the teamwork between you and your partner in the inquiry project.

Student 17, F: “We supported one another, when he came frustration, for example, from the teacher-mentor, or he did not understand him or did not understand where he is going to, then I gave him motivation that we must get from this meeting and to use the time for a project and the opposite.”

Interviewer: What was the division of roles between you?

Student 17, F: “All that was related to the technical side on the computer student 29 (M) did, to find the frequency on Audacity, graphs. I did all the measurements, writing reports. In writing the work we shared, each one did an experiment or a certain part, and then we went over the writing of each one and we fixed together.”

Interviewer: Is it preferable to work with a partner or alone? Why?

Student 17, F: “It is preferable with a partner, since we are different people and each one has different strengths, and then the partner does things in what he is strong. This is not that I did not do them, I even learned from it, but this is more comfortable, contributes, and makes the work easier.”

Interviewer: What did you learn about the teamwork with the partner?

Student 17, F: “That I am very very tolerant and that I have the power to support and give motivation. I do not give up to my partner, to continue to research.”

F. Interview with Student 10, F

Interviewer: Tell me about the teamwork between you and your partner in the inquiry project.

Student 10, F: “There was really good teamwork, I and student 11 (F) got along excellently. We sat together a lot also after the meetings, through the computer or at the home of one of us, and we worked together a lot on the inquiry journal. When we learned the theory then we helped one another a lot. We prepared an organized page with all sorts of links to websites so that each one of us can see what the other wrote, and this was terribly comfortable.”

Interviewer: Was there a division of roles between you? If so, please describe.

Student 10, F: “Yes, there was a division of roles. I think that the division of the roles was equal. Each time that we needed to write the inquiry journals or the reports that we need to submit at the end of the year, we divided the topics between us, for example – I will write the description of the experiment and she will write the conclusions. And in the end, each one of us read everything together and corrected for the other one if necessary.”

Interviewer: In your opinion, what is preferable, to perform inquiry work in a pair or alone? Why?

Student 10, F: “The truth is that at the beginning of the year I thought that it is better alone but now I understood that it is preferable as a partner, since truly there is more support, it is possible to speak about things so that we can do brainstorming. We think together what to do and this is not only my opinion, there is another opinion, and this opens different directions of thought, and this really helps. Aside from this, it is nice that always there is somebody to speak to and laugh with.

Interviewer: And why did you think at first that it is preferable alone?

Student 10, F: “Since, say that last year in the stage of preparation in most of the group works that I did I took most of the work on me, perhaps this way there is teamwork in the laboratory but in the school less – I did most of the work. But this year in the large project work – with a regular partner, this is truly was equal and equal in all the areas.

Interviewer: What did you learn from the teamwork on yourself?

Student 10, F: “I think that I learned about myself that I can work in a team since like I said last year it less worked out and I liked to work alone, and this year the teamwork was more prominent. I did not come with many expectations in terms of the teamwork and in essence it was very nice and good, since truly I could rely on my partner to do good work.”

Towards the end of the interview:

Interviewer: What did you learn in social terms from the program?

Student 10, F: “This is very nice to work in a group, this was a little new for me, the company is very nice. Especially in inquiry works it is even very essential – because of what I said before, that this increases the effectiveness of the work, each one contributes to the inquiry work, it is very difficult to do everything alone. In addition, each one offers new ideas, different directions that should be researched, thinks about different ways to solve problems that we had, and this advances our inquiry and makes it better.”

G. Interview with Student 15, M

Interviewer: Tell me about the teamwork between you and your partner in the inquiry. Did you divide the roles between you?

Student 15, M: “Everything we would do almost together ... in the Institute, we would sit together, as a group all three together with the teacher-mentor, and then when we would return home we would work, I and student 14(M), in front of the computer. This was mainly the work. Then this was really a group effort. It wasn't that they sit in different sides of the room and they do something different, this was less 'you do' and more group thinking ... also when we need to go over some material we would learn together and also when one person did not understand then the other would explain to him.”

Interviewer: What is preferable, to prepare inquiry work in pairs or alone? Why?

Student 15, M: “I think in a pair. Since you work with a partner, then you have the desire more to succeed. Since if you work alone and you did not understand something then perhaps I would give up. When you have a partner, then you have somebody who can explain to you and also you do not have the desire to give up since you understand that you are in this and also another person depends on you, and you can help one another and always works out in the end since you are carrying the same weight.”

Interviewer: What did you learn about yourself from the teamwork with the partner?

Student 15, M: “I learned that I can cooperate well in a team, I learned that I can get along very well with another person, in that we express each one his idea and do not negate the opinion of the other person. They come to the best solution in communication. Many times I was very stubborn and assertive in my opinions and I learned more to accept opinions from around me. In order to advance it is necessary to find the best way. And I learned to be more patient and attentive.”

Interviewer: What did you learn in social terms from the program?

Student 15, M: “In the social field I learned to work in a group, about cooperation in a team, in an inquiry group, to be more open to other ideas.”

H. Interview with Student 32, F

Interviewer: Tell me about the teamwork between you and your partner in the inquiry project?

Student 32, F: “The interaction between us was very good, we are friends already for many years ... we tried to do the most together but there was a division. It was clear to each one what he does but most of the things we did together rather than alone.”

Interviewer: What is preferable, to perform the inquiry work in pairs alone? Why?

Student 32, F: “In pairs, each one has his direction of thinking and especially in this work that you need to think a lot, and to think beyond what we were accustomed to, since I think that this is simply another head to think. First of all, to do something like this is very difficult, especially if this is not something you are expert in, and also like I said earlier this is another direction for thinking since this is not something you are fixated on, this is something that you need to be creative.”

Interviewer: What did you learn about yourself from the teamwork with the partner?

Student 32, F: “It appears to me that I learned that I more can rely on others in the teamwork, since once it was very hard for me to rely on others in the teamwork but I think that this improved.”

Towards the end of the interview:

Interviewer: What did you learn in social terms from the program?

Student 32, F: “In the social aspect this greatly contributed to know how to manage in teamwork, truly everything we did was in the teamwork, that this is something that greatly helped in the issue of knowing to work in teamwork.”

Interviewer: When you said that this contribute to the management in the teamwork, how did this contribute to you, for example?

Student 32, F: “I am a person who finds it difficult to rely on others in teamwork and in the program in essence the level of reliance on people increased.”

I. Interview with Student 14, M

Interviewer: Tell me about the teamwork between you and your partner in the inquiry project. Did you divide roles between you?

Student 14, M: “I and my partner are very good friends from the elementary school. The relationship between us was very close before the research. There is no doubt that the relationship grew closer following the research. Regarding the division of the roles, everything we did together also in the sessions, also at home, also independent learning, we always learned together. We did not do a division of roles really since everything was done together.”

Interviewer: What is preferable, to perform the inquiry work in pairs alone? Why?

Student 14, M: “Definitely in pairs. It is fun, experiential together, some laugh out of seriousness. We enrich one another. Together, we complement one another in the investigation and especially in the understanding of the theoretical material.”

Interviewer: What did you learn about yourself from the teamwork with the partner?

Student 14, M: “In essence I learned that in the togetherness there is power, and together we do not despair and do not give up. That this becomes complicated then it is worth it to sit together and to ask the right questions and to search together for the answers. One encourages the other.”

J. Interview with Student 9, M

Interviewer: Tell me about teamwork between you and your partner in the inquiry project.

Student 9, M: “The work flowed rather well, I and student 13 (M) were friends before this, so on the level of the team we worked together really well and we were a great team.”

Interviewer: Was there a division of roles between you? If so, describe.

Student 9, M: “The division of the roles between us comes towards the middle of the project.

Student 13 (M) emphasized the programming and choice of simulation that simulates the phenomenon. And I in the beginning addressed the solving of the equations in mathematical terms that belong to the phenomenon. After we reached the understanding that we do not

have the high mathematical knowledge of the phenomenon, I helped student 13 (M) and I took upon myself the experiment itself and the improvement of our systems. Student 13 (M) made a simulation and I worked on the system itself. But everyone knew about everything and was involved in everything. The teamwork was good and this led us forward.”

Interviewer: What did you learn about yourself from the teamwork with the partner?

Student 9, M: “I learned about myself that in teamwork each one takes a role in his field and leads it and this is his responsibility then the work is divided and a very good product is created.”

4.2.7 Students' Citations from the Interviews – The Students' Perception of the Aspect: Teamwork with the Peers in the Broader Group in the Inquiry Project

The following section presents students' citations from the Interviews (performed after the submission of the intermediate report at the end of the eleventh grade) that illustrate the aspects presented in the research in the subchapter 4.2.3.4

A. Interview with Student 13, M

Interviewer: Was there the evaluation of peers in the broader group? Tell how this was in actuality. What do you think about this instrument?

Student 23, M: “The evaluation of the peer assessments was towards the end of the research, this was a very important stage. This enabled us to focus ourselves, they gave us recommendations what it is possible further to do with the research next year, how to continue to develop, and also people gave us comments to improve the presentation. In addition, evaluation gave us considerable satisfaction since we received much praise and also security in our work. We had many doubts about the work, we always doubted in the work, perhaps the work was not good enough, since we did not have as much theoretical material like others. However, the moment we presented the work and obtained praise on what we did, we understood that we reached something good. We understood that our work truly is equal and the peer assessment helped us believe in the work more. This was a moment of satisfaction.”

Interviewer: How is your relationship with the participants in the broader group in general? Did the relationships you formed in the creation of the inquiry work help / were you helped by one another?

Student 23, M: “Some of the participants are from my school and they are my friends and I know them all and the relationship is good. With students who are not from the school I less had a relationship. Perhaps in the tenth grade there was the integration of students for research studies then I created a little relationship. We were helped by one another only with the students who are in the school, only with my friends. Especially in the presentation of the research. Each one sent the presentation to one another so that we will learn from one another and we will give comments for improvement. This was successful.”

B. Interview with Student 17, F

Interviewer: Was there peer assessment in the broader group? Tell how it was in actuality. What do you think about this instrument?

Student 17, F: “Peer assessment was good, although we received a little harsh criticism on the part of the teacher-mentors. But we understood that this was for our good. From the assessment of the peers, students, and teacher-mentors, we understood that we need more accuracy in our measurements and to do more measurements in order to obtain better conclusions. We understood how it is necessary to write the work. We understood that we need to master the theory more, and they also gave us suggestions how to give depth to our research and what we are lacking. But I am satisfied with my presentation, we both lacked confidence in what we did, and the peers gave us good feedback on how we presented. In addition, this was very nice and interesting to see what other people did and to hear periodically about another inquiry and this exposed us to other things.

Interviewer: How is your relationship with the participants in the broader group in general? Did the relationships you create in the inquiry work help you / were you helped by one another?

Student 17, F: “I did not really create social relationships with the students of other schools, since each one is very busy with his research, so that there was no time to create a social relationship or to give help to others. Even if I wanted to help, I couldn’t, since they engaged in a different field of research, and I have no idea about it. We strengthened more the relationships with students who are found with me in the school, especially with student 7 (M) and student 33 (M). They helped us in the understanding of the concepts since we were in the same topic. We did not help others since they did not ask help from us and also we could not really help since each one engaged in a different field of inquiry.

C. Interview with Student 8, M

Interviewer: Was there peer assessment in the broader group? Tell how this was in actuality. What did you think about this instrument?

Student 8, M: “Yes, there was peer assessment towards the end of the year, in the presentation of the work to Zeev, the academic counselor, the rest of the teacher-mentors, and the students. This was a moment of great satisfaction in the presentation of the work before people because of the positive assessment that we received to our activity. I think that this is one of the moments that I felt satisfaction and enjoyment. Especially since Zeev was enthusiastic and said that we did good work and really was interested in the research. To interest such a person, who engages in the field many years, this seems that our research is more of quality and better and gives us confidence.”

D. Interview with Student 33, M

Interviewer: How is your relationship with the participants in the broader group in general? Did the relationships you created in the inquiry work help you / were you helped by one another?

Student 33, M: “We did not undergo any cohesion, and this in my opinion is something that it is necessary to recommend to them to do next year. But if somebody turned to me for a question or help, that this happened infrequently, so I had fun helping, but more than this there was some sort of mutual help.”

Interviewer: Was there peer assessment in the broader group? Tell me how this was in actuality. What do you think about this instrument?

Student 33, M: “There was peer assessment but again according to my opinion it was little and there should be more. Since in the peer assessment you receive criticism “at your level” from your friends and also from the teacher-mentors who want your good. Therefore, you are not afraid to receive criticism as it is, without be insulted or something, and this helps you focus and improve your work.”

E. Interview with Student 13, M

Interviewer: How is your relationship with the participants in the broader group in general? Did the relationships you created in the inquiry work help you / were you helped by one another?

Student 13, M: “There are a few people who I knew before the group, but most I saw them for the first time and all were wonderful people and it was fun to be with them in the group. We often asked help from others, and we helped others, in other words, there is some peer learning in the group, I think that this is very important and contributes, that I learn from others and others from me, and the general experience was very fun, people are very nice, very fun.”

F. Interview with Student 9, M

Interviewer: How is your relationship with the participants in the broader group in general? Did the relationships you created in the inquiry work help / were you helped by one another?

Student 9, M: “I connected with a number of students from there. There was a relaxed and good learning atmosphere, we helped one another, for example, if somebody lacked equipment then we offered a hand ... the work with other teams was unique, this does not exist in the school, the mutual assistance, this was nice.”

4.2.8 Students' Citations from the Interviews – The Students' Perception of the Aspect: Identifying with the World of the Scientific Researcher

The following section presents students' citations from the Interviews (performed after the submission of the intermediate report at the end of the eleventh grade) that illustrate the aspects presented in the research in the subchapter 4.2.4.2

A. Interview with Student 13, M

Interviewer: Was it a good decision to come to the program or do you have regrets?

Student 13, M: “It was one of the best decisions that I have made to join the program, since first of all without any connection to get another five units for the high school matriculation, I really enjoy, this is really fun, and I learned a lot. I see myself in the future as an academic, so this is a really good station, since the level of the inquiry is high. All the things how to do an experiment, and in what ways I can inquire, how to write a summative work, how I speak with my lecturers, as preparation for a researched in academia.”

Interviewer: What in your opinion is the uniqueness of the Research Physics Program?

Student 13, M: “First of all, it is clear that the laboratory of the school was very ‘light’. Here we do things on a far higher level than in the school. The experiments are more complicated, both in their planning and in the accuracy of the measurement and number of

repetitions of every experiment, the equipment is more sophisticated, you have a teacher-mentor who accompanies you, and they give you the time to research things ...”

Interviewer: Are you satisfied with the product? What do you think about your performances in the program?

Student 13, M: “Bottom line, I am very satisfied with it, since also in general the results were very good, and I also am very satisfied with our way, I think that we worked very correctly ... The stage of explorations was very necessary and very correct in our phenomenon. I think that this was not for no reason that it took us time, this was very meaningful and very critical for the continuation, from the experiment and the graphs that we produced, we used many software programs, many aids (Excel, PASKO, Tracker, also Glowscript of the programming software, and we also made a three dimensional graph in Matlab) so I am very satisfied with our use of things. From the general experience that was, in other words, there was a very fun atmosphere I, student 9 (M), along with the teacher-mentor, greatly enjoyed. Yes, there are things to improve, but I think that in general the project is made well.

Interviewer: What did you learn from the program about yourself?

Student 13, M: “I learned to cope with such a level of research and to do things that it did not work out for me to do if I were not in the program – in other words all the inquiry itself. I learned that I can also take upon myself challenging projects ... and ability to cope with criteria at a high level of difficulty, in other words to perform an experiment on a satisfactory level, to process the data on a higher level than the school. This is not the same level that we learn in the laboratory in the school, and there is no more room to experience this. In this framework, I had an option to be exposed to a higher level of performance of experiments and inquiry. This also let me see whether I can work on a higher level also in the future. And I think that I indeed succeeded.”

B. Interview with Student 14, M

Interviewer: Are you satisfied with the program?

Student 14, M: “Yes, I am satisfied with all the inquiry skills we learned and engaged in them throughout the entire program. This will help us after the period of the high school for the academic studies. There is no doubt, this reinforced my desire to learn physics in the future and perhaps also to engage in research.”

Interviewer: Tell me what you learned from the program.

Student 14, M: “Aside from the content that I learned, from the theoretical material. The program helped me in terms of the understanding of the process of the inquiry work and gave me important skills to deal with this in the future. I believe that I will have it far easier and with fewer fears to approach a research work in the academic studies.”

C. Interview with Student 8, M

Interviewer: In your opinion, what is the uniqueness of the research physics program?

Student 8, M: “Here we are engaging in practice, learning physics through our hands, experiencing more meaningfully. In the school it is to learn by rote, to remember things, and here you discover things by yourself and it is far more meaningful. Here the inquiry is an important and meaningful process.”

Interviewer: You said that the inquiry was an important and meaningful process. Can you explain why?

Student 8, M: “Yes. I learned how to research, how in general to be a researcher, I understood the inquiry process. I never had such an in-depth and serious research. To research along only with instruction, this is something that I never experienced. I improved my abilities in the field of sciences in general and in physics in particular. I discovered new things, I learned a new field and also experienced it. I waited for Monday to engage in pure physics.”

Interviewer: With what are you satisfied in the program?

Student 8, M: “... In addition, I am satisfied with the entire inquiry process, they give you the possibility of researching, of experiencing physics in a different view, in the form of research and not to engage only in theory such as in the school. This is unique, this opens the mind. The research gives you many tools also in the field of research and also to cope with situations you did not expect. The program gave me many new tools for learning in the future.”

Interviewer: What tools?

Student 8, M: “For example, the planning of the experiment. This is something that in general I did not engage in when in the school. This is really new for me. And after two three experiments that we did, we began to understand and to improve in this skill. The time of planning was shortened. In addition, also the issue of the collection of the data, how the data are collected, how data are processed and through them we need to build systems

and write results and conclusions. Again I engaged with this and I learned how to perform a correct inquiry like an expert. In addition to learn how to work in teamwork.”

Interviewer: What did you learn from the program about yourself?

Student 8, M: “The program convinced me that the research is something interesting and I like engaging in it and I will want in the future to engage in it. Not necessarily investigation in physics but also physics.”

D. Interview with Student 10, F

Interviewer: What in your opinion is the uniqueness of the research physics program?

Student 10, F: “That there is much freedom to work in a laboratory, this is very different, there is much equipment that can be used, I think this is mainly the freedom at work and not to go according to the book, I think that there is truly more room for independent thinking, this is not similar to anything that I knew of beforehand, in it there is much independent thinking and I need to come with an open mind to learn also new things.”

Interviewer: Are you satisfied with the product? What do you think about your performances in the program?

Student 10, F: “Yes, also from our conclusions and results, since for me this truly was material that I did not know at all and this was very interesting. We did many experiments and we engaged a lot with the system and we tried always to advance also if sometimes this did not lead us to any place, this is a part of the inquiry and I am satisfied with this.”

Interviewer: What did you learn from the program?

Student 10, F: “First of all, I learned what is inquiry in general, how the inquiry goes, from the start to the end, how to begin to research things, how the process, the form of thinking of the inquiry, work in a laboratory, all sorts of tools and software programs that it is possible to research with, simulations, etc. Last how to present this before other people, how to phrase things in the written work. This even gave me motivation in the future to be a researcher. I think that without this it is impossible to do anything since nevertheless everything begins from some inquiry. So I think that this is really basic, important, and interesting.”

E. Interview with Student 9, M

Interviewer: Are you satisfied with the product? What do you think about your performances in the program?

Student 9, M: “I think that yes, I am aware that we have a place for improvement in the final product ... but nevertheless I am rather satisfied with the process that I have experienced from the start of the year, to research a phenomenon in-depth, to understand the different factors that act in the phenomenon and what their influence is, to learn alone the theory, to build software program and an experiment system for the inquiry question ... all this is really meaningful regardless of the results.”

Interviewer: What did you learn from the program?

Student 9, M: “I learned inquiry skills. In the program they let us carry out a rather serious research, and this I never did. In the school in the laboratory this is five minutes of work and home. Here we sat for hours when we were planning the experiment, we measure and need to give explanations about the results and the phenomenon and it is necessary to find creative solutions. And in general in the theoretical part the search for academic articles on the topic, reading articles in English, this was interesting.”

F. Interview with Student 33, M

Interviewer: What did the program contribute to you? What did you learn from the program?

Student 33, M: “I studied at Bar Ilan, I learned in the Open University, I learned in many places, there is no program that taught me more although the “quantity of the knowledge” that passed to me was relatively small. When I was in the Open University or in the school they taught me to solve exercises and here in the research physics program they tell me come, research, come understand, come learn, and try to learn something that you still have not encountered, come think otherwise ... and this greatly contributed in terms of tools, in terms of research, the program gives truly tools for life, this is one of the main things that there is here beyond learning about waves.”

Interviewer: What tools?

Student 33, M: “To research, to take risks, to be interested, to not give up, also if there are difficulties it is necessary to know also to cope with them. To understand that you are in a team, and truly I received from the program many things in terms of the learning materials, to learn things that are beyond to the high school. Specifically, what we are doing is different in purpose from every other program and truly I terribly enjoy and I feel that this influences me on my natural life, to look at things differently and how to research them.”

Interviewer: How can this influence life?

Student 33, M: “To understand the issue of the team, the interaction with people, to understand the issue of to research, how a research works, what you do in a research, if I want to go in a scientific direction, this is one of the things that can push me to there ... I think this opened for me the thought to engage in research in the future, not in the field of physics, I think about research in economics.”

Interviewer: What in your opinion is the uniqueness of the research physics program?

Student 33, M: “Research physics teaches you about research, this is one of the things that you encounter. Much cognitive effort, which is not effort solving regular exercises but cognitive effort of let’s think differently, let’s live differently, let’s understand differently, the program develops in you the creativity. Truly this is the difference, they do not look at you in the form of “come let’s solve an exercise in the matriculation examination” but “come let’s truly research”, you do not know what you research and you do not know what your result is.”

Interviewer: Are you satisfied with the product? What do you think about your performances in the program?

Student 33, M: “Truly we did a serious and in-depth research, a research with results, a creative research, we built, we did, we learned, and I think that this was truly a meaningful year. The end work truly was a moment of satisfaction. The summative work turned out really good, in terms of graphs, in terms of content ... that you look at the content and at all the experiments that we performed, and all the things that we did – you truly say, we did something meaningful this year.”

Interviewer: What did you learn from the program about yourself?

Student 33, M: “From a personal perspective, I understood how this research works and this influenced my future life when I will want to do a research. I was opened to a new world, simply the Weizmann Institute taught me things that are not in the everyday or in the school, the Weizmann Institute is truly a good program, I would not have given up one second from what there was. This is new knowledge, this is a new reality, and it is impossible to give up on this in my opinion.”

G. Interview with Student 12, F

Interviewer: In your opinion, what is the uniqueness of the research physics program?

Student 12, F: “In the school they do laboratories, but I knew what I need to perform and I knew what to expect and I needed to prove the theory we learned in the class. Here in the program it is different, the experiments are more complicated and there is no telling what the results will be and I needed to discover them from what we researched.”

Interviewer: Are you satisfied with the product? What do you think about your performances in the program?

Student 12, F: “I am satisfied, with the project itself, I think that it is on a very high level, both in terms of the understanding of the theory and in terms of the activity in the laboratory (building the system, isolating the variables). I also am very satisfied with the computational modeling since I learned new instrument, which caused me to develop the thinking and gave many findings and conclusions to my inquiry. In general, I obtained tools with which I can research many more other things in the future.”

Interviewer: What do you intend in the future?

Student 12, F: “Following my experience here in the program I will know to perform an investigation independently in all its stages, and I will need this in the future, in academic studies or perhaps I will engage in research.”

H. Interview with Student 32, F

Interviewer: What did you learn from the program?

Student 32, F: “First of all, it advanced me and got me to know in essence sides of inquiry that I did not have anything before ...”

Interviewer: What do you mean, sides of inquiry?

Student 32, F: “How to approach at all the inquiry, how to begin to do all the stages, from what this is built in general.”

Interviewer: What in your opinion is the uniqueness of the research physics program?

Student 32, F: “The entire thing of the inquiry, you supposedly have a laboratory in the school, but this is not the same thing, not the same equipment, access to the equipment, truly the entire issue of the inquiry is completely different from in the school, since here in essence you cope alone, you truly research something that they have not necessarily researched. In the school you know ahead of time what is necessary to do.”

Interviewer: Did the program give you the motivation to learn physics in the future or to learn research, to engage in inquiry in the future?

Student 32, F: “I think that yes this was something not routine from my perspective, and this is something interesting and intriguing.”

I. Interview with Student 15, M

Interviewer: In your opinion, what is the uniqueness of the research physics program?

Student 15, M: “That this has a very personal touch, the way of work, the way of learning, the instruction, that there are instructors and laboratory technicians and everyone is around the idea of the sciences and attempt to help you to succeed. Also, never in the school did we do experiments in physics for real. Always they would show the class from a distance. So also the personal experience is important since until you do not come and do yourself you do not understand until the end.”

Interviewer: Did the program give you the motivation to learn physics in the future, or to learn research, to engage in inquiry in the future?

Student 15, M: “The motivation increased since in the program they show you that aside from physics that you learn in the school there are many topics that you can reach and topics that are more or less interesting than the school, but show you the variety of possibilities that exist.”

J. Interview with Student 23, M

Interviewer: Are you satisfied with the product? What do you think about your performances in the program?

Student 23, M: “I am satisfied with what we reached, I did not think that we would succeed, that I would be capable of doing inquiry on a high level and that I will be satisfied. In general, the year was interesting, challenging, really an experience of research. I would do this again. I would not give up on this.”

Interviewer: What did you learn from the program?

Student 23, M: “From myself – I said that I learn to do research and all that this includes – in the beginning to find something to research, to search for and to discover different aspects that can be researched, to decide what direction we want, to focus on the inquiry question, to perform measurements and use Tracker, to process data and until to present the research – writing a research and preparing a presentation. I really am satisfied with what came out for us, from the presentation of the research. Mainly the ability to think alone, to raise ideas alone developed.”

4.3 Students' Citations – Description of Satisfaction with the Instruction of the Teacher-Mentor in the Research Physics Program

4.3.1 Students' Citations - Stage 2 – Intermediate Stage of the Inquiry Project (11th Grade) – Students' Satisfaction with the Teacher-Mentor's Instruction

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 4.3.1.2 (Qualitative Analysis – The Students' Degree of Satisfaction with the Teacher-Mentor's Instruction in the Intermediate Stage), from the students' responses (N=34) in from the Summative Questionnaire (see appendix number 1.4) to the questions: "Note two-three strengths of the program that it is important to keep, if you are not satisfied with teacher-mentor's instruction please describe what bothered you."

Students' Citations - Satisfaction of the Students with the Teacher-Mentor's Instruction in the Intermediate Stage (11th Grade)

1. Satisfaction with giving a certain free space in the choice of the direction of investigation and in the way of the investigation, which enables the students to learn and to research independently, to take responsibility for their inquiry work, and to initiate progress in the investigation. For example from the quotes, "My teacher-mentor, on the one hand gave independence and a free space of action to investigate and to learn independently and on the other hand he gave support and direction, and this allowed me to develop the ability to initiate investigation and to be more responsible for the progress of the project" (student 10, F). It is possible to see the importance of the students to preserve in the program the cultivation of their independence and initiative on the part of the teacher-mentors during the inquiry work in their responses to the question: "Note two-three strengths of the program that it is important to keep." For instance, "Encouragement of the students to initiative and independence and giving free space in the direction of the investigation and performance of the investigation" (student 11, F), "To keep the independent work of students that the teacher-mentors enable" (student 24, M), "To keep independence in the inquiry for the students" (student 08, M), "To keep the free work method" (student 16).

2. Satisfaction with the availability and responsiveness of the teacher-mentors to questions, giving feedback on their work, which enables building the knowledge. For example from the quotes, “The support of all the teacher-mentors to help the students, also in the explanations on the material and also in the method of the teacher-mentors how to build the knowledge and how to research” (student 31, F), “Teacher-mentors and instructors who are approachable and supportive, are available for our questions, and give us feedback on our work, which advances us in the work and in the understanding of the phenomenon” (student 19, F), “The setting of a teacher-mentor for every group who will help where it is needed, for question that we cannot solve alone” (student 14, M), “The responsiveness of the teacher-mentors to our questions and the desire to help with the difficulties we encounter” (student 27, F).
3. Satisfaction with the professional accompaniment of all the instruction staff that includes other teacher-mentors (not only the personal teacher-mentors), academic counselors, and laboratory technicians. The students seek to preserve in the program the support they received from the entire instructional staff of the program. For example from the quotes, “Work with teachers with extensive knowledge who help greatly at work” (student 12, F), “To keep in the program the entire process of inquiry undertaken very professionally with the accompaniment of the teacher-mentors, laboratory technicians, and supervisors” (student 1, M), “The team of laboratory assistants quickly helped. A great team who was happy to help beyond the personal teacher-mentor” (student 20, M), “The ability of the teacher-mentors and laboratory technicians to help and assist” (student 13, M), “Accessibility of all the teachers and laboratory technicians in the institute to help in the project” (student 14, M).
4. Satisfaction with the activity preparing for inquiry in the first year (in the tenth grade) prepared by the teacher-mentors so that the students would acquire inquiry practices and would receive tools for the continuation of the inquiry work in the program. For example, “Giving the possibility for the performance of a mini-project in the tenth grade to acquire tools and inquiry skills and to prepare us for the great inquiry project” (student 7, M).

Lack of Satisfaction of the Students with the Teacher-Mentor's Instruction in the Intermediate Stage (11th Grade)

1. The lack of satisfaction with the direction of the teacher-mentors in the learning and investigation despite the students' awareness of the importance in the independent learning as an inseparable part of the inquiry process. Students showed awareness of the importance of independent learning and investigation in the performance of the inquiry, but along with this they sought to give more direction on the part of the teacher-mentors in the learning and focus of the theoretical material relevant to the inquiry and in the building of the knowledge and understanding on the researched phenomenon (such as giving more information sources relevant to their inquiry, giving a preliminary explanation of the concepts, principles and ways of analysis of complicated data).

For example from the quotes, "Independent learning and inquiry – I think that this is something that is very important and needs to be preserved but it is necessary to give more direction for the students so that they will understand what is relevant to the inquiry and how to understand more the material" (student 32, F), "The learning of the theory independently, despite its importance, was not simple, we needed to read articles and summaries with complicated words, then if it is possible to do for every certain topic a preface or explanation of some of the concepts, it can save a lot of time so that we can approach the practical stage of the inquiry performance" (student 17, F), "It is desired that the teacher-mentor will give more sources of theory related to a phenomenon that we research, so that we can understand better the phenomenon from other angles" (student 8, M), "That the instructor will give more direction in the analysis of the mistakes and will teach how to calculate standard deviation in a more in-depth manner" (student 6, M).

2. Lack of satisfaction with the little freedom of action and thought for the student in the inquiry process. For example, a quote from one of the students, "It is necessary to give more freedom of thought also if the student says something mistaken, to let him act in his way" (student 6, M).

3. Lack of satisfaction with the teacher-mentor's lack of knowledge and required skills in order to promote the inquiry work. For example from the quotes, "The teacher-mentor also did not show adequate knowledge to help us advance in the inquiry. Half of the overall time of the inquiry was wasted for us since there wasn't somebody who can help and direct (especially when talking about a new topic for us and we do not have preliminary knowledge). This situation shows the importance of the teacher-mentors' expertise in the inquiry instruction with the students. Therefore, it is necessary to suit the teacher-mentor to the student and the project topic, if there is a need to change the teacher-mentor. Indeed, afterwards they changed our teacher-mentor and from this moment our inquiry advanced" (student 32, F).
4. Lack of satisfaction with the teacher-mentor's commitment to come in an orderly manner to the meetings of the program and to give them support in the inquiry work. For example, a quote from one of the students, "The first teacher-mentor did not come to barely any meetings and did not help us during the inquiry" (student 32, F).

4.3.2 Students' Citations - Stage 3 – Final Stage of the Inquiry Project (12th Grade) – Students' Citations – Students' Satisfaction with the Teacher-Mentor's Instruction

The following section presents students' citations that illustrate the aspects presented in the research in the Chapter 4.3.2.2 (Qualitative Analysis – Description of the Students' Degree of Satisfaction with the Teacher-Mentor's Instruction in the Final Stage), from the students' responses (N=34) in from the Summative Questionnaire (see appendix number 1.4) to the questions: "Note two-three strengths of the program that it is important to keep, if you are not satisfied with teacher-mentor's instruction please describe what bothered you."

Students' Citations - The Students' Satisfaction with the Teacher-Mentor's Instruction in the Final Stage (12th Grade)

1. Satisfaction with the teacher-mentor's degree of involvement, increase of the freedom of action and independence for the student in the management and leading of the inquiry, alongside giving support and direction as needed. For example from the quotes, "I think that what was most essential in the work was that they gave us the space to work how we want, in many criteria where I noted I was satisfied this

was because the teacher-mentor did not intervene for us in these topics and thus it was most comfortable for us to work. This trust, that we will do what we need to do without his intervention, developed with time” (student 19, F), “This year the teacher-mentors gave us almost complete freedom in our work. This method improved for us the feeling of success following which we worked and researched more than eleventh grade” (student 26, M), “A teacher-mentor who will be close to you who also gives you the space to do what you want and also gives help when I need it” (student 14, M), “The teacher-mentor gave you independence in the inquiry process, but in certain cases that we did not succeed in understanding and drawing conclusions, the teacher-mentor directed us more” (student 17, F).

The students seek to keep in the program the close instruction that they had throughout the work on the project and the manner of style of instruction described above. For example: “To keep the independent manner of learning in combination with help and support from the teacher-mentors” (student 18, F). “The freedom of action given to the students alongside the close teacher-mentor for every group” (student 8, M), “To preserve the independence of the students with the support and accompaniment of the teacher-mentor” (student 9, M).

2. Satisfaction with the teacher-mentors’ experience and considerable knowledge both in the content of the researched topic and in making the content accessible and in the guidance of the inquiry in general. For example from the quotes, “The teacher-mentors have experience and considerable knowledge and they help the students greatly in the discovery of new topics and mediation of the material for the students” (student 34, F), “The integration of talented teacher-mentors with considerable knowledge about the topic that we are researching and also know how to instruct us” (student 5, M).
3. Satisfaction with the cooperation and mutual coordination between the teacher-mentor and the student for the requirements and the expectations. For example from the quotes, “As the year advanced, we understood the teacher-mentor’s requirements and we attempted to work according to them and he attempted to meet our expectations” (student 34, F), “The teacher-mentor let us lead more and took out desires into account and we more adjusted ourselves to him, therefore the

- cooperation and quality of work increased” (student 6, M), “We learned how to work together with the teacher-mentor and how to find time for meetings, to get to know him, and to adjust us to him and the opposite” (student 31, F).
4. Satisfaction with providing a personal reference and display of empathy to the students and full commitment and focus of the teacher-mentors on their project. For example from the quotes, “Every group had one or two teacher-mentors and this greatly helped the performance of the work, since in this way we received a personal attitude from the teacher-mentor. He focused on our project and displayed commitment towards us, he really cared that we would succeed and therefore this should be retained” (student 31, F), “It is necessary to keep in the program the principle of action of two students and a close teacher-mentor, and outside teacher-mentors who go around between the projects, since this enables obtaining personal reference, support, and direction as needed” (student 1, M).
 5. Satisfaction with the openness and trust created between the teacher-mentors and the students enable the students to feel comfortable asking for support both in the advancement of the inquiry and in moral terms. For example from the quotes, “Openness between the management and the students, I did not feel any distance or fear speaking with Zeev or David about the problems in the project” (student 6, M). It is possible to see this also in the students’ answers in the question “Give a tip / lesson that you learned to a student who is beginning in this program”. For example, “It is necessary to share any fear or problem with those who are responsible in the project, they help effectively and directly” (student 6 M), “It is necessary to talk about the difficulties you have with the teacher-mentor. He is not there only to teach you material but to encourage and support you” (student 26, M).
 6. Satisfaction with receiving basic instruments for the performance of the inquiry project from the teacher-mentors in preparation activities. For example from the quotes, “The experiments and experiences that the teacher-mentors gave us in the tenth grade should be kept in the program since we used them in the continuation of our inquiry” (student 3, M), “Giving initial and basic tools for the performance of the research (preliminary researches, experience in inquiry, computational modeling course, etc.) so that we can do them independently” (student 7, M).

Students' Citations - Students' Lack of Satisfaction with the Teacher-Mentor's Instruction in the Final Stage (12th Grade)

1. Lack of satisfaction with the excessive involvement of the teacher-mentor in the choice of the inquiry directions and ways of investigation and not giving a sufficient space of action for the students. For example, “In the first year the teacher-mentor attempted to push us to places that we were not ready for and wanted us to research in his way, this created great pressure and disconnect between us. In the second year he changed the approach, he let us more lead the investigation and more freedom of action and we got along well” (student 6, M). The students proposed that it is necessary to coordinate expectations between the teacher-mentor and the student on the teacher-mentor's degree of involvement and the student's degree of freedom of action in the project work and to find the balance: on the one hand, to increase the student's space of action in the project work and on the other hand, to give direction and support. For example, “To coordinate expectations between the teacher-mentor and the students, what is the degree of freedom of action that is given to the student in the work on the project and how much will the teacher-mentor be involved” (student 10, F), “It is necessary to increase the maneuvering space in the project for the student and to give direction and support when necessary” (student 1, M).
2. The lack of satisfaction with giving too considerable responsibility and independence to the student in the learning and investigation of the phenomenon. In contrast to the previous aspect, some of the students seek to receive more help and direction from the teacher-mentors. For example, a quote from one of the students, “When we ask questions related to the conclusions, the teacher-mentor would tell say that we are supposed to research this by ourselves and to understand, many times the teacher-mentor “threw” on us the responsibility for the advancement of the project instead of giving more help and direction” (student 17, F).
3. Lack of satisfaction with the lack of response or the late response of the teacher-mentor to the questions or feedback on their work. Some of the students maintain that their instructor did not answer their questions in time and give feedback at a stage that is too late of the work if at all. For example from the quotes, “Writing the

- summative work – we did not receive comments from the teacher-mentor on the work until one day before the preparation exam. Also the lack of responsiveness to our questions. This caused difficulty and great load” (student 23, M). “The previous teacher-mentor neglected the cooperation with us, did not send comments on the work, and sent contents at the last moment that are not relevant to the researched topic” (student 2, M).
4. Lack of satisfaction with the teacher-mentor’s expertise in the researched topic. For example from the quotes, “The teacher-mentor was not expert in the material and did not answer us about the questions” (student 20, M). “My teacher-mentor of last year greatly delayed our experiment, he did not know in-depth the topic and how to direct, to advance in the inquiry, while this year we have a teacher-mentor with knowledge how knew to help us a lot” (student 34, F). “There were times that the teacher-mentors also did not know how it is possible to solve the question” (student 31, M).
 5. Lack of satisfaction with the teacher-mentor’s explanations about the researched phenomenon. For example from the quotes, “I feel that I experience considerable difficulty in the past two years that derived from the teacher-mentor’s lack of ability to understand frequently, I would not understand what he explained to us” (student 17, F).
 6. Lack of satisfaction with the instruction that is not focused and the teacher-mentor’s dispersion from topic to topic and in investigation directions and does not suit the students’ expectations. For example from the quotes, “Sometimes the teacher-mentor did not meet our expectations, he was a little dispersed and not focused, what wastes for us a lot of time” (student 28, M), “... Many times the teacher-mentor rather confused than focused us on certain things – for example, he tells us to research different phenomena when we have not finished one phenomenon and would jump from topic to topic...Regarding the lack of focus of the teacher-mentor, we simply understood that there is a need that we bring him back each time to the initial topic or the initial question that we asked and to attempt to coordinate between us expectations about the conduct of the project” (student 17, F).

7. Lack of satisfaction with the lack of complete commitment and focus of the teacher-mentor on the students' work and lack of personal treatment and caring from the teacher-mentor. For example from the quotes, "Lack of commitment and focus on our project, because of the lack of desire to invest in the instruction of our project and the instructor's lack of giving help although he said he would help" (student 23, M), "The teacher-mentor would go on 'vacations' at the height of the pressure of the preparation of the work and would not answer questions and would not show that he cares" (student 30, M). This difficulty arose also in the responses to the question of "Note two-three aspects of the program that should be changed and explain." Students asked that the teacher-mentors give more caring and reference to the students and express more commitment to the instruction and teamwork in their project and recommend classification in the acceptance of the teacher-mentors to the program and follow-up after the teacher-mentors' performance. For example, "Giving greater reference on the teacher-mentors' part to the students" (student 23, M), "The feeling of commitment of the teacher-mentors – to be more committed to the work" (student 20, M).

In addition, the students suggested that there be entrance classification of inquiry teacher-mentors for the instruction in the program and it is necessary to accept teacher-mentors with caring and patience to the students who perform inquiry, since they assume that the teacher-mentors who have these traits will bring the students to better inquiry work. "To add and to accept only teacher-mentors who care about the inquiry work and the students' way of learning is found at the top of their priorities and not their personal success" (student 2, M), "The lack of selection of the teacher-mentors – it is possible to see a direct relationship between the level of the works and the teacher-mentor's involvement in the work, when the teacher-mentor was more involved, more patient and caring, the work was better" (student 20, M), "There is a need to examine all the teacher-mentors who come and help the students. I have friends whose teacher-mentor barely came and was not at all a help for them" (student 34, F).

8. Lack of satisfaction from the criticism that is deterring to a certain extent of the academic counselors, when they wander around the research teams, which for example, according to the students', gives a sense of that they are being examined more than being provided help. For example from the quotes, "That fewer people who are not the teacher-mentors will wander among the classes, this feels as if all the time they are examining you" (student 6, M). "When one of the teachers/counselors would come and give comments on the conduct, this did not always seem that they are truly attempting to help and to find a solution but more like criticism" (student 17, F). For this purpose, the students offer to attempt to give equal reference to all the groups and to reduce the criticism on the part of the academic counselors. For example, "The direction of an equal attitude towards all the groups, it appeared that in the groups that were trusted there were less 'surprise visits' of the main academic counselor so as to examine progress. Even if the group on the surface gets along it is necessary to check the progress" (student 6, M), "The reduction of the frequency of the criticism of the project by the counselors" (student 1, M).