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Abstract. This paper presents a vision of a team of researchers on solving a problem of engaging future Mathematics teachers into a research activity through implementing person-centred approach to learning and teaching. The authors of the given article present a designed Learner-Centered Syllabus of a training research workshop in Mathematical Analysis for Master students, majoring in Mathematics at teacher training universities. This study presents the structure, the components and the content of a Learner-Centered Syllabus. When giving content to the sections of the syllabus, the developers take into consideration the conditions for person-centredness; creating the atmosphere of acceptance and congruence; shaping in students the personal qualities, which contribute to their research activity; arranging collaboration; engaging students into the assessment process. The researchers in the present study identify orientation at self-development as a key concept of the course policy and make each section of the syllabus personal. The following sets of attributes were used to evaluate the designed Learner-Centered Syllabus: Community, Power and Control, Assessment and Evaluation. The experimental study was done over four years, two groups of Master students majoring in Mathematics became its participants. One group was given a conventional Content-Focused Syllabus of a training research workshop in Mathematical Analysis, while the second group received a Learner-Centered Syllabus, designed in accordance with the Person-Centered Approach to Teaching and Learning. The analysis of the findings of this experiment justified the efficiency of creating a learning environment, which is determined by the emotional components, such as Congruence, Acceptance and Empathic understanding. The present paper also shows a positive impact of the syllabus on the degree of students' motivation to choose the training research workshop in Mathematical Analysis.

1. Introduction

One of the main tasks of teacher training is to develop in future teachers a research competency that can be used for further professional and academic growth. Thus, [1] consider a research learning activity to be one of the mechanisms of shaping the research competency in students,

as doing such an activity helps to develop the core skills, corresponding to the stages of scientific research. This idea correlates with the conclusions by [2, 3], who state that these very skills are crucial for a successful academic career and professional development of a teacher.

According to a research by key European organisations-stakeholders, among which are the European Association for Quality Assurance in Higher Education (ENQA), European Students' Union (ESU), European University Association (EUA), European Association of Institutions in Higher Education (EURASHE), success in developing students' scientific activity depends on the choice of the learning strategy. Being currently at the core of the educational process, student-centred learning and teaching make this process more varied and able to meet the increasing expectations from higher education stakeholders, which is emphasized in the Standards and Guidelines for Quality Assurance in the European Higher Education Area. Thus, the issue of engaging future Mathematics teachers into a research activity through person-centered approach is becoming relevant and timely.

1.1. The analysis of the scientific studies

The importance of a research activity for training future teachers. The importance of a scientific research activity of students within the framework of formal and non-formal education has been largely debated in research papers. [4] stated that the students, who are engaged into doing research projects, show better academic results. [5] consider, that students' participation in a research activity contributes to establishing positive relationship between students and a tutor, such students are more orientated at academic career in future. [6] gives evidence that students, who join scientific laboratories at their universities, attend conferences and scientific seminars, have their papers published and have a broader learning experience. [7] state, that in higher education research is "the gold standard" in the context of academic activity.

Conducting a historical review of the key elements in the development of a research and teaching culture within the Department of Retailing and Marketing at the Manchester Metropolitan University, [8] focused on issues of research management, examining and evaluating the contrasting alternative approaches of staff development responsibility. The researchers put emphasis on maintaining synergy between teaching and research activity.

Scientists have also been engaged into searching the ways that help students to identify themselves as "proactive in research". [9] consider the issues of ageing scientific manpower and engaging postgraduate students into research activities in hard science. The current situation in the realm of Mathematics and Physics causes concern, so it is emphasized by the scientists themselves that the research activity of undergraduate students, majoring in Mathematics, not only contributes to their professional development as future teachers, but also ensures their further research activity in Mathematics and continuity of the scientific school.

The experience of introducing person-centred approach to arranging a research activity when teaching Mathematics. Shamai and Kfir [10] in their paper discuss the importance of a research activity in academic teacher's colleges in Israel. Indicating the main obstacles, that impede a research activity at colleges, the authors define the conditions that have a direct impact on the research performance. The researchers focus on developing models for a research activity that are based on introducing person-centred approach to learning and teaching. Puskur [11] also considers that person-centred models of teaching develop mathematical thinking that can satisfy currents and future needs in adapting to a constantly changing environment. According to [12] such an approach to teaching Mathematics leads to developing logical and critical thinking, creativity, ability to work independently, discipline, self-development, confidence; feeling the beauty of Mathematics and unbiased necessity to look forward, into the ever-changing future. [13, 14] show in their studies that lack of a teacher's attention to the personality of a student leads to their inability to understand the research process and absence of an alternative way of thinking, which would be different from the one, demonstrated by the teacher. In this case

there is no informed understanding and the goals of a research activity are not achieved. Thus, the positive experience of the above mentioned researchers confirms the possibility to arrange the research activity of students through the application of person-centred approach to learning and teaching.

The experience of designing student-centred syllabi. The evolution of the concept of a personal-centred learning is reflected in various studies, among which are the papers by [14–18] and others. The researchers justify the relevance of designing student-centred syllabi and state, that compared with a conventional syllabus, it differs not only in content, but also in tone. It is believed, that there is a necessity to shift the focus from "What we have to cover" to "How will the course contribute to students' learning and their intellectual development". Hence, such a syllabus contains almost the same information as the conventional one, but its style and language, used for describing policies, procedures, the content differ greatly. A Syllabus-based Approach to learning and teaching was also of interest for [19], who emphasized on the fact, that a properly designed plan provides students with a road map for engagement and obtaining successful learning experience, creating a more positive learning environment. The researchers point out, that a syllabus which is not student-centred, hampers interaction between a tutor and students, increasing their level of anxiety and decreasing the total efficiency of the learning process. This idea was supported by the conclusions, made by [20], who consider, that the first impression which students have from the course syllabus, after learning it, is rather deep and lasts throughout the course. Therefore, it is critical to make a positive impression before the course starts, at the first stage of communication between a tutor and students.

[21–23] justify the necessity of designing a Learner-Centered Syllabus, which contributes to establishing rapport and improving interaction between a tutor and students, increasing students' motivation and expanding their opportunities. The conclusions, made by the scientists confirm that accompanying a learning activity by a Learner-Centered Syllabus makes students more proactive in the learning process through various interactive events that ensure collaboration, multiple opportunities for formal assessment and ownership of the learning outcomes.

1.2. Selection of an approach to designing a Learner-Centered Syllabus

Designing a syllabus for accountants, [24] chose a holistic approach to learning and assessment of a course in Information Technologies and focused on presenting a system of assessment that facilitates the students' understanding of the academic priorities. Developing and implementing a course in complier design for computer engineering students, [25] promote a pedagogical model known as "learning as a research activity". The researchers improved the course, and the classical pattern of classroom activity was replaced by an active working environment, which resembled that of a group of novice researchers under the supervision of an expert. To engage students into an active research activity, the scientists offered to acquire fundamental concepts through problem-solving, which is closely connected to the construction of scientific knowledge. [26] shared their experience in designing components of a Learner-Centered Syllabus, which has a positive impact on the process of teaching and learning. In order to present the syllabus as a quality product, the scientists recommend to constantly project the "students' voice" on its design and improvement through revisions of the problems that students encounter.

Defining the content of a Learner-Centered Syllabus, the authors of the present article took interest in a study by [27], which shows that expanding the experience and fulfilling the potential has to take place in the environment, which has *Congruence*, that is being genuine, open and transparent; *Acceptance*, which includes respect and unconditioned positive attitude to the learning process; *Empathic understanding*, which means accepting other people's feelings and empathising with them. Undertaking the analysis of the research papers of the aforementioned authors helped the researchers to define the objective of the present study.

The objective of the present study is to design a Learner-Centered Syllabus for a training research workshop in Mathematical Analysis for Master students, majoring in Mathematics at teacher training universities; to evaluate the designed Learner-Centered Syllabus and confirm the efficiency of its introduction in order to engage Master students into the course in Mathematical Analysis.

2. Materials and methods

2.1. The method for designing the Learner-Centered Syllabus

With the help of The Deductive Content Analysis of the resources (Faculty Focus [28], The Chronicle of Higher Education [29], Cult of Pedagogy [30]), that contain guidelines on developing syllabi, the authors of the present research identified the rubrics and the structure of the Learner-Centered Syllabus of the training research workshop in Mathematical Analysis for Master students, majoring in Mathematics at teacher training universities.

Also [31] method, designed to evaluate a learner-centred syllabus, was taken into account. According to this method, the main requirement for the syllabus under development is the presence of three key components: willingness to create a community, allocation of power and control in the community, clearly defined links between the learning performance and its assessment. Detailed description of the method will be presented later in the text of the section.

At the next stage, the content of the Content-Focused Syllabus was analysed and the rubrics of the syllabus were reviewed. The authors of this paper discussed the students' performance results, the description of the tasks and projects, as well as the description of the actions and strategies, used by the teachers to facilitate the learning process and to promote the atmosphere of acceptance, support, respect and positive attitudes.

The general course information. In order to replicate the atmosphere of acceptance and congruence, the information was presented as an invitation.

> Dear attendees of the training research workshop in Mathematical Analysis,
> We are happy to share a new learning experience with you and believe that research potential is inherent in every person. Our course will last for seven weeks during the second term. The meetings will take place twice a week, every Wednesday and Friday 9.45 till 11.00 a.m. in a research laboratory of Mathematics and Learning Methods Department (Room. 6211) or in the lecture hall (Room 6209), 72, Academichna Str., Building 6.
> We believe that we will be able to facilitate your learning, since our tutors are young, tolerant, creative and open. You can approach:
> Oleksii Skachko, DSc, Prof. – the course lecturer;
> Time and place of consultations: Room. 6210, 8.30 a.m. till 3.30 p.m.;
> tel., viber +380509906754, 8.30 a.m. till 6.30 p.m.;
> e-mail: ivin@gmail.com – any time;
> Facebook Messenger – any time;
> skype ivin.79.m 8.30 a.m. till 6.30 p.m.
> Mariia Ivanova, PhD, Assoc. Prof. – Assistant Lecturer;
> Time and place of consultations: Room. 6210, 8.00 a.m. till 3.00 p.m.;
> tel., viber +380736549801, 9.00 a.m. till 6.30 p.m.;
> e-mail: fgmariya@gmail.com – any time.

The course description. Being aware, that a research activity of scientists is closely connected to their interaction with the social environment, in this section the focus is placed on developing personal qualities, necessary for team work. As the research process has a dynamic nature, it must be related to the necessity to solve the problems and deal with the situations constructively. Here is the description of the key components of this section, presented as follows:

The course purpose. Science develops, if people develop! The main purpose of our course is to contribute to better understanding of the nature of the research process by every student. We are willing to teach you how to manage your creative mathematical thinking, to convey own ideas and innovations to the scientific community.
The course objectives. Any scientific activity is done by people, with their subjective personal qualities and way of thinking that is why the objective of our course is to develop the following skills:
- establishing interpersonal connections, working with like-minded people and opponents;
- responsible attitude to own learning and joint responsibility for team work;
- solving research problems and dealing with the scientific situations constructively;
- mathematical, logical and creative thinking, that can provide a feasible algorithm for obtaining scientific knowledge in Mathematics;
- productive thinking, urged by non-conventional and novel nature of scientific knowledge;
- doing independent analysis of the factual material, its critical comprehension.
The course outcomes. As a result of taking the course, you will be able:
- to collaborate with tutors and group-mates in student and scientific communities, to maintain a dialogue and a scientific discussion; to take the lead and group responsibility;
- to plan and manage own efforts in the research process;
- to obtain new knowledge, to do critical analysis, synthesis and evaluation of the new concepts; to search, process and analyse information from various sources;
- to understand such research methods as analysis, synthesis, analysis through synthesis, classifying, generalizing, systematizing information, etc.
We believe that every student can be successful in the course, so we consider these objectives and outcomes to be feasible. At the same time we will be happy to hear about your expectations in order to define the factual plan and the content of the course. Looking forward to getting your proposals: 72, Academichna Str., Building 6, Room 6210, 8.00 a.m. till 3.00 p.m. daily.

The course plan. In this section you can find a list of past proposals, concerning topics for research projects, a preliminary course structure and learning modes. Students can define what is interesting and meaningful for them. The key element of this approach is not only to give the attendees an opportunity to choose, but also to give them responsibility for their own choice. [27] state, that students must have a choice – to get prepared for the course in advance, or to join it with a clear head, which opens up new learning opportunities. To get prepared for the course, this section of the syllabus recommends scientific papers by [32–34], which present the summarized concepts of the approximation theory of periodic functions.

In this section the attendees learn about an opportunity to choose a computer lab in the cloud. We recommend (but not limit the choice) the system CoCalc (https://cocalc.com) and encourage the students to present the results of calculations in a natural mathematical language, using the systems LaTex (https://cocalc.com/doc/latex-editor.html). Students can create own accounts in CoCalc. Since this environment supports web technology of cloud computing (SaaS), it is necessary to install any browser on your computer. For a convenient group work, a subscription is recommended ($ 14+ per month). It can provide more resources for storage and calculations, increase quotas for one project, which is used by several accounts.

Course plan. We want to give your understanding about the prospective content and scope of the course. Our course is related to the approximation theory of functions of a real variable of trigonometric polynomials, which are built on the basis of the repeated summation of the partial sums of the Fourier series. The choice of this section is determined by its wide usage in practice. We believe that it is necessary to learn about three works, dedicated to different directions of the approximation theory by repeated arithmetic mean of Fourier sums:
1. Qian, T. (2006). Analytic Signals and Harmonic Measures, Journal of Mathematical Analysis and Applications, 314(2), 526-536. This research is dedicated to the problems of time-frequency analysis and is of significant interest for studying the specifics of the analytical signals that induce instant amplitude and frequency.
2. Rovenska, O. (2017). Approximation of analytic functions by repeated de la Vallee Poussin sums. Computer Research and Modeling, 11(3), 367–377. The research concerns the issue of approximation of analytical functions by repeated Fourier sums. It also states the conditions, under which the received formulas are asymptotically precise.
3. Novikov, O. and Rovenska, O. (2017). Approximation of periodic analytic functions by Fourier sums. Matematchni Studii, 47(2), 196–201. The work considers asymptotic behavior of precise upper bounds of variations in uniform metric of linear means of Fourier series on classes of analytic periodic functions.
You can get prepared for the course, reading the above mentioned papers or join it, being open to new experience.
During the introductory class we will jointly decide:
- what to study – which direction is the most interesting (a few options can be chosen), how to work on the topics;
- how to study – how to arrange the process of giving lectures, discussions, seminars, types of group and individual work, communication out of classroom (watching films, presentations, etc.);
- what virtual online computer lab will be used in the course;
- how to evaluate – the assessment methods will be chosen (for instance, an exam, a presentation of a group research, oral reports) as well as the approaches to grading (self-assessment, peer assessment, assessment by a tutor, expert opinion, etc.).
Your expectations and proposals are welcome!
The actual course plan will be defined at the introductory class after careful discussion and consideration.

The learning environment. In this section it is important to show not only encouragement, but also a requirement to collaborate throughout the course. A research by [35] states, that if students develop the strategy for the group behavior on their own, they experience negative attitude to the course less frequently. Implementing the component of Empathic understanding takes place through accessibility of the course resources to all the attendees. The recommended resources, such as [36–40] are in open access.

Class participation. Every now and again, all of us need assistance. If you fail to understand the lecture material or are unable to work out the individual task, please approach us or any other member of the group. We would also be grateful if you share the links to the sources of useful information with other group members. We expect you to take responsibility, sharing your knowledge with your peers through discussions or presentations. Since active participation is the best way to acquire knowledge, we encourage you to be proactive in the course!
Resources. There are two basic manuals you may need to work with:
1. Trefethen, L. N. (2012). Approximation Theory and Approximation Practice. Society for Industrial and Applied Mathematics, University City Science Center Philadelphia, PA, USA.
2. DeVore, R. A. and Lorentz, G.G. (1993). Constructive Approximation, Springer Verlag Berlin Heidelberg.
Additional Reading:
1. Miller, S. S. and Mocanu, P. T. (2000). Differential Subordinations: Theory and Applications, Pure and Applied Mathematics, No. 225, Marcel Dekker, New York.
2. Rovenskaya, O. G. and Novikov, O. A. (2020). On approximation of classes of analytic periodic functions by Fejer means. Chebyshevskii Sbornik, 21 (4), 218–226.
3. Keogh, F. R. and Merkes, E. P. (1969). A coefficient inequality for certain classes of analytic functions. Proceedings of the American Mathematical Society, 20, 8–12.
The books are in open access on Google Books (books.google.com), or you can order them from the library in 72, Academichna Str., Building 1, Room 1217.
In addition to the manuals we will use interesting materials from educational online platforms Khan Academy, Coursera, Prometheus, YouTube; listen to scientists-mathematicians, watch films about famous mathematicians. And much more!
Rules and attendance. After designing the course plan jointly, we need to define the rules. We usually ask students to come up with their proposals concerning behavior and then we vote for those rules. We can discuss:
- how to deal with situations when students are late for classes;
- whether it is necessary to get prepared for classes in advance;
- what activities to do in order to compensate for the missed classes;
- whether it is allowed to use mobile gadgets;
- food and drinks in the classroom.

You must attend every class, but if there is a plausible reason to skip it, please inform us about it. According to the policy of our University, if you have to skip a class, you have an opportunity to join the course remotely, on Moodle platform (http://moodle.dgma.donetsk.ua/enrol/index.php?id=708) in a synchronous or an asynchronous mode.

Assessment. [31,41] describe student-centred evaluation, when the focus is shifted from the policy of penalties and losing points, to providing options for scoring the points. Grades are related to the learning performance, not the whole scope of work, planned for the course is assessed. A system of combined assessment allows to allocate responsibility to both tutors and students.

We are in favour of a system of combined assessment (table 1), when the roles of a teacher, a student, a group are allocated evenly and are equally meaningful. Thus, the assessment process consists of:
- self-assessment;
- group assessment of a team research;
- assessment by a teacher.

Table 1. A list of assessment methods.

Assessment methods	Types of tasks for assessment	Grades
1. Study and analysis of literature	Discussions, peer questioning, answers during lectures	20
2a. Group research (discussion, proposals, obtaining results, presentations, conclusions and discussion)	Reports, discussions, quizzes, analytical papers, calculations, written descriptions	45
2b. Personal research project	Essays, interviews, analytical papers and calculations	45
3. Final exam	An essay, combined tests, oral answers	35
Evaluation	Total of 1, 2a/2b, 3	100

Revision/retaking. We know, that one of the mechanisms of developing mathematical knowledge is a researcher's desire to improve the scientific results. So, we encourage students' attempts to improve the results of their oral answers and written papers. After the discussion, we will agree upon the number of attempts and deadlines for submitting papers.

The course policies. Inquisitiveness and involvement into the research activity come top on the list of personal psychological attributes of a scientist. The focus of the course is shifted from the intellectual potential to the sphere of personal and psychological qualities in the sphere of motivation. The section shows the key concept behind the course policy, which is aimed at self-development, but not at assessment.

Creating a friendly environment is a key feature of this course. We are willing to see you develop as a researcher. Our policy is:
1. Supporting each and every course attendee at all the stages of the learning process; decision-making and increasing own responsibility, self-respect.
2. Atmosphere of trust, where inquisitiveness and natural desire to learn is developing.
3. Assistance in achieving meaningful internal results.
Empathy and studying own emotions develop the human abilities, necessary for solving problems in new situations successfully.

The course analysis. One of the elements of the system of internal quality assurance, set forth in the Standards and Recommendations on Quality Assurance in the he Standards and Guidelines for Quality Assurance in the European Higher Education Area [42] is learning expectations, needs and the degree of students' satisfaction by the syllabus, educational resources in place and support from a tutor. Person-centred learning complies with the highest degree of trust between a tutor and a student community, so monitoring and the analysis of expectations and emotional atmosphere must be done at all times. The authors of the present study recommend to give students an opportunity to provide feedback at any time during the course. Surveys in Google Forms, talks, joint out-of-class activities can become an efficient mechanism for providing such feedback.

> We are eager to make the course transparent and hope for your trust. We are changing the learning methods to make this course accessible to anybody. Please, send us your proposals and your feedback about the course to: http://moodle.dgma.donetsk.ua/enrol/index.php?id=708

2.2. The methods for evaluating the Syllabus

The syllabi were evaluated, using the method of [31], designed to evaluate a learner-centred syllabus (Rubric for Determining Degree of Learning-Centredness in Course Syllabus). In this article, the authors propose a means of assessing the degree of student-centeredness in modern teaching methods. The rubric developed for this purpose allows the development of a measure of the degree of student-centeredness present in current teaching practice, and used the results as a tool for professional development planning. It allows to cover the whole spectrum of the attributes, typical for the best student-centred teaching practices. The researchers consider, that a Syllabus, designed in compliance with the Learning-Centred approach, is to showcase three key components: willingness to create a community, allocation of power and control in the community, clearly defined links between the learning performance and its assessment. With this in mind, the evaluation is done, following three sets of criteria: *Community*; *Power and Control*; *Assessment and Evaluation*, which encompass twelve subcategories. A four-point scale from 1 to 4 points, that accords with the increase in the level of student-centredness is applied to assess the Syllabus indicators in each subcategory.

3. Results

3.1. The basis of a study

The training research course in Mathematical Analysis is a part of a series of elective courses and is taught to Master students, majoring in Mathematics in the 1st year of study at Kryvyi Rih State Pedagogical University, Kryvyi Rih, Ukraine; Bohdan Khmelnytsky National University of Cherkasy, Cherkasy, Ukraine; Sumy State Pedagogical University named after A. S. Makarenko, Sumy, Ukraine; Berdyansk State Pedagogical University, Berdyansk, Ukraine; Donbas State Engineering Academy, Kramatorsk, Ukraine.

The research was done during 2015/2016–2019/2020 academic years. In 2015 the Learner-Centered Syllabus was designed and improved. At the end of 2015 that Learner-Centered Syllabus was uploaded to the official web-pages of the Mathematics Departments at the aforementioned universities. The academic staff and Master students were engaged into the discussion, which lasted for 2 months. As a result of the discussion, one more section – the Course Analysis was added to the Syllabus. This section provides an opportunity to give anonymous feedback with the help of a survey in Google Forms.

Starting with 2016, every year in each of the mentioned universities all the Master students were divided into two groups. The 1st group was given a conventional Content-Focused Syllabus of the training research workshop in Mathematical Analysis, the 2nd group was given the Learner-Centered Syllabus, designed in accordance with the Person Centered Approach to Teaching and Learning. 416 students took part in the research (23% male and 77% female students, aged 19 to 32). Out of the total number of the attendees, 29% had at least 3 years of working experience and 14% of the attendees obtained a Master degree in other spheres.

3.2. Evaluating the Content-Focused and the Learner-Centered Syllabi

Evaluating a conventional Content-Focused Syllabus and the Learner-Centered Syllabus by the rubric of [31] was done at the beginning of 2016 by a team of independent experts of the platform "Higher School Mathematics Teacher" [43], who have a DSc degree in education and psychology. The expert communication took place on the platform forum. The results of the evaluation of

the Content-Focused Syllabus and the Learner-Centered Syllabus is presented in tables 2–4 in grey and yellow respectively.

Table 2. Indicators of the Content-Focused Syllabus (in grey) and the Learner-Centered Syllabus, designed in compliance with the Person Centered Approach to Teaching and Learning (in yellow) – Community.

1	2	3	4	5
Accessibility of a tutor	Accessible only at certain time, out of touch, does not communicate out of class	Accessible in working hours in class, provides the working phone number and e-mail	Accessible not only in working hours, provides a personal phone number and e-mail, encourages interaction	Accessible not only in working hours, accessible beyond the working place, provides a working phone number, e-mail, Skype, other contact details; encourages interaction
Justification of learning	Tasks or exercises are given without any justification	Tasks are justified, but not related to the learning outcomes	Tasks are justified and related to the learning outcomes	Tasks, methods, modes of learning, policies are justified and related to the learning outcomes
Collaboration	Collaboration is banned	Collaboration is allowed	Collaboration in groups is encouraged	Collaboration is urged, sharing experience is encouraged

The average score of the category *Community* for the conventional Content Focused Syllabus, used in the control groups, was 1.67 points; categories *Power and Control* – 2 points; categories*Assessment and Evaluation* – 1.8 points. The total average score of the Content Focused Syllabus is R=1.83.

Below are the rates of the Learner-Centered Syllabus, designed in accordance with the Person-Centered Approach to Teaching and Learning, provided to the students in the experimental groups, when they were selecting a course. The average score of the category *Community* was 3.67 points. Here the evaluation of the subcategory *Justifying the learning* process indicates the necessity to complete the information on the links between the course policy and methods with the learning outcomes. The Syllabus content accords the category *Assessment and Evaluation*, which makes 3.8 points. The category *Power and Control* scored at 3.75 points. When designing materials for the subcategory *Student's Role*, the researchers in the present study tried to take into consideration such component as *Emphatic understanding*, which not always corresponds to the possibility to demand from students responsibility for their choice of the course content. The total average score of the Learner-Centered Syllabus is R=3.75. Growth in the rate of the Learner-Centered Syllabus, against the rates of the Content Focused Syllabus is shown in figure 1.

Table 3. Indicators of the Content-Focused Syllabus (in grey) and the Learner-Centered Syllabus, designed in compliance with the Person Centered Approach to Teaching and Learning (in yellow) – Power and Control.

1	2	3	4	5
Teacher's role	No allocations of power Authoritarian rules are written as directions; the policy of penalties is in place. Differentiated approach is not applied	No allocation of power, a teacher is an authority. Partly differentiated approach to learning, some flexibility in policies is in place	Students' power is limited. The choice of the content, scope and deadlines can be offered.	Joint power of a teacher and students. Students' participation in selecting policies, content, process and methods of learning is encouraged
Student's role	Responsibility for learning is on the student	Responsibility for learning is on the students, some extra work is encouraged	Responsibility for presenting extra material in group	Students are responsible for stating problems, discussion and presentation of extra material
External resources	Manuals are a mandatory; no other external resources are required. A teacher is the primary source of knowledge	Links to external resources are provided, but their usage is not encouraged	Work with external resources is encouraged	Presenting external resources to the community is encouraged
Learning focus	Focus on unconditional following the algorithm. Discussing the algorithm is not allowed	Following the algorithm with its partial justification and explanation	The course objectives are explained. Balance between the policy of the algorithm following and justification	Following the algorithm is minimal. Discussing the learning content, the assessment process

3.3. The description of the process of introducing the Learner-Centered Syllabus

The results of evaluating the Learner-Centered Syllabus, concerning the increase in the degree of student-centredness correlate with the positive growth in the rate of the number of attendees in the experimental groups. In 2016/2017 academic years 12 out of 63 students (19.0%) in the control group chose the research workshop. In the experimental group 17 out of 58 students (29.3%) chose the same workshop. In 2017/2018 academic years the total number of students, doing their 1st year of study in Master program was 87 persons, 43 of whom were from the experimental group. The training research workshop was chosen by 10 students (22.7%) in the control groups and 16 students (37.2%) in the experimental groups. In 2018/2019 academic years, having the same number of students in both groups (47 students), the workshop was chosen by 11 students (23.4%) in the control group and 19 students (40.4%) in the experimental

Table 4. Indicators of the Content-Focused Syllabus (in grey) and the Learner-Centered Syllabus, designed in compliance with the Person Centered Approach to Teaching and Learning (in yellow) – Assessment and Evaluation.

1	2	3	4	5
Grades	Focus on losing points and the policy of fines	Grades are not related to the learning outcomes	Grades are directly related to the learning outcomes. Various ways to score points are in place	Grades are directly related to the learning outcomes. Various ways to score points are in place. Not all the activities are graded
Feedback	Only unit tests and final tests are graded. The grades are announced to students, but they are not allowed to see or keep the test papers	Current activities are partly graded. Testing does not mean communicating with a teacher. Students can see, but not keep the test papers	Grades for current activities are meaningful. Communication with a teacher during testing is in place. Some types of activities are not graded.	The assessment mechanism is based on monitoring the learning process and providing feedback
Evaluation	The final grade is obtained through testing	The final grade is obtained through tests and open-ended tests	The final grade is obtained by current grades, obligatory written papers	The final grade is obtained by current work, written papers, oral reports, presentations, self-assessment and peer assessment
Learning outcomes	The learning outcomes are not defined	The course objectives are stated, but the learning outcomes are not defined	The learning outcomes are visually presented	The learning outcomes are presented and related to grades
Rework and elaboration	Rework and elaboration are not allowed	Rework and elaboration are partly allowed	Rework and elaboration are allowed	Rework and elaboration are encouraged

groups. The total number of Master students in the 1st year of study in 2019/2020 academic years was 114 persons. In the control groups of 50 students, the workshop was chosen by 13 students (26.0%), in the experimental groups of 64 students, it was chosen by 27 persons (42.2%). The comparison of the ratios of the number of attendees of the workshop against the total number of students in 2016/2017-2019/2020 academic years is shown in figure 2.

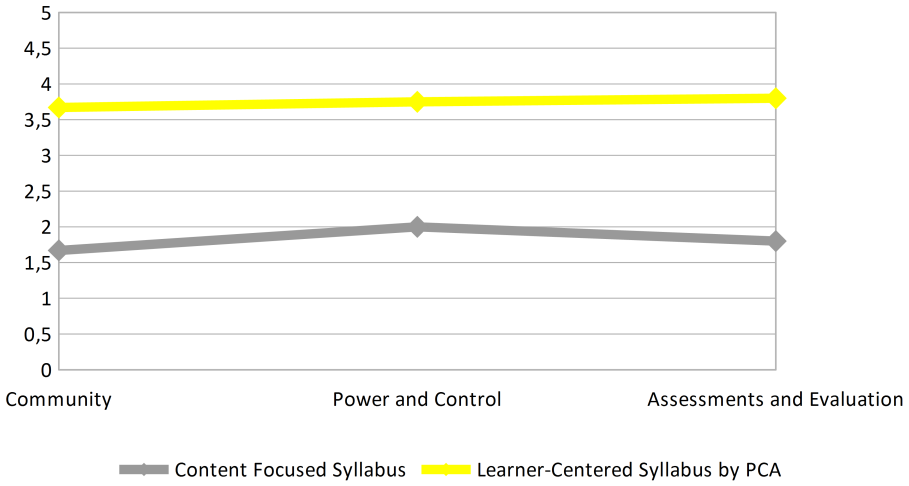

Figure 1. Comparing the rates of the Content Focused Syllabus and the Learner-Centered Syllabus, designed in compliance with the Person-Centered Approach to Teaching and Learning.

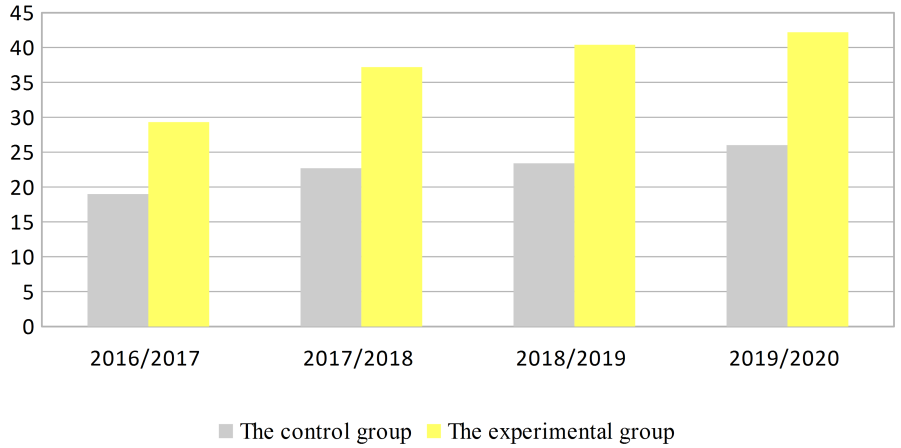

Figure 2. Comparison of the ratios of the number of the course attendees against the total number of students in 2016/2017–2019/2020 academic years.

A high level of rates, concerning student-centredness in the Learner-Centered Syllabus is confirmed by the increasing number of contacts between a tutor and students at the stage of a subject selection. During 2016/2017–2019/2020 academic years in the control groups students did not approach tutors, concerning extra explanation about the content and the nature of the course, that could help them make a choice of a subject. The data, received during a traditional entry survey, conducted before a subject selection are indicative of the fact, that the participants in the control groups, answering the question "Which source of information influenced your choice of the course?" reflects feedbacks from other students as the most important factors (36.4% of the respondents), feedbacks in social media (32.7%) and recommendations from the teachers, whom they know (12.1%). In the experimental groups the students applied for additional counselling when choosing a course from 2 to 9 times per year. The improvement of the collaboration between a tutor and students became a critical factor for increasing motivation in a significant number of attendees to select a course, which is confirmed by the results of the

entry survey of the students in the experimental group. When answering the question "Which source of information influenced your choice of the course?", the participants indicated feedbacks from other students as the most important factors (39% of the respondents), feedbacks in social media (18%), counselling of the course tutors (18%), recommendations from the teachers, whom they know (8%) (figure 3).

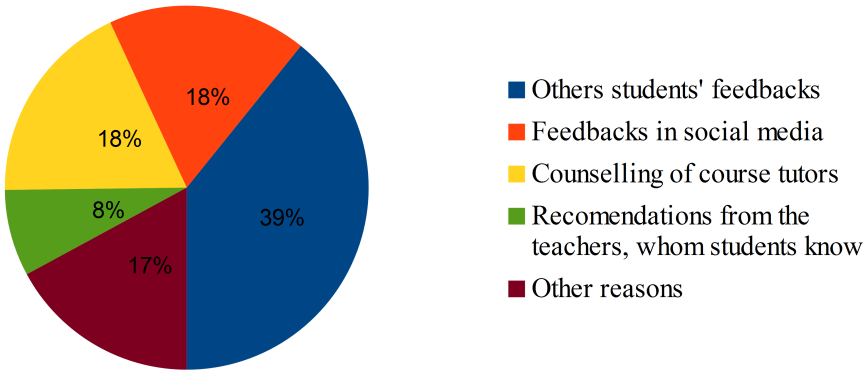

Figure 3. The sources of information that had impact on the students' choice of the course in the experimental groups.

Increasing of the total average score of the Syllabus from R=1.83 (Content Focused Syllabus) to R=3.75 (Learner Centered Syllabus) correlates with the increase in the total number of the course attendees in 2016/2017–2019/2020 academic years from 22.5% to 37.3%. The researchers took into account the fact that in 2017/2018–2019/2020 academic years the feedbacks from the students who had finished the course led to increasing the number of the course attendees, compared to the previous academic year in both, the control and the experimental groups. Due to this, the nature of the correlation between the rates of the Learner Centered Syllabus and the rates of the engagement of students was identified by the nature of the distribution of growth in the number of attendees in experimental groups (Δ_i) by the years of the research (i) (table 5).

Table 5. Distribution of the growth in the number of attendees in experimental groups by the years of the research.

i	2016/2017	2017/2018	2018/2019	2019/2020
Δ_i	10.3%	14.5%	17%	16.2%

The image of the range (figure 4) allows the authors of this study to hypothesise about the even distribution of values Δ_i. Since the distribution of the data presents a small sampling ($n < 15$), using the method of adaptive approximation on the basis of the General Purpose Simulation System (GPSS) $N = 12$ of equiprobably distributed numbers in d–neighborhood ($d = 0.1$) of values Δ_i were generated. The hypothesis about the uniform nature of the distribution on the significance level of $\alpha = 0.05$ was checked with the help of Pearson criterion. The resulting value of $\chi^2 = 8.9$ is not in the critical area $[\chi^2_{cr}; \infty)$, $\chi^2_{cr} = 16.9$, so the hypothesis about the uniform nature of the distribution of the values Δ_i can be accepted. Given that the annual increase in course participants over the last three years of the study was about 14% -17%, and the acceptance of the hypothesis of even distribution, in the future we can expect additional students who use Learner Centered Syllabus at the same level.

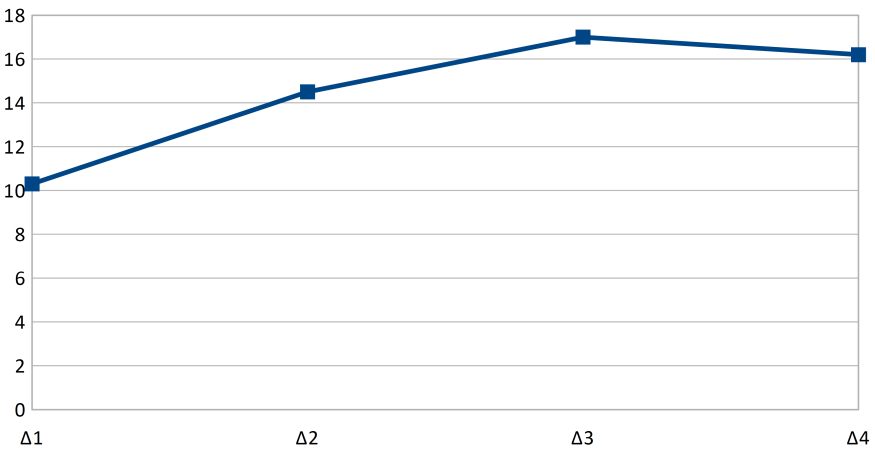

Figure 4. The range of the distribution of values Δ_i.

As the course attendees use information from the Syllabus throughout the term, their further interest in the learning research workshop is linked to the impact of the Learner-Centered Syllabus, designed in accordance with the Personal Centered Approach to Teaching and Learning.

4. Discussion

The issue of engaging students into a research activity has always been of scientific and practical interest for both, researchers and teachers. The most recent studies and work on arranging scientific learning activity of students allowed the authors of the present paper to better understand and comprehend the advantages of introducing a Person Centered Approach to Teaching and Learning. The opinions of [44–47] concerning the importance of applying student-centred methods of learning was taken into account. These methods contribute to developing in students critical scientific thinking, ability to apply analytical strategies.

The study by [19, 48] concerning the methods for developing a research competence in students, confirmed the idea of the authors of the present paper about the necessity to design a Learner-Centered Syllabus. The choice of a syllabus of this type is justified by the factors of the students' engagement into learning [47], as well as by the specifics of a teacher-student relationship when doing research [27]. The syllabus developers forecast engaging students into developing the course content throughout the development process. As [49] state, such an approach to applying the Learner-Centered Syllabus is more positive, as students are more engaged into the process of the course development and perceive their tutors as more creative, caring, responsive, reliable and interested.

Developers of the present syllabus analysed a study by [19, 21, 50] in order to find the sequence of the units and develop content for the training research workshop in Mathematical Analysis within the framework of the Learner-Centered Syllabus. According to [41, 51], careful development of the structure and sequence of components in the Learner-Centered Syllabus facilitates the transition to student-centred teaching. The authors of the present paper make the structure of the Syllabus more detailed, so that it means performing defined roles by students and a tutor, having the learning outcomes, assessment standards and procedures. Following the recommendations from scientists, the authors also gave personalised content to each section of the syllabus. The General Course Information was presented as an invitation. The Course Description was given content, factoring in the dynamic nature of the research process and focus on team work. The content of the Course Plan was discussed by the students. The main idea

behind the Learning Environment was to showcase collaboration in the course. The Assessments section states a combined process of assessing the students' achievements (assessment by a tutor, peer assessment, self-assessment). The Course Policies promote the idea of self-development. The Course Analysis presents the conditions for getting feedback so as to constantly monitor the emotional atmosphere in the course. According to the feedbacks from the students, the most meaningful sections of the syllabus are the ones which promote collaboration between tutors and students. These sections encourage students to select the course.

Within the present study one more important aspect was considered – the syllabus evaluation. According to [52], such evaluation is aimed at studying the nature and content of a syllabus in order to understand better its features and attributes; to define ways in which a syllabus reflects and conveys the goals and objectives of a university. A methodology, developed by [31] was chosen by the developers of the Learner-Centered Syllabus to evaluate the training research workshop in Mathematical Analysis. The average score of the Learner-Centered Syllabus by *Community*, *Power and Control*, *Assessment and Evaluation* criteria exceeds the average score of a conventional Content Focused Syllabus by 1.92. Designing the Learner-Centered Syllabus of the course and spreading positive feedback about the course among the students led to their engagement into a research activity in Mathematical Analysis.

5. Conclusions

The studies into creating syllabi and their impact on the students' motivation added to growing interest in a Learner-Centered Syllabus. The reducing number of Master students, majoring in Mathematics, who choose research courses, made the authors of this paper study the issue of engaging students into a research activity through designing a Learner-Centered Syllabus.

The authors of this article present the Learner-Centered Syllabus of the training research workshop in Mathematical Analysis, which is an elective course for Master students, future Mathematics teachers. The structure, the contents and the mode of presenting the Learner-Centered Syllabus was designed in accordance with the Person-Centered Approach to Teaching and Learning. The aforementioned factors led to creating the learning environment, which is defined by the emotional components of *Congruence*, *Acceptance* and *Empathic understanding*. This syllabus has a positive impact on the degree of engagement of the students into the training research workshop in Mathematical Analysis, which allowed the authors thereof to prepare guidelines for developing Learner-Centered Syllabi of research courses:

– combining friendly tone of the Syllabus and mathematical brevity in presenting the guidelines of the course, determines the first positive impression from it and contributes to spreading this impression among other students;

– giving personalised content to each section of the syllabus together with delegating certain authority to students is an important step to an informed choice of the discipline;

– focus on team work creates conditions for collaboration in the course, reducing negative attitude to it;

– discussing the ways to unite the scientific community leads to developing personal qualities of the future scientists, who are ready to make a contribution into creating their own social environment;

– giving students an opportunity to make a choice when doing research projects with practical content, leads to developing responsibility for their own choice;

– being aimed at self-development of students, the course mobilizes them during the decision-making and makes them more confident;

– introducing the policy of achievement points, giving various options for scoring them in the course without any penalties contributes to breaking the barriers between students and tutors, the latter being perceived as friendly and caring.

The authors of the present study see the prospects for further research in introducing the practice of using Learner-Centered syllabi, designed in accordance with Person-Centered Approach to Teaching and Learning in other mathematical courses of a research nature.

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