

Pedagogic case and specific course in which designed tasks and units are used

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Information for lecturers

<ul style="list-style-type: none"> • unit description a short description of the unit about its subject matter and organisation, the student level, expected prior knowledge, the significant concepts and essential questions addressed, the course and context in which it has been used in HE practice, and the estimated duration. 	<p>The theme of unit is "Multiple regression: construction and model analysis" within the discipline "Econometrics" for students of specialty "Mathematics" using a structured inquiry</p> <p>The level of internal motivation of students - sufficient, due to the applied aspect of the chosen task.</p> <p>In particular, during the survey at the beginning of the class, the students' needs were identified which motivate them to actively engage in the study of the topic: "The general econometric model: construction and analysis"</p> <ul style="list-style-type: none"> - Expansion of knowledge in economics; - Ability to easily and quickly work with large data sets. <p>The experience of guiding the trajectory of their own study at the students is not great. Since students in previous studies tried to conduct research in the selection of factor variables for building an econometric model, however, under the guidance of a teacher.</p> <p>Previous knowledge - Module of the discipline of econometrics "Construction and research of the simplest model"</p>
<ul style="list-style-type: none"> • learning objectives of the unit 	<p>To form students' skills and abilities to construct and investigate the model of multiple regression with structured IBL.</p>
<ul style="list-style-type: none"> • IBME character of the unit what <i>kind of student inquiry</i> is applied (e.g. interactive demonstration, lecturer & student discussion, confirmation inquiry, structured inquiry, guided inquiry, open inquiry, ...) and <i>what inquiry abilities</i> (i.e. engagement, exploration, explanation, elaboration, extension, evaluation; one may refer to an inquiry learning model) are students expected to develop through the unit activities? 	<p>The preparatory phase for the teacher involves the development of a scenario of training, preparation of digital resources, selection of regulatory cards that correspond to the main stages of the model 5E and structured IBL: to engage, to explore, to explain, to elaborate, to evaluate.</p> <p>The training of digital resources involves the placement of training materials in accordance with the developed scenario in the Moodle system. We believe that the theoretical material on the topic should be constructed in such a way that a student who has missed classes will easily master the teaching material, and a student who was in the classroom on the lesson was able to systematize material, test himself for understanding and perception themes using the tests included in the lecture. If students have questions or they have missed classes, students have the opportunity to ask them in the forum to discuss questions on the topic.</p> <p>The practical lesson protocol in Moodle is presented in the form of web pages that contains the following elements: subject, purpose, task, presentation form, timing and evaluation criteria. Educational materials, which are recommended to familiarize students before classes, are</p>

	<p>presented under the protocol of work: this is the methodological recommendations for the implementation of tasks, questions for preparation for practical work, step-by-step algorithms for the tasks, examples of constructing and researching models. In addition, this block contains educational videos.</p> <p>For self-study, students are scheduled to work for independent work, which involves individualized tasks for each student, methodical recommendations for their implementation, and control questions.</p> <p>The preparatory phase for students envisaged to learn theoretical material on the topic: "The general econometric model: construction and analysis" in the Moodle system. In addition, students were invited to recall independently the functions of MS Excel, which find transposed and inverse matrices, the product of matrices.</p>
<ul style="list-style-type: none"> • mathematical content what mathematical concepts and ideas are introduced? 	<ul style="list-style-type: none"> • econometric model taking into account the specifics of specific economic information (the least squares method, the Generalized least squares method); • Evaluating the reliability of the model and its parameters (correlation coefficient calculation and determination, the approximate relative error of approximation, the elasticity coefficient); • Verification of the reliability of the econometric model and its parameters (The Fisher method, Student's method); • Methods of econometric forecasting (point and interval).
<ul style="list-style-type: none"> • technological pedagogical content knowledge what common students' difficulties and alternative conceptions have been identified by mathematics education research and/or lecturers practice in higher education and what role does ICT play in the unit? 	<p>Students had difficulties in identifying variables. Some students identified the resulting variable - total costs, and the other part - the cost of food. It was used during the lesson</p> <p>At the stage of introducing IBL, I tried using the formulated questioning system to bring students to self-realizing the task of constructing and researching a multi-factor model in MS Excel.</p> <p>So, for modelling the model, MS Excel students used three methods:</p> <ol style="list-style-type: none"> 1) by the formula $\hat{A} = (X^T X)^{-1} \cdot X^T Y$. To implement this method students must be able to multiply the matrix, look for a transpose and inverse matrix in MS Excel using mathematical functions/ 2) through the add-on «Analysis ToolPak», the tool "Regression". 3) through the application of the statistical function LINEST. <p>We note that the last two methods of finding parameter estimates, in our opinion, should be used only after familiarizing students with the first method, which demonstrates the step-by-step</p>

application of mathematical apparatus for finding parameter estimates.

We consider that the application of MS Excel at the stages of specification, parameterisation, research on adequacy and statistical significance demonstrates the step-by-step application of the mathematical apparatus to the realization of an economic task with the help of digital technologies.

Training materials of unit in Moodle include: theoretical material and tasks of laboratory work.

We believe that such a methodical approach to the presentation of educational material using digital resources will facilitate the development of students' motivation to study each theme of discipline, implement a systematic approach to learning content and implement IBL. In addition, due to the use of Moodle in the educational process of studying the specified topic, the teacher will be able to organize the individual, group and frontal form of work of students.

- **learning path**, in case the unit consists of subunits or multiple activities
describe way(s) in which subunits and/or student learning activities are connect to each other; a short list of activities and possible arrangement of these activities suffices, and each item consists of activity name, inquiry type, specific inquiry abilities

Engage

Students collaborate on the online mind mapping service:

Write the List of the main phase of the construction and research of the econometric model.

Explore

Exercise. On the example of a specific economic problem, to construct an econometric model of multiple regression, namely: on the basis of the statistical data set in the task to determine the type of statistical dependence between the factor and the resultant variables and to calculate the values of the parameters of the model, check the adequacy and statistical significance of the econometric model of multiple regression.

No	Expenses on food	General expenses	Family composition
1	20	45	2
2	32	75	2
3	48	125	2
4	65	223	2
5	45	92	3
6	64	146	4
7	79	227	4
8	104	358	5
9	68	135	5
10	93	218	5

11	117	331	5
12	145	490	8
13	91	175	8
14	131	205	8
15	167	468	7
16	195	749	8

The questions list of teacher that corresponds to the main trajectory of the group's students' activity in studying the topic:

1. What first step should be in solving this task? Why?

2. Which of these indicators are factor and resultant variables? Why?

Regulatory card "Explain Arguments"

3. What are the peculiarities of the specification for the multifactor model?

Regulatory card "Discuss with another student"

3. How to implement the specification of the model in MS Excel?

4. How to calculate estimates of the coefficients of the linear model of multiple regression?

Regulatory card "Explore yourself"

5. Is it possible to provide economic content of the coefficients \hat{a}_i ? What characteristics are used for the economic interpretation of estimates in a multiple regression model?

Regulatory card "Find a connection"

Regulatory card "Test Various Options"

6. What kind of model will be?

7. What indicators should be calculated for the study of the built model?

Regulatory card "Share Your Ideas"

8. What indicators determine the adequacy of the built model?

Regulatory card "Explore in a Group"

9. What is the check for statistical significance?

10. State the purpose and features of the Fisher and Student criteria

11. What is the difference between using Fischer and Student's criteria?

Regulatory card "Formulate the hypothesis"

Regulatory card "Check special case to confirm or refute the research hypothesis"

Explain

	<p>Explain why the design and research of the model should occur according to a given algorithm. <i>Regulatory card</i> "Make generalization" <i>Regulatory card</i> "Identify main research template"</p> <p>Elaborate Can I use this algorithm to construct a model that describes the dependence on 5 factors? And if the sample of statistics is bigger (less), is it appropriate to use these tools? <i>Regulatory card</i> "Find more examples"</p> <p>Evaluate Conducting an assessment in the form of answers to a question: What did I learn after the lesson? What will I want to know? What questions did you have?</p>
<ul style="list-style-type: none"> • <i>lecturers' experiences in HE classroom practice</i> a short reflection about its use within HE classroom practice (which expectation were met or not, challenges and/or obstacles encountered in the implementation, students' reactions, ...) 	<p>On the basis of structured IBL, students learned to implement the model specification using the trend line, to search for parametric estimates in MS Excel 3 ways, to study the essence and algorithm of the process of verifying the adequacy and statistical significance of the econometric model.</p> <p>What and how could change for a better result? To provoke students to formulate a greater number of questions, this, in my opinion, will lead to the formation of skills for students to manage the process of conducting research.</p> <p>Organization of individual work of students during the specification of the model. In my opinion, individual work at the stage of the specification will target the students to independently look up the algorithm for determining the type of functional dependence for the multifactorial model and conduct analogy with the stage of the specification of the simplest linear model.</p>
<ul style="list-style-type: none"> • aspects of using the unit by <i>students with special needs</i> 	-
<ul style="list-style-type: none"> • <i>assessment</i>, in case one has items or suggests for student assessment related to the unit 	-

<ul style="list-style-type: none"> • <i>learning goals</i> 	<p>Students form skills with:</p> <ul style="list-style-type: none"> • application of the algorithm for the implementation of the process specification and parameterisation of this economic-mathematical model, • performs validation and statistical significance with the use of MS Excel, • formation of questions for the research, • - cooperation
<ul style="list-style-type: none"> • <i>significant concepts and essential questions</i> addressed 	<ul style="list-style-type: none"> • Methods for estimating the parameters of an econometric model taking into account the specifics of specific economic information (the least squares method, the Generalized least squares method); <ul style="list-style-type: none"> • Evaluating the reliability of the model and its parameters (correlation coefficient calculation and determination, the approximate relative error of approximation, the elasticity coefficient); • Verification of the reliability of the econometric model and its parameters (The Fisher method, Student's method); • Methods of econometric forecasting (point and interval).
<ul style="list-style-type: none"> • <i>inquiry types</i> and emphasis on <i>inquiry abilities</i> (if not already discussed in the section Information for lecturers) 	<ul style="list-style-type: none"> • described in the section Information for lecturers
<ul style="list-style-type: none"> • <i>tool use</i> (including mentioning of materials like whiteboard, data projector, real object, ...) and <i>supporting materials</i> (e.g. links to websites or other sources of information) 	<ul style="list-style-type: none"> • computers, MS Excel, https://elearning.kubg.edu.ua/course/view.php?id=20510
<ul style="list-style-type: none"> • <i>time needed</i> for the student activity 	<ul style="list-style-type: none"> • 1 practical work (4 hours)
<ul style="list-style-type: none"> • <i>suggestions for use</i> how to carry out the activity? how to use materials? rer could raise) 	<ul style="list-style-type: none"> • Conduct research under the guidance of a teacher, describe and record data; • Try different ways to solve a problem, solve a problem or answer a question; • Compare your ideas with the ideas of other students.

Worksheet and files

<ul style="list-style-type: none"> • <i>student tasks and worksheets</i> 	
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<ul style="list-style-type: none"> ○ in source format (Word, LaTeX, ...) 	<p>Exercise. On the example of a specific economic problem, to construct an econometric model of multiple regression, namely: on the basis of the statistical data set in the task to determine the type of statistical dependence between the factor and the resultant variables and to calculate the values of the parameters of the model, check the adequacy and statistical significance of the econometric model of multiple regression.</p> <table border="1"> <thead> <tr> <th>No</th> <th>Expenses on food</th> <th>General expenses</th> <th>Family composition</th> </tr> </thead> <tbody> <tr><td>1</td><td>20</td><td>45</td><td>2</td></tr> <tr><td>2</td><td>32</td><td>75</td><td>2</td></tr> <tr><td>3</td><td>48</td><td>125</td><td>2</td></tr> <tr><td>4</td><td>65</td><td>223</td><td>2</td></tr> <tr><td>5</td><td>45</td><td>92</td><td>3</td></tr> <tr><td>6</td><td>64</td><td>146</td><td>4</td></tr> <tr><td>7</td><td>79</td><td>227</td><td>4</td></tr> <tr><td>8</td><td>104</td><td>358</td><td>5</td></tr> <tr><td>9</td><td>68</td><td>135</td><td>5</td></tr> <tr><td>10</td><td>93</td><td>218</td><td>5</td></tr> <tr><td>11</td><td>117</td><td>331</td><td>5</td></tr> <tr><td>12</td><td>145</td><td>490</td><td>8</td></tr> <tr><td>13</td><td>91</td><td>175</td><td>8</td></tr> <tr><td>14</td><td>131</td><td>205</td><td>8</td></tr> <tr><td>15</td><td>167</td><td>468</td><td>7</td></tr> <tr><td>16</td><td>195</td><td>749</td><td>8</td></tr> </tbody> </table>	No	Expenses on food	General expenses	Family composition	1	20	45	2	2	32	75	2	3	48	125	2	4	65	223	2	5	45	92	3	6	64	146	4	7	79	227	4	8	104	358	5	9	68	135	5	10	93	218	5	11	117	331	5	12	145	490	8	13	91	175	8	14	131	205	8	15	167	468	7	16	195	749	8
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<ul style="list-style-type: none"> • supplementary files more detailed notes about the design of the unit and the activities, classroom experiences, related narratives, ... 	<ul style="list-style-type: none"> • - 																																																																				