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The Use of Exploratory Factor Analysis in Secondary Research: the Case of Motivation for Learning the Lithuanian Language by 8th Grade Students

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Abstract. The article deals with the use of exploratory factor analysis in quantitative secondary research. Exploratory factor analysis helps to find a theoretical background in the data of educational research.

The way of proceeding the data in quantitative secondary research can be described as follows: data – exploratory factor analysis – theoretical background of research – interpretation of the data of secondary analysis. The article focuses on the phenomenon of motivation for learning the Lithuanian language by 8th grade students on the basis of the data of national research (2012). Exploratory factor analysis revealed the components of intrinsic motivation for learning the Lithuanian language. The questions *Do you like Lithuanian language lessons; Are you interested in writing assignments at Lithuanian language lessons; Are you gifted in the Lithuanian language; Are you interested in reading texts in Lithuanian lessons* are related with the factor of intrinsic motivation. The variables *You are learning the Lithuanian language because you need to get a well-paid job; You are learning the Lithuanian language because it is important to obtain an interesting job; You are learning the Lithuanian language, because it is important to get entry to a higher school*; *the Lithuanian language is important to learn other subjects* have high factor loadings on another factor, namely extrinsic motivation.

Keywords: *exploratory factor analysis, motivation for learning the Lithuanian language.*

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Introcuction

In educational research, quantitative analysis refers to educational sciences that aim at understanding or predicting behavior or events through the use of mathematical measurements, as well as statistical modeling and research. The aim of quantitative analysis is to represent a given educational reality in terms of numerical value. In order to transmit educational reality into numeric value, it is important to perform the process operationalization. "The process of operationalizing a questionnaire is to take a general purpose or set of purposes and turn these into concrete, researchable fields about which actual data can be gathered" (Cohen, Manion, & Morison, 2007, p. 318). In quantitative educational research, the general purposes of a questionnaire must be clarified and then translated into a specific, concrete aim or a set of aims. The theoretical background is important in the process of operationalization. This theoretical background is important in the process of explanation of quantitative research data. Wilson and McLean (1994, p. 8–9) suggest an approach "which is to identify the research problem, then to clarify the relevant concepts or constructs, then to identify what kinds of measures (if appropriate) or empirical indicators there are of these, i.e. the kinds of data required to give the researcher relevant evidence about the concepts or constructs, e.g. their presence, their intensity, their main features and dimensions" (Cohen, Manion, & Morison, 2007, p. 320).

"Secondary analysis is a practice of analyzing the data that have already been gathered by someone else, often for a distinctly different purpose" (Crossman, 2016). According to Crossman, secondary analysis as a research method, "saves both time and money and avoids unnecessary duplication of research effort". Secondary analysis is usually contrasted with primary analysis, which is an analysis of the data independently collected by a researcher. Scientists who carry out secondary analysis do not know the process of operationalization of the primary research. In the secondary quantitative research, it is important to determine what the theoretical basis of the primary research is.

Examples are the studies in which questionnaires consisting of a lot of questions (variables) are used, and the studies in which mental ability is tested via several subtests, like verbal skills tests, logical reasoning ability tests, etc (Darlington, 2004). It gives the possibility to receive a big amount of data from different areas of educational practice. In the secondary quantitative research, it is important to determine what the theoretical basis of primary research is. It is difficult to establish a theoretical framework of a large qualitative database. "It is not always clear how data were collected, why certain types of data were collected while others were not, or whether any bias was involved in the creation of tools used to collect the data. Polls, questionnaires, and interviews can all be designed to result in pre-determined outcomes" (Crossman, 2016). The exploratory factor analysis can be used for finding out of theoretical background of primary research. factor analysis attempts to bring intercorrelated variables together under more general underlying variables. The goal of factor analysis is to reduce "the dimensionality of the

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original space and to give an interpretation to the new space, spanned by a reduced number of new dimensions which are supposed to underlie the old ones" (Rietveld & Van Hout, 1993, p. 254), or to explain the variance in the observed variables in terms of underlying latent factors" (Habing, 2003, p. 2).

In the national or international (TIMSS, PISSA) research, the field of questionnaire design is vast. Data sets are never fully used and the data re-used for new purposes. The problem of our research is how to adapt exploratory factor analysis in the secondary analysis of the national research.

The aim of the research is to reveal the possibility of exploratory factor analysis of school students' motivation for learning the Lithuanian language on the basis of the national research data.

Methodology

The secondary analysis of schools students' motivation for learning the Lithuanian language was carried out on the basis of the data of the national research (2012) on 8th grade students. The questions about the motivation for learning the Lithuanian language (Table 1) were included into the questionnaire for eighth grade students (Questionnaire about the Lithuanian language for 8th grade students, 2012). The questionnaire contained a group of questions (L1) related to the motivation for learning the Lithuanian language. Exploratory factor analysis (EFL) of questions from group L1 was completed.

EFA allowed to reduce the data about the motivation for learning the Lithuanian language (*You like Lithuanian language lessons L1a; You are gifted for the Lithuanian language L1b; You are interested in reading texts in Lithuanian lessons L1c; You are interested in writing assignments at Lithuanian language lessons L1d; the Lithuanian language is important for learning other subjects L1e; You are learning the Lithuanian language because it is important to obtain entry to a higher school L1f; You are learning the Lithuanian language because it is important to obtain an interesting job L1g; You are learning the Lithuanian language because you need to get a well-paid job L1h*) to a lower number of unobserved variables – factors. A priori assumption was that any indicator might be associated with any factor. All observed variables of questions in group L1 can be associated with the latent variable – different levels of motivation for learning Lithuanian: a motivation, extrinsic motivation, intrinsic motivation (Ryan & Deci, 2002).

The national student achievement tests were selected on the basis of random samples of students. The sampling principle is a nested random sample of a randomly selected class (or school). All school students of randomly selected classes were involved in the national research. 4479 eighth grade students from 160 schools (212 classes) participated in the research.

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Results

EFA was carried out in six steps of factor analysis: reliable measurements, correlation matrix, factor analysis versus principal component analysis, the number of factors to be retained, factor rotation, and use and interpretation of the results. In the application of factor analysis, it was taken into account that variables can be measured at a range level, normally distributed (Field, 2000, p. 444). The skewness (from –1 to +1) and kurtosis (from –1 to +1) of variable from questions group L1 were well within a tolerable range for assuming a normal distribution.

Table 1
Descriptive statistics for the motivation of learning the Lithuanian language of 8th grade students (N = 4479)

Question	No. of items	M (SD)	Skewness	Kurtosis
You like Lithuanian language lessons	L1a	2.55 (0.802)	–.341	–.385
You are gifted for the Lithuanian language	L1b	2.41 (0.723)	–.079	–.328
You are interested in reading texts in Lithuanian lessons	L1c	2.53 (0.790)	–.305	–.384
You are interested in writing assignments in Lithuanian language lessons	L1d	2.29 (0.770)	–.033	–.551
The Lithuanian language is important for learning other subjects	L1e	2.97 (0.722)	–.803	0.940
You are learning the Lithuanian language because it is important to obtain entry to a higher school	L1f	3.05 (0.725)	–.742	.932
You are learning the Lithuanian language because it is important to obtain an interesting job	L1g	2.74 (0.793)	–.304	–.270
You are learning the Lithuanian language because you need to get a well-paid job	L1h	2.88 (0.794)	–.581	.150

Factorability was examined by measures of sampling adequacy. The Kaiser-Meyer-Olkin test (KMO-test) was used for sampling adequacy (KMO-test). The sample is adequate if the value of KMO is greater than 0.5. It was disclosed that KMO = 0.817 for the observed variables of questions in group L1.

Intercorrelation was checked by using Bartlett's test ($\chi^2(28) = 3029.911$, $p < .05$). The data of Bartlett's test showed that factor analysis could be applied.

All elements on the diagonal (MSA – Measure of Sampling Adequacy) of anti-image correlation matrix should be greater than 0.5 if the sample is adequate (Field, 2000, p. 446). All variables are suitable for factor analysis (Table 2).

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After having obtained the correlation matrix, it was decided to use principal component analysis (PCA) for investigating the variables of questions in group L1. The rule of Guttman-Kaiser was used for determining the number of factors. Initial eigenvalues indicated that the first two factors explained 46 % and 19 % of the variance respectively (Table 3). They explain 75 % of the variance. The third and all following factors explain smaller and smaller portions of the variance. Two factors (Table 3) correspond to Guttman-Kaiser rule. It means that two factors are appropriate for the data.

Table 2
Anti-image correlation matrix of questions from group L1

	You like Lithuanian language lessons	You are gifted for the Lithuanian language	You are interested in reading texts in Lithuanian lessons	You are interested in writing assignments in Lithuanian language lessons	The Lithuanian language is important for learning other subjects	You are learning the Lithuanian language because it is important to obtain entry to a higher school	You are learning the Lithuanian language because it is important to obtain an interesting job	You are learning the Lithuanian language because you need to get a well-paid job
1	.820a	–.400	–.223	–.275	–.086	–.019	–.081	.003
2		.823a	–.037	–.106	–.068	–.097	.074	.016
3			.856a	–.342	–.059	–.088	–.034	.028
4				.841a	–.082	.025	–.050	.009
5					.882a	–.359	–.107	–.073
6						.840a	–.051	–.315
7							.762a	–.586
8								.735

Note. a. Measures of Sampling Adequacy (MSA)

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Table 3
Initial eigenvalues of factors and rotation sums of squared loadings of questions in group L1

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.715	46.442	46.442	3.715	46.442	46.442	2.612	32.649	32.649
2	1.499	18.738	65.180	1.499	18.738	65.180	2.603	32.531	65.180
3	.696	8.695	73.875						
4	.608	7.596	81.471						
5	.452	5.654	87.125						
6	.401	5.008	92.134						
7	.362	4.531	96.665						
8	.267	3.335	100.000						

Note. Extraction Method: Principal Component Analysis

The rotation method *Varimax* was used for the simplification of factor interpretation in PCA. After the Varimax rotation, the first factor explained the variance decrease to 33 %, the second factor explained part of the increase to nearly 33 % (Rotation Sums of Squared Loadings) (Table 3).

The last step in EFA was the interpretation of the results. The factor loadings are represented in the rotated component matrix (Table 4). The relationship of each variable to the underlying factor is expressed by factor loading. The variable *You like Lithuanian language lessons* has a correlation of 0,816 with Factor 1. Other three variables, *You are interested in writing assignments in Lithuanian language lessons; You are gifted for the Lithuanian language; You are interested in reading texts in Lithuanian lessons,* are also associated with Factor 1. Based on the variables loading highly onto Factor 1, we called it intrinsic motivation: interest, engagement, satisfaction.

The variables *You are learning the Lithuanian language because you need to get a well-paid job; You are learning the Lithuanian language because it is important to obtain an interesting job; You are learning the Lithuanian language because it is important to obtain entry to a higher school*; *Thevb Lithuanian language is important for learning other subjects* have high factor loadings on another factor, i.e. Factor 2. They seem to indicate the identified regulation: personal relevance, and conscious evaluation. Factor 2 was named extrinsic motivation: identified regulation: personal relevance, and conscious evaluation.

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Table 4
Rotated Component Matrix of the observed motivation for learning the Lithuanian language variables and the levels of motivation (Ryan & Deci, 2002)

Observed variables	Latent variables: factors		Levels of motivation
	F1	F2	
You like Lithuanian language lessons	.816		**Intrinsic motivation** Interest, engagement, satisfaction
You are interested in writing assignments at Lithuanian language lessons	.783		
You are a gifted in Lithuanian language	.744		
You are interested in texts reading at Lithuanian lessons	.741		
You are learning Lithuanian language, because they need to get a well-paid job		.885	**Extrinsic motivation** Identified regulation: personal relevance, conscious evaluation
You are learning Lithuanian language, because it is important to obtain interesting job		.839	
You are learning Lithuanian language, because it is important to obtain entry to high school		.759	
Lithuanian language is important learning other subjects		.648	

Note. Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 3 iterations.

Discussion

The data of factor analysis of the questions in group L1 revealed two levels of motivation for learning the Lithuanian language: extrinsic motivation and intrinsic motivation. The first factor was named intrinsic motivation: interest, engagement, satisfaction. The second one was referred to as extrinsic motivation: identified regulation (personal relevance, conscious evaluation).

The questions *You like Lithuanian language lessons; You are interested in writing assignments in Lithuanian language lessons; You are gifted for the Lithuanian language; You are interesting in reading texts in Lithuanian lessons* are related with the factor of intrinsic motivation. Loadings close to –1 or 1 indicate that the factor strongly affects the variable. It means that the factor has a strong effect on the variable.

Stevens (1992; in Field, 2000, p. 441) then "recommends interpreting only factor loadings with an absolute value greater than 0.4 (which explain around 16 % of variance)". This

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is only possible in principal component analysis. In our case, the principal component analysis was used and the value of all factor loadings was greater than 0,741. Two variables have the greatest factor loading with the factor of intrinsic motivation. The factor loading of the variable *You like Lithuanian language lessons* was 0,816; the factor loading of the variable *You are interested in writing assignments in the Lithuanian language* – 0,783. The variable *You are interesting in reading texts in Lithuanian lessons* has less factor loading – 0,741. Consequently, writing assignments are more important for the promotion of intrinsic motivation for learning the Lithuanian language by school students.

The statements *You are learning the Lithuanian language because you need to get a well-paid job; You are learning the Lithuanian language because it is important to obtain an interesting job; You are learning the Lithuanian language because it is important to obtain entry to a higher school; the Lithuanian language is important for learning other subjects* are related with Factor 2, i.e. extrinsic motivation: the identified level. "A more autonomous, or self-determined, form of extrinsic motivation is regulation through identification. Here, the person has identified with the personal importance of a behavior and has thus accepted its regulation as his or her own" (Rayan & Deci, 2000, p. 62). Locus of causality perceived at the identification level of extrinsic motivation is named "somewhat internal". There are two locus of causality in our research: educational (*You are learning the Lithuanian language because it is important to obtain entry to a higher school; the Lithuanian language is important for learning other subjects*) and social (*You are learning the Lithuanian language because you need to get a well-paid job; You are learning the Lithuanian language because it is important to obtain an interesting job*). The variables of social identification have the greatest factor loading with the factor of extrinsic motivation: *You are learning the Lithuanian language because you need to get a well-paid job* – 0.885; *You are learning the Lithuanian language because it is important to obtain an interesting job* – 0.839. The variables of educational identification have less factor loading with the factor of extrinsic motivation: You are learning the Lithuanian language because it is important to obtain entry to a higher school – 0.759; the Lithuanian language is important for learning other subjects – 0.648.

Conclusions

Motivation for learning the Lithuanian language can be described by different variables: *You like the Lithuanian language; You are gifted for the Lithuanian language; You are interesting in reading texts at Lithuanian lessons; You are interested in writing assignments in Lithuanian language lessons; the Lithuanian language is important for learning other subjects; You are learning the Lithuanian language because it is important to obtain entry to a higher school; You are learning the Lithuanian language because it is important to obtain an interesting job; You are learning the Lithuanian language because you need*

to get a well-paid job. Exploratory factor analysis allowed distinguishing two factors of these variables: the factor of intrinsic motivation and the factor of extrinsic motivation identified regulation: personal relevance, and conscious evaluation.

Extrinsic motivation for learning the Lithuanian language at the identification level involves a conscious acceptance of the personally valued benefit. The analysis of the benefit for learning the Lithuanian language revealed an educational (*the Lithuanian language is important for learning other subjects; You are learning the Lithuanian language because it is important to obtain entry to a higher school)* and a social (*You are learning the Lithuanian language because it is important to obtain an interesting job; You are learning the Lithuanian language because they need to get a well-paid job)* dimension. The educational benefit of learning the Lithuanian language for students is more important than social benefit. The data of Freedman test (χ^2 (3) = 193.439, $p < .05$) confirm a statistically significant difference between the students' answers to different questions about the educational and social benefit for learning the Lithuanian language.

Intrinsic motivation for learning the Lithuanian language is characterized by the self-determined behavior with a different background: an emotional (*You like Lithuanian language lessons),* a self-confident (*You are gifted for the Lithuanian language)* and an emerging personal interest toward the Lithuanian language (*You are interested in reading texts in Lithuanian lessons; You are interested in writing assignments in Lithuanian language lessons*).

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Tiriamosios faktorinės analizės taikymas antrinėje nacionalinių mokinių pasiekimų tyrimų analizėje: aštuntos klasės mokinių lietuvių kalbos mokymosi motyvacijos aspektas

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Santrauka

Atviros nacionalinių ir tarptautinių edukacinių tyrimų duomenų bazės suteikia galimybę tolesniems tyrimams. Tokio pobūdžio tyrimų priemones sudaro daug klausimų apie įvairius edukacinės realybės aspektus. Antrinę duomenų analizę atliekantis tyrėjas nežino pirminio tyrimo klausimyno sudarymo teorinių pagrindų, operacionalizavimo proceso. Tai sukelia problemų interpretuojant tyrimo rezultatus atliekant antrinę duomenų analizę. Tiriamosios faktorinės analizės taikymas gali padėti išskirti klausimų grupes, juos susisteminti. Antrinės duomenų analizė gali būti vykdoma tokiu nuoseklumu: pirminio tyrimo duomenys – tiriamoji faktorinė analizė – teorinis tyrimo pagrindas – antrinės duomenų analizės rezultatų interpretavimas.

Straipsnyje aprašomo tyrimo tikslas – atskleisti tiriamosios faktorinės analizės taikymo rezultatą nagrinėjant mokinių lietuvių kalbos mokymosi motyvaciją remiantis antrinės nacionalinių mokinių pasiekimų tyrimų analizės duomenimis.

Nacionalinių mokinių pasiekimų tyrimų klausimyne buvo įtraukti įvairūs klausimai apie mokinių mokymosi motyvaciją: *Tu mėgsti lietuvių kalbą*; *Tu esi gabus lietuvių kalbai*; *Tu domiesi tekstais, skaitomais per lietuvių kalbos pamokas*; *Tu domiesi rašymo užduotimis lietuvių kalbos pamokose*; *Tu mokaisi lietuvių kalbos, nes ji yra svarbi kitų dalykų mokymuisi*; *Tu mokaisi lietuvių kalbos, nes ji yra svarbi stojant į aukštąją mokyklą*; *Tu mokaisi lietuvių kalbos, nes tai padeda gauti įdomų darbą*; *Tu mokaisi lietuvių kalbos, nes tai padeda gauti gerai apmokamą darbą*. Tiriamoji

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faktorinė analizė atskleidė dvi faktorių grupes pagal teorinį motyvacijos modelį, atitinkančias išorinę ir vidinę motyvaciją.

Tiriamoji faktorinė nacionalinių mokinių pasiekimų tyrimų analizė atskleidė, kad mokinių išorinė lietuvių kalbos mokymosi motyvacija atitinka trečiąjį išorinės motyvacijos lygmenį – identifikuotą lygmenį. Kaip elgesio kontrolės būdai šiame lygmenyje veikia paties asmens elgesio pasekmių ar rezultatų vertinimas. Išorinės motyvacijos identifikuotas lygmuo pasireiškia tuo, kad mokiniai sąmoningai įvertina mokymosi naudą. Tiriamoji faktorinė analizė atskleidė du mokymosi naudos tipus: edukacinį (*Tu mokaisi lietuvių kalbos, nes ji yra svarbi kitų dalykų mokymuisi; Tu mokaisi lietuvių kalbos, nes ji yra svarbi stojant į aukštąją mokyklą*) ir socialinį (*Tu mokaisi lietuvių kalbos, nes tai padeda gauti įdomų darbą; Tu mokaisi lietuvių kalbos, nes tai padeda gauti gerai apmokamą darbą*).

Nustatyta, kad mokiniai daugiau vertina edukacinę lietuvių kalbos mokymosi naudą nei socialinę. Freedmano testo rezultatai (χ^2 (3) = 193,439, $p < 0,05$) patvirtina statistiškai reikšmingą skirtumą tarp mokinių atsakymų apie edukacinę ir socialinę lietuvių kalbos mokymosi naudą.

Mokinių vidinė lietuvių kalbos mokymosi motyvacija grindžiama apsisprendimo (angl. *self-dedermination*) teorija, kuri išryškina įvairius vidinę motyvaciją lemiančius komponentus: emocinį komponentą (*Tu mėgsti lietuvių kalbos pamokas*), pasitikėjimo savo jėgomis komponentą (*Tu esi gabus lietuvių kalbai*), asmeninį interesą lietuvių kalbos atžvilgiu (*Tu esi gabus lietuvių kalbai*; *Tu domiesi tekstais, skaitomais per lietuvių kalbos pamokas*; *Tu domiesi rašymo užduotimis lietuvių kalbos pamokose*).

Esminiai žodžiai: *tiriamoji faktorinė analizė, lietuvių kalbos mokymosi motyvacija.*

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