

Validity and reliability analyses for the climate of science subjects research tool

Abstract

The climate belongs amongst the most critical dimensions that influences to effective teaching and learning. In terms of science subjects, the climate is rarely discussed in researches all over the world. The main aim of the research was to adapt a research tool regarding the climate in science subjects. The research sample consisted of 121 pupils of the 7th and 8th grades of elementary school and the questionnaire included 26 items. Constructive validity of the questionnaire was assessed by means of an exploratory factor analysis, which divided items into three factors. The loading values of all items varied between 0.45 and 0.88 and explained 69.55 % of the total variance. By using Cronbach's alpha coefficient as an internal consistency, it resulted in a value of 0.89. The results showed that a research tool can be used as a valid and reliable instrument in further research.

Keywords: climate, reliability, science subjects, validity, climate, exploratory factor, analysis,

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Introduction

The concept of school or learning climate does not have a clear and definite definition. The definition is described in the older works e.g.¹ but also in the newer ones.² There is also a problem with the concepts; the concept "learning climate" is used in a significant lower amount of cases, as the more used term is "school climate". However, in many papers these two concepts are conceived as synonyms. Moreover, many authors only used the term "climate". In our case, the term "school climate" or only "climate" was used throughout the paper. As³ showed, there is variability in individual perceptions of a school's climate, and researchers propose that it is the subjective perception of the environment that influences individual student outcomes⁴ considered the school climate as a critical dimension that is linked to effective teaching and learning. A similar definition is possible to find in other works.^{5,6} It is appropriate to mention that the first description of the definition of the term "school climate" is possible to find in the work of.⁷ However, it took nearly 50 years until this concept was adequately examined and received a place in the educational research.⁴ The examination of the school climate amongst pupils is part of the portfolio of many researches. Hence, in the text below, an outline of selected research works regarding the school climate can be found and at the end of this text, research works are presented which relate to the school climate in science subjects.

Many papers were focused on the problematic relationship between the school climate and the pupils' achievements, because the school climate is a crucial factor in for explaining the pupils' achievements and outcomes.⁸⁻¹⁰ Similar results are possible to be found in older studies¹¹ examined the relationship between the school climate and the children's academic and social development in elementary school. The results indicated that the overall school climate and the teacher-students relationship significantly influenced the school adjustment. The school climate significantly influenced the pupils' achievements in reading and mathematics. A similar result is found in the research of, Haynes, MacNeil et al.,^{12,13} Prater an used standardized tests as research tools for the examination of the influence of the school climate on achievement. Authors stated the positive influence of the school climate on achievement in standardized tests¹³ revealed that a mastery climate accounted to higher levels of academic competence

in the first year of middle school. A moderate effect was found, in which greater attachment security to the mother appeared to lessen the relationship between a performance climate and anxiety symptoms during the transition to middle school. Some researches asserted positive correlations between the school climate and the motivation to learn.¹⁴ A positive school climate also had a positive effect on the mental health of high school pupils.¹⁵

Furthermore, the positive school climate had a significant influence on drug addiction. If the school climate was positive, a low level could be seen in the occurrence and use of drugs by pupils at school.^{16,17} The positive school climate significantly affected the level of violence and bullying amongst pupils.¹⁸⁻²¹ Other factors which are influenced by the school climate can be found in an overview of a study of.²² The problematic aspects of the school climate in science subjects are examined very marginally; they mainly concern works which focus on scientific concepts of the general climate at school and in the classroom²³⁻²⁶ focused on the effect of the school climate and on the choice of elective subjects during learning. If the school climate was perceived positively during the teaching of science subjects, then pupils chose elective science subjects. Similar results were found in other research works²⁷⁻²⁹ examined three factors: the school (classroom) climate, interest about science subjects and the use of innovative methods during teaching. Authors found out, that when teachers used innovative teaching methods (no frontal teaching), then the climate at school was more positive and the interest in science subjects increased³⁰ examined more factors regarding the school climate during Physical Education. The authors clarified that the teachers' leadership style had a positive effect on the school climate and on the interest in subjects. It is also possible to find research studies focused on the evaluation of school climate instruments. In the majority of cases, the authors of these studies used an exploratory factor analysis, a determination of reliability and also an item-total correlation.³¹ A similar approach was used in the study of²¹⁻³² adapted a research tool regarding the school climate amongst Brazilian elementary school pupils. These authors showed that there is a small amount of school climate studies regarding the adaptation process of questionnaires. Similar results were found in studies with a different focus.³³⁻³⁷

Aims of the research

The main aim of the research was to adapt a research tool regarding the climate in science subjects. It was used in a questionnaire, in which items were put on a scale. All participants were informed about the purpose of the research before completing the questionnaire. The questionnaire was administered in a pen-paper format during lessons of biology.

Methods

Respondents

The sample was collected from two elementary schools. The research sample consisted of 121 pupils of the 7th and 8th grade (13–15 years). This sample is appropriate for studies as the validation and adaptation of a research tool is realized.³⁸ The average age of respondents was 14.02 years. The number of respondents from the 7th grade was 58 and the rest of them (n=63) was from the 8th grade. The participation of students of the research was voluntary, so this fact led to a relatively low amount of respondents in the entire research. All the respondents had got an experience with every science subject (biology, physics and chemistry).

Preparation of Items

Since the questionnaire was intended to determine the school climate in science subjects, literary sources were reviewed for similar research tools over the world. After the literature review, the initial research tool with 38 items was created. Next, items were reviewed by three experts of education methodology, who worked on the university environment, its readability, its representation of content and how well the items are likely to measure climate in the science subjects. Twelve items were eliminated for the inconsistency with other items. The final questionnaire included 26 items. Respondents were asked to respond to each item using a 5-point Likert scale regarding to the determination of the school climate: never, sometimes, often, usually or always. The questionnaire started with the sentence: "Please

evaluate how you perceive the learning process in science subjects". A similar procedure was found in the work of Kurbanogl et al.,³⁹ The responses of respondents were coded: never–1, sometimes–2, often–3, usually–4, always–5.

Procedure

Before administration of the instrument, all respondents were informed about the purposes of the research. All respondents were assured that the research was anonymous and that all the data was only going to be used for research purposes. The administration took approximately 15 minutes and all the questionnaires were filled in correctly and the data were included into analyses. The analysis of the data was put in two divisions: (a) determination of reliability by using the Cronbach alpha coefficient and calculating the item total correlation to obtain the internal consistent reliability estimates of the scale scores and (b) testing the construct validity by means of the exploratory factor analysis. SPSS 22.0 and Statistica 10.0 software were used for statistical analyses.

Results

For construct validity, an exploratory factor analysis was conducted to validate the underlying structure of the model. For using the factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were used.⁴⁰ The value of the KMO test was 0.87 and the values of the Bartlett's test of sphericity was ($\chi^2 = 1215.59$; $p < 0.001$). Both values showed that the relationship between the variables was strong and appropriate for a factor analysis.⁴¹ Items were divided into three dimensions see Table 1:

- I. The teacher's style of teaching (11 items),
- II. The meaningfulness of the teaching process (8 items),
- III. Fair approach of teacher toward pupils (6 items). These dimensions explained 69.55 % of total variance, and the most variance was explained by the first dimension (36.25 %).

Table 1 Results of the factor analysis

| | I. | II. | III. |
|--|-------|-------|-------|
| The rules during the learning process are strictly determined. | 0.66 | 0.21 | -0.15 |
| The tasks have to be done precisely and reliably. | 0.75 | 0.18 | 0.2 |
| The tasks are controlled continuously. | 0.55 | 0.32 | -0.12 |
| The tasks are in line with what I learned. | 0.88 | 0.1 | 0.09 |
| I manage the home preparation of the learning process without problems. | 0.59 | 0.29 | 0.02 |
| The teacher is teaching interestingly and with enthusiasm. | 0.51 | 0.09 | 0.3 |
| The teacher is using explanatory examples and aids. | 0.45 | 0.22 | 0.19 |
| The teacher asks us what we know about a new topic, before he/she begins to explain a new topic. | 0.84 | 0.1 | -0.09 |
| The teachers is focused on the actual topic, he/she does not talk about other topics. | 0.72 | 0.12 | 0.13 |
| The teacher keeps my attention by his/her teaching style. | 0.56 | -0.16 | -0.05 |
| The teacher answers questions of pupils. | 0.62 | -0.08 | 0.16 |
| I have to explain my opinion. | 0.18 | 0.51 | 0.22 |
| I can apply my good ideas during the learning process. | 0.11 | 0.65 | -0.15 |
| The learning process also takes place outside of school. | -0.21 | 0.59 | -0.12 |

Table Continued

| | I. | II. | III. |
|---|-------|-------|-------|
| The teacher explains us how and where to use the elements which we learned during class. | 0.08 | 0.74 | 0.12 |
| The teacher tells us in which profession it is possible to use a topic being taught in class. | 0.11 | 0.7 | 0.15 |
| The teacher is trying to find out if we understand the topic during the examination process. | 0.17 | 0.49 | 0.31 |
| We are working in groups during the learning process. | 0.05 | 0.82 | -0.1 |
| The teacher leads us, to discuss about procedures by the solving of tasks. | 0.09 | 0.74 | 0.1 |
| I share my opinion to with the teacher without fear. | -0.03 | -0.06 | 0.89 |
| The teacher supports me if I am interested in a specific topic. | 0.12 | 0.22 | 0.65 |
| When I have problems with solving tasks, the teacher helps me. | 0.31 | 0.02 | 0.45 |
| When I am faster than other schoolmates in solving tasks, the teacher gives me another task. | 0.12 | 0.13 | 0.68 |
| The results of my works in school are evaluated fairly. | -0.19 | 0.11 | 0.73 |
| I am in a good mood before the examination process. | 0.21 | -0.09 | 0.58 |
| Eigen values | 7.23 | 3.22 | 1.49 |
| % of variance | 36.25 | 19.18 | 14.12 |

According to,⁴² the prime factor should explain at least 20 percent of the total variance and the difference between the second and the third factor should be lower than the difference between the first and the second factor. The critical value for inclusion of an item to a dimension was 0.40. The numbers of items are identical to the numbers in the questionnaire. The reliability of the questionnaire was calculated using Cronbach's alpha coefficient. The value of reliability was high ($\alpha=0.89$), which indicated an acceptable reliability of the questionnaire.⁴³ The high value of reliability coefficient in our study implies that the instrument used for investigation of the climate in science subjects was reliable and its usage for further analysis was appropriate. Values of Cronbach's alpha for specific factors (areas) were between 0.62–0.85. According to,^{44,45} a reliability score between 0.59 and 0.75 can be considered acceptable. The analyzed result of the corrected item-total correlation of the 26 items ranged from 0.49 to 0.82.

Discussion and conclusion

The main aim of the study was to evaluate a research tool regarding the climate in the learning process of science subjects. For the evaluation process, the methods of multidimensional statistics were used as an exploratory factor analysis and a determination of reliability was established by using Cronbach's alpha coefficient and total-item correlation. A similar approach was used for example in the study of³¹ and in another study conducted by Kohl.⁴⁶ The value of reliability of the research tool was appropriate for the questionnaire and it is possible to use it in other researches. The value of Cronbach's alpha was higher than 0.70, which is in concordance with the methodology literary sources, which made this value appropriate.⁴³ Also, the values for the factors gave appropriate values. It is also comparable with other sources like.⁴⁷ The use of the factor analysis for the determination of construct validity, showed acceptable results, the items of research tool were distributed into three factors and all conditions for the use of the exploratory factor analysis were respected. During the use of the factor analysis, it was accepted that one item in one factor and every factor loading score for the item was higher than 0.40. This rule was also mentioned in the work of.⁴⁸ In conclusion, the adaptation process required special attention. The adapted research tool, which

is validated and which has been found reliable, could be used in the main research. This result is also an indicator, that the questionnaire could be used universally. Although the sample size included lower secondary school pupils, it could be tested in high schools as well. In the main research, the sample size will be higher due to the different goals and conditions of this research. The statistical methods are planning to use with the respect to determined aims in the main research.⁴⁹

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Conflict of interest

The author declares there is no conflict of interest.

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