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Development and validation of a survey instrument for detecting basic motor competencies in elementary school children

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Abstract: Basic motor competencies (in German: Motorische Basiskompetenzen; MOBAK) are motor performance dispositions formulated as minimum standards that empower children to participate in the culture of human movement. In opposition to movement-specific and process-oriented fundamental movement skills assessing the quality of movement execution, basic motor competencies are context-specific and product-oriented and focus on the mastery of minimum motor demands. Consequently, the promotion of basic motor competencies is a central goal of physical education, as they are essential prerequisites to be able to develop a physically active lifestyle. For the diagnosis of basic motor competencies, teachers need valid survey instruments that can help them to adapt their didactic-methodical action. For this purpose, a test battery for the assessment of the basic motor competencies of third graders was developed (MOBAK-3) and subjected to empirical validation (N = 399; 50.4% female; M = 8.45 years, SD = .52). The exploratory structural equation modeling indicates a structure with three factors named "Locomotion," "Object-control" and "Moving in water". This structure could be confirmed in the confirmatory factor analysis (CFI = .998; RMSEA = .009)

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Claude Scheuer works at the University of Luxembourg for the institute for Applied Educational Sciences and teaches in primary school teacher education (BScE: Bachelor of Educational Sciences), this after having worked before as a physical education teacher in elementary and secondary school (including vocational education) for 13 years. His research is focused on basic motor competencies of children and adolescents with the aim to develop and evaluate competence-oriented motor tests for elementary school children for class levels 1, 3, 5 and 7 in Luxembourg. These test instruments should make possible an easy and reliable diagnosis of children's motor competencies for the purpose of pedagogical diagnosis and educational monitoring. The present development and validation of a motor testing instrument for elementary school children was conducted in the frame of the development of these motor test instruments following the approach of basic motor competencies

PUBLIC INTEREST STATEMENT

In education, testing has gained in relevance over the last decades. This applies also to physical education, with the purpose to identify students with motor deficiencies or to assess motor proficiency levels in general. Basic motor competencies (in German: Motorische Basiskompetenzen; MOBAK) are motor performance dispositions formulated as minimum standards empowering children to participate in the movement culture. In opposition to fundamental movement skills assessing the quality of movement execution, basic motor competencies focus on the mastery of minimum motor demands. As teachers need valid instruments for the diagnosis of motor competencies, we developed a test battery for the assessment of the basic motor competencies of third graders (MOBAK-3). We identified three areas of motor competence: "Locomotion," "Object-control," and "Moving in water". The MOBAK-3 test battery satisfies test theory requirements and is suitable for an analysis of basic motor competencies and the identification of students' support needs in motor competence.

and there was no differential item functioning (DIF) between boys and girls and the age. Furthermore, the sensitivity of the test instrument with regard to pedagogical diagnosis was confirmed based on a normative definition of support needs in motor competence. The MOBAK-3 test battery satisfies the requirements of test theory and is suitable for an analysis of basic motor competencies and the identification of motor deficiencies in students.

Subjects: Motor Control and Development; Skill Acquisition; Primary Physical Education; Physical Education; Childhood; Assessment & Testing; Assessment

Keywords: motor competence; motor testing; motor assessment; test development; pedagogical diagnosis; educational monitoring; physical education

1. Introduction

In recent years and across many educational systems, similar standards have been implemented across different subjects. This includes physical education. Thus, school performance measures, and in particular the modeling and recording of competencies, have become key contents of educational policy and educational science discourse in recent years (Klieme et al., 2003). Particular importance has been given to the topic of “test tasks,” which should make students’ competencies accessible to empirical verification. Consequently, by supporting the diagnostic competence of teachers, the teachers can support the development and promotion of the students’ competencies through more individualized learning. On a concrete application level (e.g. teaching development, school (sports) development, initial and continuous teacher training, and educational monitoring), a variety of opportunities for the use of appropriate test methods have been identified (Altrichter, 2010; Helmke, 2010; Serwe, 2011; Süßenbach, 2009).

1.1. The MOBAK approach

To develop an appropriate test instrument, one must ask which concept the development of the test tasks will be based on. The approach based on “fundamental movement skills” is focusing on the basic motor skills of everyday motor activity and follows the assumption that, in early childhood, children acquire a series of motor skills that are called “fundamental movement skills” (FMS). These consist of locomotion skills (running, jumping, gliding, etc.), object-control skills (throwing, catching, bouncing, shooting, etc.), and stability skills such as balancing (Burton & Miller, 1998; Clark & Metcalfe, 2002; Haibach, Reid, & Collier, 2011; Stodden et al., 2008). These skills are considered the basis for the subsequent acquisition of motor and physical activities in the sense of becoming “physically literate” or “physically educated” (Whitehead, 2010). A test that is based on FMS is the TGMD (Test for Gross Motor Development; Ulrich & Sanford, 2000), which includes 12 tasks that load on two factors that can be designated “locomotion” and “object control.”

In addition to the concept of motor skills, the basic motor competencies (in German: Motorische Basiskompetenzen; MOBAK) approach has come along in recent years. Basic motor competencies are defined as a prerequisite for active participation in the culture of movement, play, and sports. Thus, they ensure that children and adolescents can participate in the education-related processes of this culture (Gogoll, 2012; Herrmann, Bund et al.,2015; Kurz & Fritz, 2007; Kurz, Fritz, & Tscherpel, 2008). They are operationalized as basic motor qualifications, which express a level of minimal requirements in the form of minimum standards. In this sense, they determine the lower limit of the ability to move. Basic motor qualifications are not to be confused with motor abilities and sport motor skills (techniques). Unlike motor abilities (strength, speed, coordination, etc.), motor qualifications are complex and context-bound. In opposition to movement-specific and process-oriented FMS (Barnett et al., 2016), basic motor qualifications are context-specific and product-oriented and are based on pedagogical reflections assuring their curricular validity. Furthermore, they are also more general than specific skills and form a foundation upon which skills and thus the further development of competence are built.

1.2. The MOBAK-3 as a diagnostic tool for teachers

For teachers, in order to estimate learning and task requirements appropriately, it is essential that they are able to assess the characteristics of their students adequately. As this diagnostic competence is a prerequisite for teachers' ability to select appropriate learning tasks and individualized feedback on the basis of what each learner requires, it can be considered a key aspect of the development of high-quality teaching (Karst, Schoreit, & Lipowsky, 2014; Oelkers & Reusser, 2008; Schrader, 2009). In addition, after a respective diagnosis, teachers need a stringent indication about what they can change in their teaching, as well as about the conditions under which such changes are feasible. In this context, it is essential to conceptually design supportive measures by implementing competence-oriented movement instruction, appropriately oriented tasks, and opportunities for internal differentiation (Pfitzner, 2012).

For this reason, the main focus in developing the MOBAK-3 was to develop a valid and reliable test instrument based on the expected outcomes of the physical education curriculum that can independently be used by teachers in regular physical education classes and that will thus allow them to establish a diagnosis of students' basic motor competencies on the basis of competence-based motor test tasks (MOBAK items). This in turn should allow them to identify strengths and weaknesses in the specification of these basic motor competencies for both individual students and entire school classes. This information should allow teachers to plan interventions in the form of support measures at the classroom level as well as at the school level.

1.3. The operationalization of basic motor competencies

In the process of operationalizing basic motor competencies in the form of basic motor qualifications as test tasks, the following question guided the actions: What should a child at a certain age be able to master in order to be able to actively participate in the sports and movement culture? (Kurz et al., 2008). To secure curricular validity, this should be done in close association with the objectives set out in the respective curricula. In this case, the reflections were based on the Luxembourgish curriculum, whereas a generalization of the test battery in the light of other similar curricula seemed possible as well.

In this context, the MOBAK items involve motor tasks that are used to assess basic motor qualifications that (1) are sufficiently complex and therefore require several motor skills or abilities for their successful execution; (2) are explicitly context dependent and relate to specific situations that are required in the movement, play, and sports culture; (3) represent a consensus on the minimum requirements that children and adolescents need to participate in the culture of human movement in terms of cultural participation; (4) are not bound by any time limits or other measurable limits or expectations except the limits of the minimum standards that are accepted as plausible for the living environment; (5) can in principle be learned sustainably by all children and adolescents, which means that physical prerequisites are not relevant; (6) do not require any specific technical requirements but allow for individual and/or functional solutions; (7) are passed or failed and are thus coded dichotomously (Herrmann, Bund et al., 2015). Normative basic motor qualifications are defined as the minimum requirements that should be achieved by all students. Students who cannot implement MOBAK tasks are deficient in the domain of basic motor competencies. Thus, they might have problems as they progress through school, and their participation in the sports, play, and movement culture in society might be in danger.

This article aims to contribute to this debate by presenting the development and validation of a survey instrument that was designed to record the basic motor competencies of third-grade students at the age of eight to nine years. Since the survey instrument was consistently oriented toward minimum standards, the test items should all have a similar level of difficulty. In addition, the test items should be related to the curriculum, and it was verified whether they could be assigned to a latent factor. In terms of pedagogical diagnostics, the results produced by the tests should allow teachers or administrators to identify students with special needs at both the class and school levels, with the aim of offering support for the students and their parents. In addition, in the context of educational monitoring, the application of this test should make it possible to identify risk populations who require increased support in their basic motor competencies.

2. Method

The present test battery included a total of 15 tasks (Table 1) that can be used to detect basic motor competencies (MOBAK) among elementary school students in the third grade (eight- to nine-year olds). The final composition of the present test battery resulted from a much larger selection of possible test items that had been developed and discussed in the context of several expert discussions on the basis of normative pedagogical considerations.[1]

Table 1. MOBAK-3 test tasks, structured in five movement areas as test dimensions

Item	Qualification	Item task
Moving on devices		
Balancing	Knowing how to balance on shaky ground	Level 1: The child goes forward over a bench flipped on a springboard without descending from the bench and without pushing the feet forward
		Level 2: Ditto, and going backward as well
Rotating	Knowing how to roll forward	Level 1: The child executes a forward roll on an inclined mat and lands on his/her feet
		Level 2: Ditto, on a flat mat
Stabilizing	Knowing how to support one's own body weight	Level 1: The child crosses a two-piece gymnastic box with a run-up by touching the box only with the stabilizing hands.
		Level 2: Ditto, without a run-up
Running and jumping		
Persistent running	Knowing how to run persistently	Level 1: The child runs 8 min without a rest
		Level 2: The child runs 10 min without a rest
Coordinated running	Varied moving and orienting	Level 1: The child runs according to the instructions (running forward and backward, side-step) around predefined marks
		Level 2: The child runs according to the instructions (hop running forward and backward, side-step) around predefined marks
Rhythmic skipping	Continuous, rhythmic forward skipping	Level 1: The child jumps continuously over four carpet tiles (40 × 40 cm, distance 40 cm). The legs are closed between the tiles and straddled next to the tiles
		Level 2: Ditto, the child jumps on one leg between the tiles and with both legs straddled next to the tiles
Playing with balls		
Throwing and catching	Knowing how to throw and catch	Level 1: The child throws a ball from a distance of 1.5 m six times against a wall and catches the ball at least three times, without the ball touching the ground
		Level 2: Ditto, catches the ball at least five times
Bouncing	Knowing how to bounce accurately	Level 1: The child dribbles a ball down a marked corridor (10 × 2 m) without losing the ball and without touching one of the traffic cones
		Level 2: Ditto, with one hand only
Dribbling	Knowing how to control a ball with the feet	Level 1: The child controls a soccer ball with the feet running down a marked corridor (8 × 2 m) without losing the ball and shoots the ball out of a shooting zone into a goal
		Level 2: Ditto, without touching one of the obstacles in the corridor

(*Continued*)

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Table 1. (*Continued*)

Item	Qualification	Item task
Playing with small devices		
Target throw	Knowing how to throw accurately	Level 1: The child throws at least 3 out of 6 rice bags from a distance of 1.5 m into three different hoops (Ø=80 cm) lying one behind another
		Level 2: Ditto, at least 5 out of 6
Hitting a target	Knowing how to control a ball by hitting it with a racket	Level 1: The child hits a tennis ball with a racket from a distance of 3 m against a wall above a net line (height 1 m) and catches the ball after one ground contact with one or two hands
		Level 2: Ditto, the child hits the ball after one ground contact once back against the wall over the net line
Controlling with a stick	Knowing how to control a ball with a stick on the floor	Level 1: The child controls a hockey ball with a hockey stick down a marked corridor (8 × 2 m) without losing the ball and shoots the ball out of a shooting zone into a goal
		Level 2: Ditto, the child is running down the corridor
Moving in water		
Gliding	Knowing how to glide on the water	Level 1: The child pushes off in the water with feet from the pool edge and glides for at least a distance of 2.50 m
		Level 2: Ditto, for at least a distance of 4.00 m
Diving	Knowing how to orient under water	Level 1: The child dives into chest-deep water and collects a diving ring of the color named by the test conductor from the pool floor
		Level 2: Ditto, the child dives with the head forward
Floating	Knowing how to use the water's buoyancy	Level 1: The child lies with outstretched arms and legs in a supine position in chest-deep water and floats for 4 s on the water without touching the floor or the edge of the pool
		Level 2: The child stands in chest-deep water, takes a deep breath, envelops his/her legs with his/her arms and floats like a jellyfish for two seconds on the water's surface. Then the child exhales vigorously so that he/she sinks down to the pool floor

2.1. The development of the MOBAK-3

The test items were developed by the MOBAK-3 project team and by the teachers who participated in the project. The test instrument was adapted and improved on the basis of feedback from field reports and the subsequent group discussions that accompanied the practical implementation of the tasks and through expert meetings that were held to ensure the content validity of the items. Furthermore, four independent experts—two physical education teachers and two sport pedagogues—rated the test items toward their content validity (Scheuer, Bund, & Becker, 2014).

Due to the above-mentioned specific criteria of the MOBAK tasks, the process of developing the items, which was an important step for maintaining curricular and content validity, was difficult and complex. Here, the MOBAK-3 item pool, used as a measurement tool, was defined as the minimum standard that should be achieved by all students. Thus, students who cannot pass a MOBAK task have deficiencies in basic motor competencies.

The initial aim was to develop an item pool that reflected the dimensions, facets, and levels of a pragmatic competence model based on the so-called "movement areas" (e.g. "running and jumping" or "playing with balls") that are used to structure the contents of the physical education curriculum in Luxembourg as well as in many other German-speaking countries in Europe (Ministère de l'Education Nationale et de la Formation Professionnelle, 2011; Scheuer et al., 2014). The focus of the development of the tasks was on their link with curricular circumstances, which in this case were related to the minimum standards for physical education in elementary schools in Luxembourg. For the purpose of item selection, the developed tasks were checked for objectivity (standardization of test instructions), reliability (test-retest and inter-rater), and validity (content, construct and criterion) using the methods of classical test theory (Scheuer et al., 2014). For pedagogical purposes, special attention was given to the average passing rate of the items. As the focus was on the minimum standards for basic motor competencies, a high passing rate of 80–95% was targeted. Further criteria for the final compilation of the test items consisted of curricular and factorial validity, as well as considerations about the feasibility and the age appropriateness of the task design.

In a second phase, a component of secondary difficulty was added to all test items to adjust the difficulty of the tasks. Thus, in addition to verifying the minimum standard (level 1), each test item provided a way to determine whether the students were performing at an advanced level (level 2). These included, for example, an additional level of difficulty for an expanded task or the execution of the task under more difficult conditions. The test items were then structured as ordinal scales ("fail" = 0, "level 1 passed" = 1, "level 2 passed" = 2). For the test items "Throw and catch" and "Target throw," the number of successful attempts out of six were counted, and this number was decisive for identifying the difficulty level (0, 1 or 2 = "fail," 3 or 4 = "level 1 passed," 5 or 6 = "level 2 passed"). In this way, it was possible to obtain results that could differentiate between students more precisely. This was helpful because significant ceiling effects were to be expected in the test results due to the initial focus on a minimum standard. Consequently, the data reflected an ordinal structure, which was helpful for optimizing the test battery in terms of item difficulty.

2.2. Design

The data collection took place from May to July 2014 in ten elementary schools in Luxembourg. A total of 23 classes with 399 students (N = 399; 50.4% female) were tested in the third grade. The age of the pupils was recorded to the month and averaged M = 8.45 years (SD = .52, range: 7.42–10.50 years; boys: M = 8.47 years, SD = .48, range: 7.42–9.92 years; girls: M = 8.43 years, SD = .55, range: 7.50–10.50 years). The survey was conducted with entire school classes by the teachers who taught physical education during regular school hours, for which five to eight lessons were needed per class, depending on the duration of a single lesson. Nineteen teachers previously trained in a three-hour training session conducted by two MOBAK-experts were involved in the survey process.

2.3. Test execution

The standardization of the test procedure and assessment was ensured by having experts from the University of Luxembourg provide training to the regular physical education teachers prior to the tests. After the test administrator provided a brief statement and a one-time demonstration, the students were allowed to try out the test tasks, except for the task "persistent running." Then the students were allowed two attempts to pass the first level of difficulty of each test task. If the student was successful in at least one attempt, he/she was given two additional attempts to pass the second difficulty level. The ordinal scaled MOBAK test tasks were recorded separately for each test task. Exceptions were the test items "balancing," "gliding," "persistent running," "throwing and catching," and "target throw" because, for these items, the two levels of difficulty could both be assessed with one single try.

Further data (age, gender, immigration background, physical activity per week) were recorded with a small questionnaire filled out by the students with the help of their teachers. As for immigration background, the students were asked about the first language they spoke at home. Physical activity level per week was determined by asking how often per week the students were physically active in school, in sport clubs, and in their leisure time.

2.4. Analysis technique

The data were prepared in SPSS version 21. All subsequent calculations were also implemented in SPSS version 21 as well as in the program Mplus 7.0 (Muthén & Muthén, 2012). Using the *Full Information Maximum Likelihood* (FIML) estimation procedures implemented in Mplus 7.0, it was possible to also take into account students who showed design-related missing data (Muthén & Muthén, 2012). All reported data referred to the complete estimated sample of 399 students. For ease of interpretability, the actual non-estimated data are reported for only the descriptive analyses in Tables 2 and 3 as well as in the comparative analysis of students' special educational needs in Table 7.

The data analysis was performed in two steps: (1) The factor structure was determined with exploratory structural equation modeling (ESEM) and (2) the data were submitted to a confirmatory factor analysis (CFA). In all models, the MOBAK test items were treated as ordinally scaled, and the Means-and-Variance-Adjusted-Weighted-Least-Squares (WLSMV) estimator was applied accordingly.

In model 1a, an exploratory structural equation modeling with an oblique GEOMIN rotation was calculated for one to four factors with the 15 test items (Table 1). The factor loadings and residual variances were thereby released for estimation, and cross-loadings were allowed. In model 1b, the same analysis was calculated with a shortened test battery of 12 test items, and the fit indices were compared.

Based on these calculations, the structure with 12 test items that emerged from model 1b was tested under the more restrictive conditions of a confirmatory factor analysis (in model 2). Here, cross-loadings were not permitted. The factor loadings and residual variances were estimated freely for each test item. In model 3, the dispositions age (to the month) and sex were added to model 2 as covariates. The covariate age was set to correlate with the covariate sex. Additionally, the modification indices for the direct effect of the covariate sex and age in the manifest variables of the test items were requested in order to test for differential item functioning (DIF).

The evaluation of the goodness-of-fit of the model followed the fit indices suggested by the literature (Schreiber, Nora, Stage, Barlow, & King, 2006). As the chi^2 value was not interpretable without further calculation due to the WLSMV estimators, it was not specified in the fit indices. Thus, only standardized coefficients were reported continuously due to the better interpretability of the results.

In a subsequent process, the students were divided into three classes on the basis of a normative key established with a view to possible special educational needs in their basic motor qualifications in the determined test areas. Then, differences in relation to gender (boys/girls), immigration background (no/yes), and physical activity (0–6 h PA per week/more than 6 h PA per week) between these classes were determined and checked for significance using a U-test. By applying this process, it was possible to verify the potential influence of these variables on the students' basic motor qualifications and to further interpret the data from a content point of view.

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Table 2. Passing rates and samples (total sample *n* = 399)

Test item	*N*		Total (%)	Boys (%)	Girls (%)
Balancing	323	Fail	6.2	5.8	6.2
		Level 1	17.0	16.0	17.3
		Level 2	76.8	78.2	76.5
Rotating	323	Fail	5.3	5.8	4.9
		Level 1	13.9	18.1	8.6
		Level 2	80.8	76.1	86.5
Stabilizing	338	Fail	4.4	2.4	5.3
		Level 1	15.7	12.2	18.3
		Level 2	79.9	85.4	76.3
Persistent running	386	Fail	18.1	12.2	24.2
		Level 1	18.4	19.7	17.0
		Level 2	63.5	68.1	58.8
Coordinated running	366	Fail	5.7	3.4	8.2
		Level 1	35.5	37.6	33.2
		Level 2	58.7	59.0	58.7
Rhythmic skipping	368	Fail	11.4	9.4	13.0
		Level 1	13.0	15.0	10.3
		Level 2	75.5	75.6	76.6
Throwing and catching	374	Fail	11.2	5.0	15.8
		Level 1	11.0	9.5	12.6
		Level 2	77.8	85.5	71.6
Bouncing	380	Fail	7.9	4.3	10.0
		Level 1	10.0	5.4	14.7
		Level 2	82.1	90.3	75.3
Dribbling	378	Fail	13.0	8.1	18.2
		Level 1	19.6	19.4	18.7
		Level 2	67.5	72.6	63.1
Target throw	345	Fail	3.8	3.6	4.1
		Level 1	20.6	15.4	25.0
		Level 2	75.7	81.1	70.9
Hitting a target	352	Fail	36.1	26.5	44.1
		Level 1	25.6	28.8	22.6
		Level 2	38.4	44.7	33.3
Controlling with a stick	348	Fail	14.9	13.5	16.8
		Level 1	31.9	28.7	34.1
		Level 2	53.2	57.9	49.1
Gliding	304	Fail	14.5	12.4	16.1
		Level 1	46.1	43.4	49.7
		Level 2	39.5	44.1	34.2
Diving	290	Fail	13.1	16.4	10.3
		Level 1	5.2	1.4	8.9
		Level 2	81.7	82.1	80.8
Floating	280	Fail	13.2	11.9	13.5
		Level 1	36.8	31.1	42.6
		Level 2	50.0	57.0	44.0

Table 3. Spearman rank correlations between the MOBAK-3 test items, gender, and age in SPSS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Balancing	1														
2. Rotating	.34**	1													
3. Stabilizing	.48**	.36**	1												
4. Persistent running	.10	.17**	.22**	1											
5. Coordinated running	.25**	.18**	.27**	.11*	1										
6. Rhythmic skipping	.18**	.24**	.19**	.09	.13*	1									
7. Throwing and catching	.22**	.09	.28**	.18**	.13*	.10	1								
8. Bouncing	.27**	.25**	.29**	.21**	.14**	.17**	.24**	1							
9. Dribbling	.23**	.17**	.27**	.11*	.13*	.15**	.32**	.16**	1						
10. Target throw	.14*	.17**	.23**	.12*	.10	.14**	.18**	.18**	.23**	1					
11. Hitting a target	.28**	.20**	.26**	.22**	.00	.18**	.25**	.26**	.27**	.21**	1				
12. Controlling with a stick	.27**	.18**	.26**	.10	.09	.03	.26**	.16**	.31**	.21**	.25**	1			
13. Gliding	.15*	.17**	.04	.16**	.06	.11	.13*	.18**	.10	.11	.13*	.04	1		
14. Diving	.14*	.17*	.08	−.03	.10	.10	.04	.07	.08	.03	.11	−.08	.30**	1	
15. Floating	.26**	.11	.18**	−.02	.09	.10	.13*	.13*	.25**	.11	.24**	.17**	.45**	.36**	1
Gender[a]	−.02	.13*	−.12*	−.12*	−.02	.00	−.17**	−.20**	−.12*	−.11*	−.17**	−.09	−.11	.01	−.12
age	−.10	−.11	−.11	−.08	−.12	−.04	−.14*	−.09	−.01	−.07	.07	.01	.08	.04	.02

[a]Male = 0; Female = 1.

*The correlation was significant at the .05 level (2-sided).

**The correlation was significant at the .01 level (2-sided).

3. Results

3.1. Descriptive statistics and correlational analyses

In the complete sample ($n = 399$), 63.9% (of $n = 363$) of the students had an immigration background and the students ($n = 345$) were physically active in average for M = 6.55 h a week (SD = 2.91, range: 1.50–21.50 h). The missing values that appeared in “immigration background” and “physical activity level” could be accounted for by missing answers to the respective questions on the questionnaire.

The passing rates were different for the two difficulty levels of the test items (Table 2). For all test items, a large majority of the students passed the test tasks at level 1 (between 81.9 and 96.2%), except for the test item “hitting a target” (63.9%). Furthermore, at least half of the students passed level 2 of the respective test items (between 50.0% and 82.1%) except for the items “hitting a target” (38.4%) and “gliding” (39.5%). Here, the missing values could be explained by the fact that some students did not participate in all the tasks, especially in swimming, for different incidental reasons (e.g. absence, illness, or no sportswear).

Table 3 shows the correlations between the test items, gender, and age. The item correlations between the test items had consistently low to medium values. Gender (dummy coded: male = 0, female = 1) revealed a limited correlation with the test items “rotating,” “stabilizing,” “persistent running,” “throwing and catching,” “bouncing,” “dribbling,” “target throw,” and “hitting a target.” For these test items, boys performed better than girls except for “rotating.” Age also had only a small correlation with the test items and thus appeared to have no relevant influence on test performance.

3.2. Determination of the factor structure

The exploratory structural equation modeling in model 1a was calculated with all 15 test items (Table 1) with one to four factors. Four factors were extracted. For 15 tasks, the scree plot of the eigenvalues ([1] 4.96, [2] 1.79, [3] 1.26, [4] 1.09) suggested that three factors should be extracted because there was a break between the third and fourth eigenvalues. The three-factor solution showed good fit indices, whereas the one-factor and two-factor solutions showed worse values (Table 4). The four-factor solution had high cross-loadings on 7 of the 15 test items, and its content did not permit a coherent assignment of the items to the latent factors. Thus, the three-factor solution was favored, although the test tasks "persistent running" and "target throw" had low factor loadings (.28 or .34; Weiber & Mühlhaus, 2014), and "bouncing" had significant cross-loadings.

As a result, these three test items were removed from the test battery and the rest of the items were subjected to a new exploratory structural equation modeling in model 1b. On the basis of the scree plot of the eigenvalues ([1] 4.23, [2] 1.70, [3] 1.25, [4] .94) and the interpretability of the content, the three-factor solution was again favored. The cross-loadings were consistently low and non-significant (Table 5). Given the slightly better fit values and the clearer allocation of the test items to the factors, this model with 12 test items was favored (Table 4).

Table 4. Results of the analysis

Model	Analysis	CFI	TLI	RMSEA [CI]	SRMR	WRMR
1a	ESEM (15 Items) 1 factor	.86	.84	.063 [.054–.073]	*.10*	
	ESEM (15 Items) 2 factors	.96	.94	.037 [.024–.050]	*.07*	
	ESEM (15 Items) 3 factors	.99	.98	.024 [.000–.041]	*.05*	
	ESEM (15 Items) 4 factors	1.00	1.00	.000 [.000–.030]	*.04*	
1b	ESEM (12 Items) 3 factors	.99	.98	.023 [.000–.045]	*.05*	
2	CFA (12 Items) 3 factors	1.00	1.00	.009 [.000–.034]		.64
3	CFA with covariates age, sex	.99	.99	.014 [.000–.033]		.67

Notes: CFI = comparative fit index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean residual; WRMR = weighted root mean square residual; ESEM = exploratory structural equation modeling with oblique GEOMIN rotation; and CFA = Confirmatory factor analysis.

Table 5. Factor structure of the exploratory structural equation modeling

	Model 1a			Model 1b		
	F1	F2	F3	F1	F2	F3
Balancing	.788*	.028	.012	.806*	.037	−.020
Rotating	.734*	−.107	.002	.737*	−.141	.017
Stabilizing	.877*	.011	−.183	.884*	.011	−.202*
Persistent running	.280*	.127	.140			
Coordinated running	.544*	−.122	−.010	.548*	−.129	−.014
Rhythmic skipping	.480*	−.039	.027	.503*	−.084	.035
Throwing and catching	.058	.631*	−.065	.055	.618*	−.028
Bouncing	.411*	.309*	.010			
Dribbling	.081	.606*	−.004	.100	.617*	.000
Target throw	.153	.339*	.082			
Hitting a target	.153	.499*	.043	.146	.468*	.078
Controlling with a stick	−.015	.581*	−.135	−.002	.602*	−.143
Gliding	.070	.321	.556*	.019	.299	.614*
Diving	.316	−.006	.661*	.307	−.005	.645*
Floating	−.010	.569*	.795*	−.009	.564*	.771*

*The correlation was significant at the .05 level (2-sided).

The first factor (F1, Table 5) was characterized by test items that included movements requiring the entire body. Thus, this factor was designated "locomotion." The second factor (F2, Table 5) involved test items for which the safe handling of an object was required. Accordingly, this factor was named "object control." The third factor (F3, Table 5) included the three test items that were performed in the water. Thus, this factor was designated "moving in water."

3.3. Verification of the factor structure

A replication of the three-factor structure under more restrictive conditions (without cross-loadings) with confirmatory factor analysis in model 2 resulted in a very good model fit (Table 4). The factor loadings covered an acceptable range of values from .44 to .96. The inter-correlations of the three factors were between .40 and .69 (Figure 1). Thus, the confirmatory factor analysis confirmed the results of the exploratory factor analyses and the three-factor structure of the MOBAK test items.

Model 3, in which the covariates age and sex were added to Model 2 (Figure 2), achieved a satisfactory model fit (Table 4).

Figure 1. Confirmatory factor analysis (model 2).

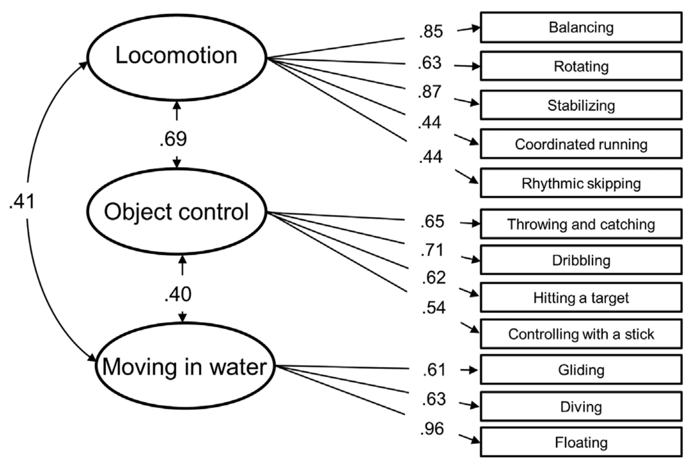
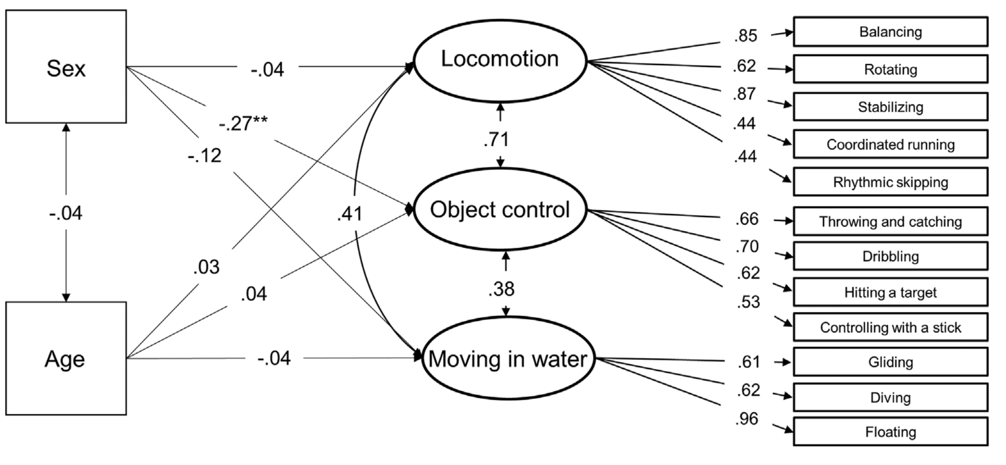


Figure 2. Confirmatory factor analysis with the covariates sex and age (Model 3; * *p* < .05; ** *p* < .01).



Whereas age had no significant influence on the factor “locomotion,” “object control” and “moving in water,” there was a (moderately) negative coefficient for “object control” ($\beta = -.275$; $p < .001$) with regard to the covariate sex (male = 0, female = 1). The boys achieved better “object control” performances than girls. On the basis of the requested modification indices, no modifications were suggested, which could be rated as evidence that there was no differential item functioning (DIF) between boys and girls and the age.

3.4. Educational support needs in motor competence

The interpretation of educational support needs in motor competence is determined normatively. Table 6 presents the interpretation keys in which was assumed, similar to the original MOBAK approach (Kurz & Fritz, 2007), that students who passed fewer than two-thirds of the tasks in at least one of the three previously determined test areas had educational support needs in this area. In addition, the second level allowed a statement about advanced motor competencies in a test area.

Looking at the overall results, it was concluded that a student had general educational support needs in the basic motor competencies (level 0) when educational support needs had been identified in at least one of the three test areas. If a student complied with the minimum requirements in all three test areas, it was concluded that he/she embodied the necessary basic motor competencies to participate in the movement culture (level 1). If a student surpassed the minimum requirements in all three test areas, it was concluded that he/she embodied advanced basic motor competencies in the overall results (level 2).

According to the interpretation key, Table 7 shows the educational support needs in the respective test areas. In addition, “MOBAK-total” shows the respective percentage of students who showed evidence of support needs in at least one of the three test areas (“special needs”) or who exceeded the minimum requirements in all three test areas (“level 2”). Here, data only from students who had participated in all the tasks were used, which thus allowed to interpret their potential support needs ($n = 200$). Most students exhibited a need for specific support in the area “object control,” and one-quarter of the students exhibited support needs in at least one test area. Across all test areas, the boys performed better than the girls, whereas the differences were significant in the area “object control” and in “MOBAK-total.” Also, students without an immigration background demonstrated better results in all test areas than students with an immigration background, especially in the area “object control.” Finally, there were only minor differences between the students who were physically active for up to six hours per week and those who were physically active for more than six hours per week, except for the test area “object control,” where the less active students demonstrated significantly worse results.

Table 6. Normative interpretation of educational support needs in one test dimension

Result	Interpretation
Fewer than two thirds of the test items passed in one test area	Students who pass fewer than two thirds of the tasks in one test area don’t reach the minimum requirements and need practice specifically in this area: specific educational support is needed
At least two thirds of the test items passed in one test area	Students who pass at least two thirds of the tasks in one test area reach the minimum requirements for participation in this area
At least two thirds of the test items passed on level 2 in one test area	Students who pass at least two thirds of the tasks in a test area on level 2 fulfil advanced requirements for participation in this area

Table 7. Educational support needs in the test areas "locomotion," "object control," "moving in water," and in "MOBAK-total" (total, gender, immigration background, physical activity per week)

	Total (*n* = 200)	Boys (*n* = 96)	Girls (*n* = 100)	Lux (*n* = 61)	Migr (*n* = 129)	0–6 h/week (*n* = 95)	>6 h/week (*n* = 64)
Variables	**%**	**%**	**%**	**%**	**%**	**%**	**%**
Locomotion							
Special needs	8.5	6.3	10.0	8.2	8.5	2.1	.0
Level 1	30.5	33.3	26.0	26.2	31.8	40.0	26.6
Level 2	61.0	60.4	64.0	65.6	59.7	57.9	73.4
U-test		$z = .26$, $p = .791$		$z = -.71$, $p = .476$		$z = 2.06$, $p = .039$	
Object control							
Special needs	19.0	11.5	25.0	14.8	20.2	20.0	9.4
Level 1	41.5	42.7	40.0	34.4	44.2	38.9	39.1
Level 2	39.5	45.8	35.0	50.8	35.7	41.1	51.6
U-test		$z = -2.21$, $p = .027$		$z = -1.87$, $p = .061$		$z = 1.70$, $p = .088$	
Moving in water							
Special needs	7.0	6.3	7.0	4.9	7.0	6.3	6.3
Level 1	37.0	30.2	44.0	41.0	34.9	44.2	31.3
Level 2	56.0	63.5	49.0	54.1	58.1	49.5	62.5
U-test		$z = -1.91$, $p = .056$		$z = .37$, $p = .713$		$z = 1.48$, $p = .138$	
MOBAQ-total							
Special needs	25.5	18.8	31.0	23.0	25.6	24.2	15.6
Level 1	53.5	58.3	49.0	52.5	54.3	56.8	53.1
Level 2	21.0	22.9	20.0	24.6	20.2	18.9	31.3
U-test		$z = -1.58$, $p = .115$		$z = -.66$, $p = .507$		$z = 1.93$, $p = .053$	

4. Discussion

In order to identify students with special educational needs, adequate test instruments are required. For this purpose, the presented test instrument, the MOBAK-3, was developed and validated for the evaluation of basic motor competencies.

The exploratory structural equation modeling with all 15 test items (Table 1) showed a three-factor structure with the factors "locomotion," "object control," and "moving in water." Due to high cross-loadings and low factor loadings, three test items were gradually removed from the test instrument, whereafter the factor structure was manifested more clearly. The final 12-item test instrument was tested with a confirmatory factor analysis, which confirmed the 3-factor structure. While boys achieved better in "object control" than girls, there was no differential item functioning (DIF) between boys and girls and the age.

The basic motor competencies operationalized by the test items showed three latent factors that were named "locomotion," "object control," and "moving in water." The presented results with the described structure thus suggested a model that was similar to the constructs that were identified in other validation studies of tests instruments that were based on the concept of basic motor competencies (Herrmann, Bund et al., 2015; Herrmann, Gerlach, & Seelig, 2015). The respective sets of results all contained the two factors: "locomotion" and "object control."

In addition, there was evidence that the current results may be compatible with other model concepts from the field of motor skills. The structure of basic motor competencies provided at least in part an analogy with the concept of fundamental movement skills, for which a difference is made between "locomotor skills" (cf. "locomotion") and "object control skills" (cf. "object control") (Haibach et al., 2011).

Another goal of the current study was to diagnose support needs in motor competence. Thus, the test instrument needed to be sensitive enough to determine students' competency profiles, which can provide information about the MOBAK-3 test areas in which students have the necessary basic motor competencies or exhibit educational support needs. By means of a normative interpretation key used in the interpretation of the results, the individual students can be assigned to three different classes in each area:

- students with educational support needs;
- students with basic motor competencies;
- students with advanced motor competencies.

Hereby, a total of one-quarter of the students exhibited educational support needs in at least one test area, mainly in the area "object control."

In terms of pedagogical diagnostics, the results generated by the MOBAK tests allow teachers or school administrators to identify students with educational support needs by making visible their motor competence profiles at either the class and/or school levels. On the classroom level, teachers can adapt their teaching toward a more individualized learning in order to support their students in acquiring basic levels of motor competence (teaching development). On the school level, school-based curricula can be adapted and support measures can be offered in special courses (school development). This said, the MOBAK tests could be implemented at the beginning of a school year, in order to collect relevant information to plan the teaching as well as adaptations on the school level on a long term.

The proportion of students meeting the criteria for each of the three classes was determined in conjunction with the external criteria of gender, immigration background, and physical activity. Boys showed better results than girls in all test areas. Also, students without an immigration background had better results than students with an immigration background across all test areas. Somewhat surprising, there were only minor differences between frequently active and less active students. One exception here was for the less active students who showed worse results in the area "object control."

4.1. Limitations and outlook

It is important to consider the high passing rates for most of the tasks. This can be explained by the concept of "basic competencies," which means that as many children of a certain age as possible should have mastered these tasks. In addition, the second level of difficulty showed very high passing rates as well. This can be explained by the fact that due to a movement-intense or sportive socialization, many children already exhibited very diverse motor competencies or well-developed motor skills at the age of eight years (Rothgang, 2009).

It was tried to ensure objectivity in the implementation and evaluation of the MOBAK-3 test instrument by employing standardized criteria. The detailed descriptions of the test items in the test manual should ensure that teachers will be able to implement the test in a standardized fashion. The MOBAK-3 test instrument benefits from its (partially) dichotomous scale level, which is considerably easier to handle and evaluate in comparison with ordinally scaled skill tests (e.g. TGMD-2; Ulrich & Sanford, 2000). This makes the present test battery practicable for a corresponding internal evaluation in terms of pedagogical diagnostics in physical education, as the teachers can implement the MOBAK-3 test items independently during their regular classes. Nevertheless, these standardization criteria should be further clarified in future studies so that measurement error in the implementation and evaluation process can be kept as low as possible.

In this study, the sensitivity of the test instrument was established by following a normative approach. However, this important question of the differentiation ability and the informational role of the MOBAK-3 should be investigated in further analyses by following an empirical approach, with the aim of creating empirically based qualification or competence profiles for students.

Because it can be assumed that the MOBAK-3 meets the corresponding criteria of test sensitivity at least when based on a normative definition of educational support needs (Kurz & Fritz, 2007), considerations of how this identification of support needs can be used in a meaningful way in the context of physical education should be discussed didactically. This test instrument provides a tool that can be used to implement an internal evaluation of pedagogical diagnostics, and teachers can implement this tool independently in their teaching, thus helping them to individually adapt their teaching. Consequently, teachers need appropriate support to foster their students adequately so that in the future, these students will be able to acquire any basic motor competencies that they have not yet acquired. Thus, a future aim should be to develop a framework of support to help teachers deal with students with educational support needs as identified by the MOBAK-3.

Finally, further research should aim to explore in more depth the possible impact of determining values such as “immigration background” or “physical activity level.” The question of which factors determine the specification of basic motor competencies in students remains. Possible influences might consist of previous knowledge and experience (encouragement to engage in physical activity inside and outside the family), cognitive characteristics (intellectual capacity and cognitive performance at school), non-cognitive characteristics (self-concept, interests, or achievement motivation), family support and influences, school influences (school climate or teacher behavior), peer group influences, age-related influences (physical changes), changes in the social environment (self-dependence), or cultural change-related influences (cultural environment) (Rothgang, 2009).

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Note
1. The development of the items relied on the expertise in the development of MOBAK-based test instruments and in school curriculum development of several experts from the University of Bielefeld (Prof. Dietrich Kurz’s work group), the University of Basel (Dr. Christian Herrmann’s work group), the University of Potsdam (Prof. Erin Gerlach’s work group), and the University of Education Heidelberg (Prof. Peter Neumann’s work group).

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