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Development and Validation of an Instrument for Assessing Student's Attitudes Towards the Use of Video-based Media in Physical Educationn

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Abstract

Background. The integration of digital media, particularly video-based technologies, has become an important element of contemporary education. While teachers' attitudes toward digital media are well researched, students' attitudes toward the use of video in physical education remain underexplored. Existing instruments capture only selected components of attitudes and do not fully represent the cognitive, affective, and behavioral structure. Therefore, a validated and comprehensive instrument is needed to assess students' attitudes toward video-based media in PE.

Objectives. To develop, refine, and validate a questionnaire measuring students' attitudes toward the use of video-based media in physical education, based on an extended Technology Acceptance Model (TAM).

Materials and Methods. The initial questionnaire consisted of 33 items covering cognitive, affective, and behavioral attitude components. A sample of 202 eighth-grade students (M = 13.26; SD = 0.54) participated. A series of confirmatory factor analyses (CFA) was conducted to optimize the factor structure. Internal consistency (ω, α), factor loadings, model fit indicators (CFI, RMSEA), and convergent/discriminant validity were evaluated.

Results. The final scale includes 21 items forming a three-component structure: cognitive (ω = .74), affective (ω = .81), and behavioral (ω = .87). The factor model demonstrated acceptable fit (CFI = .82; RMSEA = .10). Significant correlations among subcomponents confirmed convergent validity, while the absence of substantial associations with demographic characteristics supported discriminant validity.

Conclusions. The developed scale is a reliable and valid instrument for comprehensively measuring students' attitudes toward the use of video-based media in physical education. It can be applied in future research on technology acceptance and in designing pedagogical interventions aimed at optimizing the use of video in PE lessons.

Keywords: physical education, video-based media, attitudes, scale validation, Technology Acceptance Model, questionnaire.

Introduction

As it is true for almost every aspect of our everyday life, digital media influences the culture of human motion, play, and sport. Consequently, physical education (PE) lessons that are centered on the daily life of students must strongly consider the use of digital media, particularly since the digitization of schools is now established as a cross-sectional task at an international level (KMK, 2016). This way, educational institutions are addressing their social responsibility of promoting competencies that enable learners to participate responsibly, confidently, and actively in the digitalized world (KMK 2021, p. 6). Whereas media usage increased massively in the last two decades (Rideout & Robb, 2020), the impression that the young generation generally has a positive attitude towards the use of digital media in school and likes to use it for learning purposes may be outdated (Oblinger & Oblinger, 2005). Research has shown that this is a rather superficial view of children's and adolescents' attitudes towards the use of digital media at school, and researchers demand a

more nuanced consideration of these interconnections (Jones et al., 2010). Therefore, the examination of media-related attitudes is gaining importance as a prerequisite for empirically testing intended effects in this area. The didactic relevance of students' attitudes towards the use of video-based media in physical education unfolds both in and out of school: From the knowledge of students' attitudes and their genesis, consequences for the didactic staging of the use of video-based media in physical education can be derived. In addition, it has not yet been clarified to what extent the reference to movement in the subject of physical education influences the attitudes of the students, so that the question of subject-specificity and generalizability of their genesis cannot yet be answered on the basis of evidence. Since digital media plays a central role in this extracurricular culture today (e.g., Wendeborn, 2019), the media-related attitudes of students do not only concern media use in school contexts, where the choices are often limited by the lesson design and the framework conditions. In terms of promoting physical activity, findings also indicate that the sports-related media use of young people has an increasing influence on the amount of sports activity (Braumüller & Hartmann-Tews, 2017). In recent years, computer-related attitudes of students have been examined increasingly (e.g., Petko et al., 2018). The results provide evidence that media use in school can positively influence students' attitudes towards digital media. Nevertheless, the findings show that students' attitudes toward media use at school are not as fundamentally positive as previously assumed (Jones et al., 2010). Although previous research shows ambiguous results, it seems that the media-related attitudes of students are a relevant criterion for media use within and outside of school contexts (Al-Qaysi et al., 2020; Granić & Marangunić, 2019) and are therefore the target perspective of media didactic efforts. However, there is a significant research gap concerning the topic of students´ attitudes towards digital media in PE.

Studies on the use of digital media in PE are characterized by a great heterogeneity in the operationalized goals of media use in PE, ranging from physical, social, cognitive to affective goals. However, despite thorough research, we are not aware of any reliable data on the quantity of media use in PE lessons. The connection between digital media and physical goals of physical education, which is probably the most dominant goal level in PE overall, has been researched the most (Jastrow et al., 2022). With regard to the development of physical goals in digitally supported PE, a distinction can be made between two categories: increasing physical activity and developing sport-specific skills (Jastrow et al., 2022). In many cases, it has been shown that increasing physical activity through the use of digital media in PE lessons is often unsuccessful, whereas the development of sport-specific skills with the help of digital media can often be successful under suitable conditions. Feedback and demonstration videos are primarily used, with video feedback being the best researched for motor learning (e.g., Mödinger et al., 2021). The underlying theory is the motor approach, based on the information theory approach, according to which movement representations can be stored centrally and retrieved as needed (Schmidt, 1975). During the learning process, movement representations are reinforced and parameterized (Mödinger et al., 2021). Both forms of video use for motor learning are forms of learning via video modelling. Feedback videos differ from demonstration videos in that they can be described as 'a form of observational learning with the distinction that the observed and the observer, object, and subject, are the same person' (Dowrick, 2012). This form is therefore also referred to as video self-modelling (Casey & Jones, 2011; O'Loughlin et al., 2013). Therefore, the term video-based media includes both feedback and instructional videos and thus distinguishes itself from activity enhancement technologies such as trackers etc. in the context of the physical goals of media use in PE. Based on this, digital media is specified as video-based media in this study.

Attitudes and Attitude Measurement

A key part of the study is the psychological construct of attitude. Attitudes are general evaluations that can refer to oneself, others, or objects and situations (Mummendey & Grau, 2014) and are based on experience. Attitudes consist of a cognitive, an evaluative (affective), and a behavioral component, with an emphasis on the evaluative component of attitude (Rosenberg & Hovland, 1960). In accordance, attitude is defined as a learned tendency to evaluate classes of objects or people 'favorably' or 'unfavorably' as a function of one's beliefs and feelings (Zimbardo & Gerrig 1996, p. 521). In this multidimensional attitude construct, the cognitive component refers to a person's beliefs, thoughts, and knowledge about video-based media in PE (e.g., usability, usefulness). Thus, this dimension refers to cognitive representations of the world that can be true or false, influencing a person's behaviors (Cuéllar, 2022). The evaluative component is often used synonymously with the term "attitude" itself, leading to ambiguities and misinterpretations (Johnson et al., 2022). However, in line with the cognitive (and behavioral) dimension, the affective dimension is only on aspect of the whole construct of the attitude. The evaluative component refers to a person's emotional response or feeling towards the video-based instruction (favorable or unfavorable), reflecting favor or disfavor along an evaluative continuum (Johnson et al., 2022). The behavioral component refers to a person's tendency to act in a certain way towards video-based media (e.g., the actual use of or engagement with video-based digital media). While attitudes are formed through a combination of cognition, emotion, and behavior, and are automatically activated upon exposure to the entity in question (Jain, 2014), they are naturally interrelated (Fishbein & Ajzen, 1977), leading to medium and even high correlations or regression analytic effect sizes (e.g., Farley & Stasson, 2003).

There have been numerous studies on students' attitudes toward PE (e.g., Li et al., 2014; Ntovolis et al., 2015; Subramaniam & Silverman, 2000). Most of these studies focus on the influence of PE-related attitudes and participation in extracurricular sports, with students' attitudes towards media use in PE not playing a role so far. For example, research shows that positive attitudes toward PE can help students create healthy, active lifestyles that extend beyond adolescence (Haible et al., 2019) and into adulthood (Subramaniam & Silverman, 2007). Regarding the changeability of PE-related attitudes, it appears that they can be influenced by meaningful experiences, relationships, and increased self-efficacy (Digelidis et al., 2003).

Attitudes are explicitly measured with subjective measures (semantic differentials or short statements) rated on scales (Hair et al., 2019). These ratings provide information about how people are attuned/disposed with respect to defined topics. However, measurements of attitudes in the context of PE and video-based media use have been conducted rudimentarily and with only a few items (Davis, 1989; Venkatesh et al., 2012). The most popular instrument for assessing students' attitudes toward PE, the SAtPE (Students Attitudes Toward Physical Education Questionaire; Subramaniam & Silverman, 2000), works with a two-component view on attitudes, involving cognitive and evaluative components (usefulness and enjoyment), and includes a total of 20 items (Subramaniam & Silverman, 2000). Thus, it measures only a subset of possible variables that can be assigned to the evaluative or cognitive component and does not consider the behavioral component. It has been used in numerous studies with secondary school students, and an adapted version is available for elementary school students (Phillips & Silverman, 2012). From a psychological perspective, using a more comprehensive questionnaire that covers all components of the attitude construct in more detail is appropriate (Zimbardo & Gerrig, 1996).

Media Related Attitudes

In the context of PE, recently there have been numerous studies on various aspects of digital media, including exemplary studies on the Digital Video Games Approach (Price et al., 2022), the use of digital media in elementary school (Greve et al., 2022), and the motivational effects of digital media on students in PE (Mackenbrock & Kleinert, 2023). However, empirical findings on students' attitudes toward video-based media in PE are lacking, and students' technology-related attitudes and beliefs, as well as their genesis, have not been comprehensively clarified (Petko et al., 2018). However, technology acceptance models (TAM; Davis, 1989; Venkatesh, et al., 2012; Alsharida & Hammond, 2021), developed based on the Theory of Planned Behavior (Fishbein & Ajzen, 1977), suggest that attitudes play a central role in predicting future media-related actions (see Figure 1). Therefore, the study employs the Technology Acceptance Model (TAM), which will be discussed in more detail.

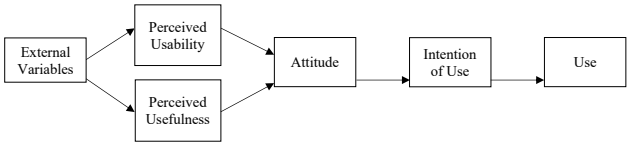

Fig. 1. Technology Acceptance Model (own representation)

The TAM serves as a basis for validating students' attitudes toward the use of video-based media in PE for two reasons: (1) the model outlines that external variables can influence the emergence of attitudes, and (2) the TAM can reflect the three-component structure of the psychological construct of attitudes. According to the TAM, external variables affect the cognitive component of attitudes that are reflected in terms of perceived usability/usefulness in prior TAM versions. This cognitive component affects the evaluative component. Considering general ambiguities regarding the definition of the evaluative component of attitudes discussed above, this evaluative facet is often defined as "attitude" in prior TAM versions. The evaluative component further affects the behavioral component (intention to use and actual use).

However, previous TAMs show inconsistencies, especially regarding the conceptualization and dimensionality of attitudes (e.g., Davis, 1989; Park, 2009). For example, the evaluative component is synonymously referred as "attitude" although this is merely a partial component of the actual attitude. Furthermore, prior research provided little focus on this evaluative component of the attitude, which is only partially addressed in individual studies (Al-Rahmi et al., 2021), although it can be of crucial importance (Rosenberg & Hovland 1960). In the "unified theory of acceptance and use of technology model" developed based on the TAM (e.g., Chao, 2019), not all three components of attitude are explicitly surveyed as well. In particular, the cognitive component is not explicated. Thus, it is difficult to make comprehensive statements about the influence of attitudes on usage behavior. Doubts about the general validity of the model are increasingly expressed, and the necessary adaptations to the respective application context are demanded (Al-Emran & Granic, 2021). Therefore, the TAM was updated in the context of this study to capture students' attitudes toward video-based media use in PE. To do so, additional sub-constructs have to be taken into account and should be explicitly included in the TAM. Every attitude component was enriched by additional sub-constructs in order to holistically assess all relevant aspects of the attitude dimensions. All relevant constructs are thus, described and discussed below.

Relevant Scale Constructs

Attitude components, as well as most sub-constructs, are based on research on attitudinal constructs from a psychological perspective, in addition to previous research regarding the TAM. However, since this study has a strong focus on PE, additional variables need to be considered.

Cognitive Component

First, the cognitive component was divided into "perceived usefulness" and "perceived usability" (obtained from prior TAM versions; e.g., Park, 2009) since perceived usefulness as well as usability served as major influencing variable on intention to use or course acceptance in prior research (e.g., Selim 2003). Further, studies on the media-related attitudes of PE teachers revealed subject-specific characteristics that have to be included as a sub-construct of the cognitive component because they might be relevant for students as well. There is a belief that PE should primarily serve physical activity (motion preference or primacy of movement; Roth, 2022). Consequently, the use of video-based media might disrupt the goals of PE since media reception could leave less time for the activity. In this context, the teacher plays a central role in guiding the focus by means of individual feedback (Mödinger et al., 2021). Consequently, both teachers and students may doubt that video-based instruction is appropriately designed for sport-

related instructional purposes because the lack of individual feedback by the teacher cannot be compensated for by feedback options provided by videos. Thus, the variables "motion preference" and "adequate design" were included as well.

Evaluative Component

There was a focus on the evaluative component of the attitude since prior research often neglected this component (e.g., Al-Rahmi et al., 2021). Consequently, the evaluative component was included, and both positive and negative evaluations were considered. Positive evaluation is defined as positive affective attitudes towards video-based media use, negative evaluation is defined as negative affective attitudes. Both variables were considered separately since students might have both, positive affections and negative affective attitudes towards differentiated aspects regarding video use in PE which would be not visible within one single scale (e.g., Cacioppo, 1994). The evaluative component was explicitly included since Park (2009) found that the evaluative component mediated the relationship between the cognitive and behavioral component.

Behavioral Component

The behavioral component encompasses the intended use rather than the actual use. Students do not have autonomy over the use of media, as this is determined by the teachers. Therefore, the students' perspective is insufficient, given their limited or decision-making power in this context. Consequently, it is crucial to emphasize that the behavioral component can only be considered to a limited extent.

To summarize, the main goal of this study is to develop an instrument that can validly survey the attitudes of students towards the use of video-based media in PE. In this vein, the latent construct of this attitude with its components will be operationalized in order to use this instrument in subsequent studies to, for example, analyse structural relationships between attitude dimensions or to test which variables determine the attitude. An example of how these variables can be included in the TAM is presented in Figure 2.

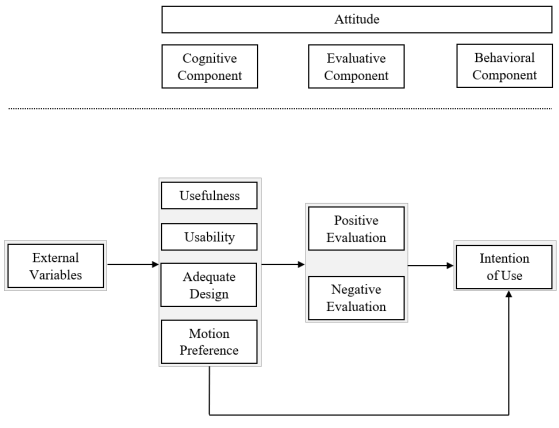

Fig. 2. Adapted Technology Acceptance Model

Materials and Methods

Scale Development

There is evidence that rating scales are useful in recent studies on (general) attitude measurement (e.g., Reschke & Jude, 2022) and can explicitly account for all dimensions through specific item formulation. It must be considered that attitudes may be implicit; however, it is possible that effects of social desirability regarding sensitive topics prevent attitude measurement from being bias-free when using differentials (Garms-Homolová, 2020). Nevertheless, attitudes regarding media use or attitudes toward media content can be considered non-sensitive constructs, which recommend the use and sensitivity of semantic differentials (SD) (Neumann et al., 2018). Since we aimed to measure a specific attitude, attitude toward video-based media use in PE, an appropriate scale was created and validated following recommendations from various methodologists (e.g., DeVellis & Thorpe, 2022).

In the first step, the authors developed 33 items: 17 items for sub-facets of the cognitive component, 8 items for sub-facets of the evaluative component, and 8 items for the behavioral facet (see Appendix A). These items measured the cognitive facet (perceived usefulness, perceived usability, adequate design, motion preference), the evaluative facet (positive and negative evaluation), and the behavioral facet (intention of use). This was preceded by an extensive literature review regarding the TAM. The authors referred to prior literature (e.g., Park, 2009; Natasia et al., 2022) to formulate the items as precisely as possible. Additionally, new items were created to include constructs relevant to PE didactics (i.e., motion preference). In this regard, PE didactic publications with regard to attitudes towards the use of digital media in PE were reviewed (e.g., Roth, 2022) to create adequate items. According to this literature research, each subscale mostly consisted of two to four items, as prior research outlined that constructs could be measured reliably even with a short number of items (Davis, 1989; Venkatesh et al., 2012). Items were adopted and, in some cases, reformulated to reflect the context of video-based media. The term video-based media is not differentiated in the questionnaire with regard to video feedback, so that in addition to video feedback the term also includes other video-based aspects. One example are demonstration videos, which are increasingly finding their way into PE as an alternative to "demonstrating" movements. Each item presented a short statement (e.g., "Videos are not useful for physical education."). The participants assessed the items based on a 5-point Likert-type scale (1 = fully agree; 2 = tend to agree; 3 = neutral; 4 = tend to disagree; 5 = do not agree at all).

Data Curation

The questionnaire was validated using a sample of secondary school students. This sample has high practical relevance for the research questions to be investigated because these students actively and regularly attend PE classes. Overall, 202 8th-grade students (Mean age = 13.26; Age Standard Deviation = 0.54) participated in the study. Forty-nine percent of the participants were female. Students

were recruited from secondary schools in and around the cities of Freiburg and Dortmund. This sample was chosen because scale validation with a confirmatory factor analysis (CFA; Lance & Vandenberg, 2002) requires large sample sizes. In line with recommendations from methodologists (e.g., Koran, 2016), a ratio of 8-11:1 (participants to items) was used to determine the appropriate sample size for the CFA. Since three separate CFAs were conducted (for the cognitive component, the evaluative component, and the behavioral component), a sample size of 202 participants was adequate for CFAs with a maximum of 17 items.

Data were collected using two methods: (1) Since some secondary schools did not have a sufficient internet connection, the questionnaire, including all items, was provided in a paper-pencil format. (2) The questionnaire was also made available digitally using the open-source survey software LimeSurvey. During regular school lessons, students were given either the printed or the digital version of the questionnaire. Prior research outlined mode effects regarding the administration of surveys as paper pencil tests vs. digital tests, most differences emerge in terms of completion or response rate (e.g., Weigold et al., 2019) and in terms of data quality for sensitive or personal questions (e.g., Swartz et al., 2007). However, since teachers were present in order to ensure that every student worked on the questionnaire till the end and since no sensitive questions were asked, we argue that mode effects were negligible for this questionnaire.

Initially, students provided their informal consent for participation and were instructed about the study's purpose. Afterward, demographic data were collected. Before the participants completed the main questionnaire, a sample item was presented to instruct how a rating scale should be used. Subsequently, the participants answered the questionnaire with all 33 items. All instructions are displayed in Appendix B. The entire study took approximately 10-15 minutes. Since questionnaires were presented in a paper-pencil format, some students inadvertently skipped items, for example, by accidentally skipping a page during the study. Overall, data from 16 students were incomplete. Seven participants skipped one or more single items without a systematic pattern and nine participants skipped a page. To avoid excluding these subjects, multiple imputation was conducted (Murray, 2018) to fill in missing data. For this, all available variables were used as predictors, as well as the variables that needed to be imputed. Using a linear imputation model, five iterations were conducted, and the mean values of these iterations were used to fill in the missing values.

Analysis Plan

Four confirmatory factor analyses (CFAs) were performed using maximum likelihood estimation. CFAs were conducted for the cognitive component (four potential factors: perceived usefulness, perceived usability, adequate design, motion preference), the evaluative facet (two potential factors: positive and negative evaluation), and the behavioral component (one-factor model: intention of use). It was assumed that the factors were correlated. Varimax rotation was applied. Based on the results of the factor loadings, items were selected to be included in the final questionnaire for model validation. In general, it is assumed that an item can be deleted due to (1) a poor factor loading (< 0.50; Mertler & Vannatta, 2001), and/or (2) cross-loadings (> 0.40, considering a sample size of around 200; Hair et al., 2009). The Comparative Fit Index (CFI) and the root mean square error of approximation (RMSEA) were reported for each analysis. Values greater than 0.90 are usually interpreted as an acceptable fit and values greater than 0.95 are interpreted as good fit for the CFI (Bentler, 1990). Concerning the RMSEA, the value should not exceed the cut-off 0.10 (Browne and Cudeck, 1992).

After conducting the CFAs, the remaining items of the subscales were examined in terms of reliability. In line with current developments regarding scale development, internal consistency was conducted as reliability score (McDonald's ω; McDonald, 1999, or Cronbach's α; Cronbach, 1951, when only two items remained since ω can only be computed for three or more items).

Finally, an overall CFA was conducted using maximum likelihood estimation to check if the three attitude components (3 factors) are reflected as significant factors with regard to the final items. Again it was assumed that the factors were correlated.

To further investigate validity of the scale, the validity concept of the AERA (2014) was applied. According to the authors, validity is the measure "to which evidence and theory support the interpretation of test scores for proposed uses of tests" (AERA, 2014, p. 11). Thus, validity is not understood as a property of a test, but as a criterion regarding the admissibility of test score interpretations, which in turn depend on the intended use of the test (Hartig et al., 2020). With the test instrument to be developed, we intended to measure the components of the attitude towards the use of video-based media in PE in order to use this instrument in future studies to assess relations between the components and to investigate how relevant variables affect the components. With this goal in mind and following the argumentation-based validity concept of Kane (2013), we aimed to test for construct validity. Since no other (related ort unrelated) scales were implemented, validity can only be investigated exploratory. In this vein, the sub-constructs from all attitude components were correlated to examine convergent validity. Since prior research outlined medium to large correlations between the attitude components (e.g., Farley & Stasson, 2003), correlation analyses aimed to replicate these effects to interpret convergent validity. Discriminant validity was carried out regarding demographic variables: gender, age, type of school. This approach was chosen since prior research outlined that demographic variables like gender and age only marginally correlate with attitudes towards physical education (e.g., Luke & Sinclair, 1991; Lepir et al., 2010) as well as media use in education (e.g., Ramirez-Correa et al., 2015). Thus, it was to be expected that no relevant correlations would occur here ($r < .25$; Greiff et al., 2015) which can be interpreted as support for discriminant validity. However, it has to be mentioned that results regarding secondary students (based on the TAM or not) are rare. The Pearson correlation coefficient was used and interpreted according to the conventions from Senthilnathan (2019; $0 < r < 0.20$: negligible; $0.20 < r < 0.35$: weak but considerable; $0.35 < r < 0.50$: moderate; $0.50 < r < 0.70$: strong; $0.70 < r < 1$: very strong).

The final scale (after item exclusion) with all item characteristics can be found in Table 1.

Table 1. Descriptive values and factor loadings of the items of the confirmatory factor analysis for all attitude components.

Factor/Item	Mean (*SD*) [Difficulty]	Skewness	Kurtosis	Inter-item correlation	Factor loading
Cognitive component					
Factor 1 (usefulness)					
Videos will improve learning in Physical Education classes. (UF2)	3.69 (1.00) [0.74]	-0.43	-0.35	.58	.51
The content of Physical Education classes is unsuitable for video-based teaching. (UF4)	3.82 (1.00) [0.76]	-0.57	-0.34	.58	.98
Factor 2 (usability)					
It's easy to learn how to use videos in Physical Education. (U2)	3.22 (1.03) [0.64]	0.003	-0.47	.70	.63
The use of videos in physical education is complicated. (U3)	3.25 (1.12) [0.65]	-0.16	-0.67	.70	.88
Factor 3 (adequate design)					
I see the most important things better when someone shows them to me than when I watch a video. (AD3)	3.45 (1.12) [0.69]	-0.19	-0.70	.81	.50
I would rather be taught sports by real teachers than by videos. (AD4)	3.51 (1.13) [0.70]	-0.16	-0.87	.69	.85
I think videos are just as good as teachers in providing knowledge in sports. (AD5)	3.09 (1.11) [0.62]	-0.17	-0.45	.80	.55
Teachers can convey information in physical education much better than videos. (AD6)	3.62 (0.97) [0.72]	-0.09	-0.59	.72	.81
Factor 4 (motion preference)					
When we use videos in gym class there is less time for me to move. (MP1)	3.31 (1.17) [0.66]	-0.22	-0.83	.48	.50
I exercise less when I watch videos in gym class. (MP3)	2.91 (1.28) [0.58]	0.10	-1.06	.48	.78
Affective Component					
Factor 1 (positive evaluation)					
I think it's good that videos are used in Physical Education. (PE1)	3.21 (1.21) [0.64]	-0.21	-0.83	.74	.85
Learning things about sports with a video is a good idea. (PE2)	3.41 (1.17) [0.68]	-0.30	-0.66	.71	.77
I don't see anything positive about videos in Physical Education. (PE3)	3.53 (1.17) [0.71]	-0.54	-0.51	.58	.61
Factor 2 (negative evaluation)					
I don't think videos in Physical Education are bad in general. (NE1)	2.55 (1.18) [0.51]	0.46	-0.55	.47	.98
The use of videos in Physical Education does not cause any particular dislike in me. (NE2)	2.42 (1.12) [0.48]	0.35	-0.65	.47	.42
Behavioral Component					
Factor 1 (intention of use)					
I would like to know more about videos in Physical Education. (IU2)	2.91 (1.31) [0.58]	0.05	-1.12	.50	.54
I wonder why I should continue to engage with videos in Physical Education. (IU4)	3.08 (1.32) [0.62]	-0.05	-1.09	.48	.51
I would like to see more videos in Physical Education class. (IU5)	3.07 (1.32) [0.61]	-0.13	-1.07	.76	.84
In the next Physical Education lesson, I would like to see a video. (IU6)	2.84 (1.32) [0.57]	0.09	-1.10	.74	.80
My teacher should not use videos in Physical Education. (IU7)	3.26 (1.31) [0.65]	-0.31	-1.03	.75	.82
I don't want videos to be used in Physical Education. (IU8)	3.34 (1.41) [0.67]	-0.32	-1.19	.74	.80

Results

Cognitive Component

The CFA included 17 items (four for perceived usefulness, four for perceived usability, six for adequate design, and three for motion preference). Bartlett's test of sphericity (Bartlett's $\chi^2(136) = 1385.94$, $p < 0.001$) confirmed the sample fit for factor analysis, CFI = .82, RMSEA = .10. Overall, 49.40% of the variance could be explained considering the factor structure. The entire rotated factor matrix is displayed in Appendix C. The data revealed that the postulated factor structure could not be supported. Consequently, the entire scale was reworked. Eight items were deleted (two items for perceived usefulness, two items for perceived usability, two items for adequate design, and one item for motion preference). In Appendix C, these variables are marked in red. Consequently, these items were removed from the scales. An updated CFA with the remaining 10 items confirmed the sample fit for factor analysis (Bartlett's $\chi^2(45) = 772.86$, $p < 0.001$) with 62.43% of the explained variance, CFI = .97, RMSEA = .06. The entire rotated factor matrix is displayed in Appendix C. Reliabilities of the subscales were satisfactory: $\alpha = .74$ for usefulness, $\alpha = .82$ for usability, $\omega = .82$ for adequate design, and $\alpha = .75$ for motion preference. The inter-item correlations were in acceptable range.

Evaluative Component

The CFA included 8 items (four for positive evaluation, four for negative evaluation). Bartlett's test of sphericity (Bartlett's $\chi^2(28) = 821.85$, $p < 0.001$) confirmed the sample fit for factor analysis, CFI = .91, RMSEA = .14. Overall, 56.05% of the variance could be explained considering the factor structure. The entire rotated factor matrix is displayed in Appendix D. The data revealed that three items (one item for positive evaluation, two items for negative evaluation) did not fit the postulated factor structure. In Appendix D, these variables are marked in red. Consequently, these items were removed from the scales. An updated CFA with the remaining 5 items confirmed the sample fit for factor analysis (Bartlett's $\chi^2(10) = 343.31$, $p < 0.001$) with 62.80% of the explained variance, CFI = 1.00, RMSEA = .00. The entire rotated factor matrix is displayed in Appendix D. Reliabilities of the subscales were satisfactory for positive evaluation: $\omega = .83$. However, it should be noted that reliability for negative evaluation was slightly restricted: $\alpha = .64$. The inter-item correlations were in acceptable range.

Behavioral Component

The CFA included 8 items for intention of use (one-factor structure). Bartlett's test of sphericity (Bartlett's $\chi^2(28) = 837.41$, $p < 0.001$) confirmed the sample fit for factor analysis, CFI = .77, RMSEA = .22. Overall, 46.07% of the variance could be explained considering the factor structure. The unrotated factor matrix is displayed in Appendix E (since no rotation could be conducted for one factor). The data revealed that two items did not fit the postulated factor structure. In Appendix E, these variables are marked in red. Consequently, these items were removed from the scales. An updated CFA with the remaining 6 items confirmed the sample fit for factor analysis (Bartlett's $\chi^2(15) = 600.55$, $p < 0.001$) with 53.51% of the explained variance, CFI = .92, RMSEA = .16. The updated factor matrix is displayed in Appendix E. The reliability of the scale for intention of use was satisfactory: $\omega = .87$. The inter-item correlations were in acceptable range.

Overall CFA

The overall CFA included the remaining 21 items. Bartlett's test of sphericity (Bartlett's $\chi^2(186) = 593.24$, $p < 0.001$) confirmed the sample fit for factor analysis, CFI = .82, RMSEA = .10. Overall, 56.65% of the variance could be explained considering the factor structure. The entire rotated factor matrix is displayed in Appendix F. Overall, the factor loadings were acceptable. Please note that negative factor loadings for motion preference, adequate design and negative evaluation arise since items are formulated inverse in contrast to the other constructs. Reliabilities of the subscales were satisfactory: $\omega = .74$ for the cognitive component, $\omega = .81$ for the evaluative component, and $\omega = .87$ for the behavioral component.

Validation

The correlation matrix is displayed in Appendix G. All correlations reached significance. Within the attitude components, sub-facets correlated with at least considerable effect sizes. For example, perceived usability and usefulness showed a large correlation ($r = 0.52$). Perceived usefulness and usability showed significant negative correlation with design concerns and motion preference ($-0.48 \leq r \leq -0.33$), indicating a fit with theoretical assumptions. Furthermore, there are at least medium effect sizes between the attitude components. High scores on variables in the cognitive component are thus associated with high scores in the evaluative ($|r| \geq 0.34$) as well as behavioral component ($|r| \geq 0.47$). The same pattern could be observed with regard to the correlations between the evaluative and behavioral component ($|r| \geq 0.47$). In summary, convergent validity could be assumed. Discriminant validity could be assumed as well since all correlations between the attitude dimensions and the demographic variables were: $|r| \leq 0.23$.

Discussion

Results have shown that the created scale sufficiently fulfills all relevant quality criteria. All sub-scales exhibited high reliability, with the exception of negative evaluation, which had slightly lower reliability, as will be discussed in the limitations section. These findings indicate a high level of measurement accuracy. The presence of sufficient inter-item correlations further supports this claim.

Regarding the scale's validity, two procedures were adapted. First, factor analyses revealed that consistent sub-facets were defined within attitude components, and these sub-facets individually contributed to each attitude component. Second, exploratory correlation analyses demonstrated that convergent and discriminant validity could be assumed, as significant correlations of considerable sizes were found. However, additional studies need to be conducted to utilize further scales and compare them with

the subscales used here in order to strengthen assumptions about validity. With regard to the results this exploratory study, it can be argued that the scale created is reliable and valid for measuring attitudes toward (video-based) media use in PE.

The strength of the scale lies in its multidimensional approach to recording attitudes, bridging the fields of PE didactics and psychology. Furthermore, the sub-facets of the attitude components have been specified and optimized based on research regarding the TAM, psychological research, and concepts from PE didactics. This ensures that the scale is optimally adapted to the didactical context. The results can serve as an encouragement to initiate intervention studies based on the validated scale. The scale has been shown to be reliable and valid, and thus, can be used to further investigated media related attitudes in physical didactics. As discussed, media use, particularly video feedback, holds great instructional potential for motor learning in PE (e.g., Mödinger et al., 2021). Additionally, the attitudes of students towards the use of video-based media in PE should be a relevant focal point.

The educational significance of students' attitudes toward using video-based media in physical education is evident both within and outside the school setting. Insights into these attitudes and their development can inform how video-based media is integrated into physical education lessons. Moreover, the extent to which the movement component in physical education influences students' attitudes remains unclear, leaving open the question of whether these attitudes are specific to the subject or generalizable. The use of the questionnaire can help to make didactic decisions that take into account any existing scepticism about the use of digital media in physical education lessons by students. It also makes it possible to map the extent to which interventions can change attitudes towards the use of video-based media in PE lessons.

Limitations and Future Research

Four methodological limitations need to be discussed. Firstly, the reliability of the negative evaluation scale was relatively low. This might provide an additional explanation for the absence of a connection between negative evaluation and the intention of use. Future research could focus on delve into individual relationships within our model and measure each construct with more items and to reformulate the negative evaluation scale. However, since we aimed to examine the model as a whole, we measured each sub-construct with only a few items to avoid overwhelming the secondary students.

Second, the items were formulated with regard to "video-based" media. We choose this approach to ensure that students could actually have a comparable association, and not just use the abstract term "media", where each student could have their own association of what is meant. Thus, future research could replicate our finding by using different media in the context of PE. Since our items were formulated in a way that the term "video-based" could easily be replaced with another term without changing the wording in general, this might be a promising approach for future research.

Third, no external scales were used to validate the instrument. Validity could thus, only exploratory be analyzed by correlating dimensions of the attitude with each other and with demographic variables. Follow-up studies should build on these exploratory analyses. Future studies should further validate the overall structure of the scale with confirmatory factor analyses and validity should be verified with additional scales related (or unrelated) to the developed scale.

Fourth, the behavioral facet could only be considered to a limited extend since students do not have autonomy over the use of media. Consequently, only the intention of use could be considered. Further studies should foster on additional samples. For example, teachers could be investigated. The scale could therefore, be adapted and an additional sub-scale for the actual use could be integrated.

Conflict of Interest

I declare that I and all Co-Authors have no conflict of interest.

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Appendix A: Original Questionnaire with 33 Items

Code	Original Item	Translated Item
Cognitive component: usefulness		
UF1	Videos sind nicht nützlich für den Sportunterricht.	Videos are not useful for Physical Education.
UF2	Videos werden den Lernerfolg im Sportunterricht verbessern.	Videos will improve learning in Physical Education classes.
UF3	Videos machen es einfacher, die Inhalte des Sportunterrichts zu lernen.	Videos make it easier to learn the content of Physical Education.
UF4	Die Inhalte des Sportunterrichts sind für videobasierte Lehre ungeeignet.	The content of Physical Education classes is unsuitable for video-based teaching.
Cognitive component: usability		
U1	Videos sind im Sportunterricht einfach zu nutzen.	Videos are easy to use in Physical Education classes.
U2	Es ist leicht zu lernen, wie man Videos im Sportunterricht nutzt.	It's easy to learn how to use videos in Physical Education.
U3	Die Bedienung von Videos im Sportunterricht ist kompliziert.	The use of videos in Physical Education is complicated.
U4	Man kann schnell lernen, wie man Videos im Sportunterricht nutzt.	You can quickly learn how to use videos in Physical Education.
Cognitive component: adequate design		
AD1	Auf Videos kann ich wichtige Aspekte des Unterrichts möglicherweise nicht erkennen.	I may not be able to see important aspects of the lesson on videos.
AD2	Die Gestaltung von Videos für den Sportunterricht stelle ich mir schwierig vor.	I consider the design of videos for Physical Education to be difficult.
AD3	Ich sehe die wichtigsten Sachen besser, wenn sie mir jemand zeigt, als wenn ich ein Video schaue.	I see the most important things better when someone shows them to me than when I watch a video.
AD4	Ich möchte lieber von echten Lehrer*innen, als von Videos im Sport unterrichtet werden.	I would rather be taught sports by real teachers than by videos.
AD5	Ich finde Videos genau so gut wie Lehrer*innen bei der Wissensvermittlung im Sport.	I think videos are just as good as teachers in providing knowledge in sports.
AD6	Lehrer*innen können im Sportunterricht deutlich besser Informationen vermitteln, als Videos.	Teachers can convey information in Physical Education much better than videos.
Cognitive component: motion preference		
MP1	Wenn wir Videos im Sportunterricht nutzen bleibt mir weniger Zeit, mich selbst zu bewegen.	When we use videos in Physical Education there is less time for me to move.
MP2	Videos im Sportunterricht sorgen dafür, dass ich mich auch selbst mehr bewege.	Videos in Physical Education make me move more.
MP3	Ich treibe weniger Sport, wenn ich mir Videos im Sportunterricht ansehe.	I exercise less when I watch videos in Physical Education.
Evaluative component: positive evaluation		
PE1	Ich finde es gut, dass Videos im Sportunterricht eingesetzt werden.	I think it's good that videos are used in Physical Education.
PE2	Mit einem Video Sachen über Sport zu lernen ist eine gute Idee.	Learning things about sports with a video is a good idea.
PE3	Ich kann den Videos im Sportunterricht nichts Positives abgewinnen.	I don't see anything positive about videos in Physical Education.
PE4	Ich bin mir nicht sicher, ob ich den Videos im Sportunterricht gegenüber positiv gestimmt bin.	I'm not sure I'm positive about the videos in Physical Education class.
Evaluative component: negative evaluation		
NE1	Ich finde Videos im Sportunterricht nicht prinzipiell schlecht.	I don't think videos in Physical Education are bad in general.

Appendix A (continued). Original Questionnaire with 33 Items

Code	Original Item	Translated Item
NE2	Der Einsatz von Videos im Sportunterricht ruft bei mir keine besondere Abneigung hervor.	The use of videos in Physical Education does not cause any particular dislike in me.
NE3	Ich finde Videos im Sportunterricht nicht gut.	I don't think videos are good in Physical Education class.
NE4	Ich bin dem Einsatz von Videos im Sportunterricht gegenüber negativ gestimmt.	I am negative about the use of videos in Physical Education.
Behavioral component: intention of use		
IU1	Ich möchte mich gerne zum Videoeinsatz im Sportunterricht informieren.	I would like to get information about the use of video in Physical Education.
IU2	Zu Videos im Sportunterricht würde ich gern mehr wissen.	I would like to know more about videos in Physical Education.
IU3	Ich fände es nicht interessant mich weiter mit Videos im Sportunterricht zu beschäftigen.	I would not find it interesting to continue dealing with videos in Physical Education.
IU4	Ich frage mich, warum ich mich weiter mit Videos im Sportunterricht beschäftigen sollte.	I wonder why I should continue to engage with videos in Physical Education.
IU5	Ich möchte mehr Videos im Sportunterricht sehen.	I would like to see more videos in Physical Education class.
IU6	In der nächsten Sportstunde möchte ich ein Video sehen.	In the next Physical Education lesson, I would like to see a video.
IU7	Meine Lehrer*in sollte keine Videos im Sportunterricht einsetzen.	My teacher should not use videos in Physical Education.
IU8	Ich will nicht, dass Videos im Sportunterricht eingesetzt werden.	I don't want videos to be used in Physical Education.

Appendix B: Overview about all instructions

"Students' Attitudes Towards the Use of Video-Based Digital Media in Physical Education (EdiSU)"

With the ongoing process of digitalization, digital teaching and learning resources are becoming increasingly important. This applies not only to classroom lessons but also to physical education. Videos, in particular, are often used in physical education. With this survey, we aim to find out what your attitudes are towards the use of video-based digital media in physical education. The survey will take approximately 15 minutes. In addition to information about yourself (e.g., gender and age), we will ask about your attitudes towards the use of video-based digital media in physical education. The results will be evaluated completely anonymously, meaning that your responses cannot be traced back to you. The questionnaires you fill out will only be processed by us as project staff and will not be published later. Some of the questions may seem very similar or identical at times. This is because we need to determine which wording is best suited for our study. Therefore, please try to answer all the questions.

Thank you very much for your cooperation!

Information About You

What gender do you identify with?
How old are you?
Which grade are you in?
What type of school do you attend?
What is the name of your school?
Do you have any special educational needs?
If yes, which?

Filling in the Questionnaire

You are about to read several statements. Please assess to what extent these statements apply to you personally. There are no right or wrong answers. Simply follow your first impression as you read the statements. You will rate the statements on a scale that ranges from 'Strongly agree' to 'Strongly disagree.' Just mark the option that applies to you.

Here is an example:

Stimme voll und ganz zu	Stimme eher zu	teils / teils	Stimme eher nicht zu	Stimme überhaupt nicht zu
☐	☐	☐	☐	☐

I like eating pizza.

If you fully agree with the statement 'I like eating pizza,' then mark 'Fully agree.' If you mostly like eating pizza, then mark 'tend to agree.' If you like eating pizza sometimes and sometimes not, then mark 'Neutral,' and so on.

Again, there are no right or wrong answers; just follow your first impression. Please mark your choices clearly. If you need to make a correction, fill in the box with the incorrect mark completely, and place your mark in another box.

You can now turn the page and start the questionnaire.

Appendix C: Rotated Factor Loadings of the CFA for the Cognitive Component

Before Item Exclusion				
	Factors			
	1	2	3	4
UF1	.385	-.133	.484	-.395
UF2	.642	-.150	.254	-.162
UF3	.552	-.139	-.104	-.268
UF4	.755	.001	.234	-.089
U1	-.263	.170	-.184	.395
U2	.356	-.156	.750	-.077
U3	.295	-.181	.707	-.280
U4	.375	-.159	.231	-.126
AD1	-.449	.336	-.190	-.011
AD2	-.510	.247	-.111	.203
AD3	-.265	.502	-.108	.213
AD4	-.209	.807	-.230	.124
AD5	-.075	.514	-.363	.191
AD6	-.173	.798	-.093	.209
MP1	-.147	.287	-.200	.532
MP2	.024	.312	-.462	.127
MP3	-.147	.127	-.121	.709

Extraction: Maximum Likelihood; Rotation: Varimax with Kaiser-Normalization

After Item Exclusion				
	Factors			
	1	2	3	4
UF2	-.239	.289	.511	-.161
UF4	-.064	.181	.976	-.100
U2	-.246	.629	.341	-.089
U3	-.226	.882	.184	-.245
AD3	.502	-.165	-.150	.223
AD4	.850	-.176	-.136	.126
AD5	.545	-.279	-.067	.158
AD6	.812	-.081	-.075	.160
MP1	.328	-.137	-.165	.504
MP3	.155	-.143	-.076	.783

Extraction: Maximum Likelihood; Rotation: Varimax with Kaiser-Normalization

Appendix D: Rotated Factor Loadings of the CFA for the Evaluative Component

Before Item Exclusion		
	Factors	
	1	2
PE1	.672	-.485
PE2	.597	-.544
PE3	.763	-.148
PE4	.462	-.176
NE1	-.176	.664
NE2	-.208	.545
NE3	-.834	.296
NE4	-.739	.396

Extraction: Maximum Likelihood; Rotation: Varimax with Kaiser-Normalization

After Item Exclusion		
	Factors	
	1	2
PE1	.851	-.265
PE2	.769	-.304
PE3	.610	-.145
NE1	-.186	.982
NE2	-.300	.422

Extraction: Maximum Likelihood; Rotation: Varimax with Kaiser-Normalization

Appendix E: Factor Loadings of the CFA for the Behavioral Component

Before Item Exclusion	
	Factor
	1
IU1	.483
IU2	.580
IU3	.478
IU4	.518
IU5	.839
IU6	.785
IU7	.815
IU8	.797

Extraction: Maximum Likelihood

After Item Exclusion	
	Factor
	1
IU2	.543
IU4	.513
IU5	.841
IU6	.797
IU7	.816
IU8	.801

Extraction: Maximum Likelihood

Appendix F: Factor Loadings for the Overall CFA

						95% Confidence Intervall	
Factor		**Loading**	**SE**	**z-value**	**p**	**Lower**	**Upper**
Factor 1	UF2	0.550	0.068	8.149	< .001	0.418	0.682
	UF4	0.500	0.069	7.237	< .001	0.365	0.635
	U2	0.698	0.066	10.596	< .001	0.569	0.828
	U3	0.802	0.071	11.376	< .001	0.664	0.940
	AD3	-0.596	0.076	-7.804	< .001	-0.745	-0.446
	AD4	-0.780	0.073	-10.682	< .001	-0.924	-0.637
	AD5	-0.664	0.073	-9.053	< .001	-0.807	-0.520
	AD6	-0.610	0.065	-9.444	< .001	-0.737	-0.484
	MP1	-0.666	0.079	-8.472	< .001	-0.820	-0.512
	MP3	-0.599	0.088	-6.772	< .001	-0.772	-0.425
Factor 2	PE1	1.031	0.070	14.786	< .001	0.895	1.168
	PE2	1.014	0.066	15.324	< .001	0.885	1.144
	PE3	0.696	0.077	9.020	< .001	0.545	0.847
	NE1	-0.602	0.080	-7.556	< .001	-0.758	-0.446
	NE2	-0.491	0.077	-6.340	< .001	-0.642	-0.339
Factor 3	IU2	0.681	0.089	7.677	< .001	0.507	0.855
	IU4	0.703	0.089	7.939	< .001	0.529	0.876
	IU5	1.105	0.076	14.462	< .001	0.955	1.255
	IU6	1.029	0.079	12.956	< .001	0.873	1.184
	IU7	1.056	0.078	13.539	< .001	0.903	1.209
	IU8	1.161	0.083	14.013	< .001	0.999	1.324

Appendix G: Correlation matrix for all attitude components and sub-facets

			cognitive component					**affective component**	**behavioral component**
		usefulness	**usability**	**adequate design**	**movement preference**	**positive evaluation**	**negative evaluation**	**intention of use**
cognitive component	usefulness	-	.52*	-.33*	-.32*	.53*	-.37*	.47*
	usability		-	-.48*	-.39*	.65*	-.40*	.66*
	adequate design			-	.45*	-.65*	-.40*	.66*
	movement preference				-	-.55*	.34*	-.50*
affective component	positive evaluation					-	-.48*	.79*
	negative evaluation						-	-.47*
behavioral component	intention of use							-

Pearson correlation coefficients are displayed; *p < .05

		sex	**age**	**type of school**
cognitive component	usefulness	-.13	.01	-.23*
	usability	-.13	.01	-.08
	adequate design	.15*	.02	.01
	movement preference	.03	.06	.07
affective component	positive evaluation	-.06	-.02	-.09
	negative evaluation	.16*	-.03	.20*
behavioral component	intention of use	-.14*	-.03	-.12

Pearson correlation coefficients are displayed; *p < .05

Розроблення та валідизація інструменту для оцінювання ставлення учнів до використання відео-базованих медіа у фізичному вихованні

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 15 с., 1 табл., 2 рис., 70 джерел.

Історія питання. Використання цифрових медіа, зокрема відео-базованих технологій, стає важливою складовою сучасного освітнього процесу. Хоча ставлення вчителів до цифрових технологій активно досліджується, ставлення учнів до застосування відео у фізичному вихованні залишається малодослідженим. Наявні інструменти оцінювання охоплюють лише окремі компоненти ставлення та не відображають повністю когнітивний, емоційний і поведінковий аспекти. Це створює потребу у валідованому вимірювальному інструменті, який відображав би комплексну структуру ставлення учнів до відео-базованих медіа.

Мета. Розробити, удосконалити та валідизувати опитувальник для оцінювання ставлення учнів до використання відео-базованих медіа на уроках фізичної культури, базуючись на розширеній моделі прийняття технологій (TAM).

Матеріали і методи. Початкову версію опитувальника складали 33 пункти, що охоплювали когнітивний, афективний і поведінковий компоненти ставлення. У дослідженні взяли участь 202 учні 8-х класів (M = 13.26; SD = 0.54). Було проведено серію підтверджувальних факторних аналізів (CFA) для оптимізації структури інструмента. Оцінювали внутрішню узгодженість підшкал (ω, α), факторні навантаження, відповідність моделей критеріям CFI та RMSEA, а також конвергентну й дискримінантну валідність.

Результати. Після оптимізації інструмент включає 21 пункт, що формують трикомпонентну структуру: когнітивний (ω = .74), афективний (ω = .81) та поведінковий (ω = .87) компоненти. Показники факторної моделі свідчать про прийнятну відповідність даним (CFI = .82; RMSEA = .10). Виявлено значущі кореляції між субкомпонентами ставлення (конвергентна валідність) та відсутність значущих зв'язків із демографічними характеристиками (дискримінантна валідність).

Висновки. Розроблений інструмент є надійним і валідним засобом для комплексного вимірювання ставлення учнів до використання відео-базованих медіа на уроках фізичної культури. Він може бути використаний для подальших досліджень прийняття технологій та для планування педагогічних інтервенцій, спрямованих на оптимізацію використання відео в освітньому процесі.

Ключові слова: фізична культура, відео-базовані медіа, ставлення, валідизація шкали, модель прийняття технологій, опитувальник.

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