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An Exploration of Physical Literacy and Movement Creativity

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At present, community-based movement experiences for children are heavily structured, highly prescriptive and sport-centric, with a near singular focus on development in the physical domain (e.g., performance-related and health-related fitness, sport-specific movement skills, etc.). The absence of consideration of psychosocial and creative domains in programming could impact the nature of the relationship between physical literacy and movement creativity. This pioneering study was designed to explore the associations between movement creativity and multiple physical literacy measures. A cross-sectional study of 125 fifth-grade children was performed with assessment of movement creativity and multiple physical literacy assessments of each child (self, parent, teacher and trained assessor). The study revealed no relationships between physical literacy measures and overall movement creativity, and limited relationships between specific movement competencies with Flow ($r=-0.28$, $p<0.05$ with manipulation) and Originality ($r=0.21$, $p<0.05$ with body control). Cluster analysis revealed a gradient of three clusters, with the lowest movement creativity levels associated with the highest motor competence and reports of the child's physical literacy. These findings are consistent with community and school-based programming that highlights prescriptive development of physical competencies without intentional consideration of movement exploration and problem solving. The results of this study support the inclusion of movement exploration-based practices such as circus arts instruction, parkour and dance. Further interventional research is indicated to examine the impact of movement exploration programming on the movement creativity and physical literacy of children.

Keywords: motor competence, physical education, sport, circus, parkour

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Actuellement, les expériences communautaires menées sur le mouvement chez l'enfant sont extrêmement structurées, très normatives et axées sur le sport. Elles se focalisent presque exclusivement sur le développement physique (p. ex., performance et santé physiques, aptitudes motrices propres au sport, etc.). La non-prise en compte des aspects psychosociaux et créatifs dans le programme pourrait avoir des répercussions sur la nature de la relation entre capacités physiques et créativité de mouvement. Cette étude pionnière a été élaborée dans le but d'examiner les rapports pouvant exister entre plusieurs mesures de capacités physiques et la créativité de mouvement. Une étude transversale a été menée auprès de 125 enfants en 5e année de primaire durant laquelle la créativité de mouvement et différents aspects liés à leurs capacités physiques ont été évalués (par eux-mêmes, mais aussi par les parents, le corps enseignant et un·e évaluateur·rice qualifié·e). On constate qu'il n'existe aucun lien entre les capacités physiques mesurées et la créativité de mouvement globale. De plus, l'étude montre que le rapport entre les aptitudes spécifiques liées au mouvement et la fluidité ($r = -0{,}28$, $p < 0{,}05$ avec manipulation) et l'originalité ($r = 0{,}21$, $p < 0{,}05$ avec contrôle du corps) est limité. Une analyse typologique a mis en valeur un gradient de trois groupes, avec les niveaux de créativité de mouvement les plus faibles associés aux capacités motrices les plus élevées, ainsi que des rapports sur les capacités physiques de l'enfant. Ces conclusions sont en phase avec les programmes communautaires et scolaires qui mettent l'accent sur un développement normatif des aptitudes physiques, sans tenir compte de manière réfléchie de l'exploration du mouvement et de la résolution des problèmes. Ces résultats viennent appuyer la nécessité d'intégrer à l'enseignement des pratiques basées sur l'exploration du mouvement, comme les arts du cirque, le parkour et la danse. Il conviendrait de mener une recherche interventionnelle plus poussée afin d'examiner l'impact d'un programme d'exploration du mouvement sur les capacités physiques et la créativité de mouvement chez les enfants.

Mots-clés: capacités motrices, éducation physique, sport, cirque, parkour

Introduction

Children value movement at school and with family and friends,[1] which presents an opportunity for using movement experiences to develop creative competency and confidence.[2] Creativity-based interventional trials have shown that new approaches (e.g., circus and parkour)—as well as the adaptation of traditional prescriptive approaches of coaches in sport, teachers in physical education and recreation instructors—can successfully foster creativity in children.[3,4] We operationally define movement creativity as "the combination of perceptions into new and fresh patterns that could be either a solution to a pre-established problem or the expression of an idea or an emotion by the means of the human body."[5,6] Although one goal of public education and recreation is the

development of innovative and creative children, a child's movement opportunities in school and community settings are often highly prescriptive, with instructors providing sport-centric, technically-focused programming[7] that also reveals gender bias in delivery.[8] As such, these standard movement experiences are unlikely to foster the creative potential of children.

Physical literacy is a multidimensional construct that intentionally couples competence and confidence development across multiple domains (physical, psychological, social and creative).[9] Despite this holistic standpoint emphasized in published physical literacy consensus statements,[10,11] frameworks/models[12] and processes,[9] most physical literacy interventional trials have focused on the physical domain.[13] Therefore, the relationship between physical literacy and the creative domain is not well elucidated, and understanding this relationship is critical to designing future physical literacy interventions that may involve circus, parkour and dance.

The objective of this study was to explore the relationships between movement creativity and a battery of physical literacy variables. We would expect little to no associations in this "standard" PE context. By providing foundational knowledge about current practices and future interventional studies, this exploration may offer insight into the impact that standard elementary school programming practices can have on physical literacy and movement creativity.

Methods

This was a cross-sectional observational study adhering to the STROBE criteria[14] to enhance its replicability and interpretation. Human research ethics board approval was granted (Human Research Ethics Board at the University of Manitoba, HS21075). Parental consent and child assent were obtained.

Participants

A cross-sectional study of fifth-grade children from six classes at five public schools in two school divisions in a suburban setting in Canada was performed, with an assessment of movement creativity and multiple physical literacy assessments of each child (self, parent, teacher and trained assessor). In these elementary schools, there were no formal movement exploration components (dance, parkour or circus) in the physical education and scholastic programming. Manitoba's Physical and Health Education curriculum has five general learning outcomes, including movement, fitness management, safety, personal/social management and healthy lifestyle practices.[15] Given these learning outcomes, the focus is often on the traditional delivery of movement skills, which is likely technically focused and lacking emphasis on the creative components of movement.

Instruments

The instruments deployed for this study included the PLAY*creativity* tool for assessment of movement creativity and multiple tools for assessment of the child's physical literacy, including assessment by the child (PLAY*self*, PLAY*inventory*), parent (PLAY*parent*) and teacher (PLAY PE teacher), as well as assessment of curricular-linked movement competencies by a trained assessor (PLAY*fun*). The PLAY tools were selected for this study because they provide multiple perspectives on and measure various components of physical literacy.

PLAY*creativity* (twelve minutes per child) and PLAY*fun* (about 45 minutes per twenty children) assessments were performed by trained assessors, and each evaluation was conducted on a separate day during the week of assessment. The physical education teacher was not present for the assessments to mitigate response bias. PLAY*self* (twelve minutes) and PLAY*inventory* (five minutes) survey measures were completed in one classroom session the same week as other data were collected. PLAY*parent* was sent to parents during the week of data collection and completed at home. PLAY PE teacher was completed at the end of the assessment week by the physical education teacher.

PLAY*creativity*

PLAY*creativity* uses eleven tasks to assess the following creativity features: Imagination, Detail, Flow, Originality and Fluency. For this tool, the term "Flow" relates to the elaboration of movement expressed by the participant, assessed as the seamless sequencing of separate movement expressions in the task. PLAY*creativity*'s characteristics and development have been described previously.[16] An overall aggregate movement creativity score was derived from the sum of all PLAY*creativity* features. In addition, sub-scores for each of the creativity features were derived: eleven tasks with five levels for Imagination, nine tasks with three levels for Detail, eleven tasks with three levels for Flow, four tasks with five levels for Originality, and the number of tasks exhibited across three tasks for Fluency (ω=0.87).

PLAY*fun*

PLAY*fun* is a competence assessment of eighteen land-based movement skills categorized into locomotor and transport, upper and lower body manipulation, and body control using a 100-point visual analog scale with four categorical anchors, where a score of 50 corresponds to entry-level competency.[17,18] Overall motor competence and categorical competencies for locomotor/transport (eight skills), manipulation (six skills) and body control (four skills) were derived (ω=0.78).

PLAY*self*

PLAY*self* has three distinct unidimensional subscales derived from the self-report tool: environmental participation (six items, five levels), physical literacy self-description (eleven items, four-level Likert) and movement valuation (three items, four-level Likert)[19] (ω=0.87).

PLAY*inventory*

PLAY*inventory* is a 95-item inventory checklist for self-reported activity exposures over the last six months.[20] The total number of activities were derived.

PLAY*parent*

The PLAY*parent* tool consists of fifteen physical literacy items (three levels) and four environmental participation items (four levels) answered by the parent about their child.[20] High internal consistency (ω=0.86) of the scale was observed.

PLAY *PE teacher*

PLAY PE teacher reflects a teacher's perception of a child's physical literacy (thirteen items, five levels) and physical fitness (three items). An aggregate physical literacy score is derived from the thirteen items by the teacher. In addition, the teacher provides an overall rating of physical literacy using a ten-point numeric rating scale (Teacher NRS with 0.5 increments). Internal consistency of the scale was ω=0.9, and the correlation between the overall numeric rating scale and the physical literacy sub-score was 0.81.

Statistical Analysis

Associations were first described using Spearman correlation based on the ordinal nature of the scales to explore the relationship between physical literacy and movement creativity. Then, we determined whether natural clustering was evident between physical literacy and creativity variables using K-means cluster analysis and exploratory factor analysis. Cluster analysis used the Hartigan-Wong algorithm, and the optimal cluster number was derived using

the "knee method."[21] Finally, due to the non-continuous nature of the scales, we deployed ordinal regression to examine predictors of creativity. Mann-Whitney U tests examined differences between sexes. Statistical analysis was performed using JAMOVI v 2.3.26 with a level of significance set to p=<0.05.

Results

A sample of 125 fifth-grade students was recruited (65F:60M, 9.9 ± 0.1 SD years). Significant sex differences were observed for overall motor competence, with males having a median score of 46.9 (IQR 5.0) and females having a median score of 43.3 (IQR 7.0), revealing a mean difference of -3.3 [-5.1:-1.7] (p<0.001, rank biserial effect size=0.39). PE curricular expectations for this grade are to achieve entry-level competency in all eighteen of the movement skills assessed (PLAY*fun*); only three of 65 females (4.6%) achieved this goal, while twenty percent of males met expectations (twelve of 60). There was a significant sex difference observed for manipulation skills (mean diff -7.8 [-10.2:-5.4] p<0.001, rank biserial effect=0.62), but not transport or body control. There was also a sex difference revealed for both teacher-rated physical literacy scores (Teacher NRS p<0.05, rank biserial effect=0.24; teacher score p<0.05, rank biserial effect=0.25). No other parameters measured revealed sex differences.

Table 1 reports the correlations between the aggregate movement creativity score (median=101, IQR of 22, min 47, max 139, normally distributed Shapiro Wilk p=0.21) and physical literacy measures. Table 2 reports the correlations between motor competence categories and features of creativity. Ordinal logistic regression was performed with aggregate movement creativity as the dependent with all physical literacy measures as predictors and sex as a co-factor, revealing a significant model (X^2=21.0, p<0.01). The only significant predictor was movement valuation (X^2 of 11.2, p<0.001, odds ratio of 1.65), but with very low explained variance (McFaddens's R^2=3.9%). The K-means cluster analysis is reported in Figure 1, with three identified clusters showing an aggregate creativity gradient with associated physical literacy characteristics. Due to the difference in scale magnitudes, the variables are plotted in standardized values.

Discussion

This study set out to explore the relationship between movement creativity and physical literacy in the "standard" delivery of physical education, which is largely prescriptive and sport-centric with minimal movement-exploratory elements as guided by the current PE/HE curriculum in the province.[7,15] As

Table 1. Spearman correlation coefficients (*p*-value, $p<0.05$ bolded) for physical literacy variables and overall movement creativity

	1	2	3	4	5	6	7	8	9
1. Average Motor Competence	—								
	—								
2. Environmental Participation	**0.292**	—							
	0.001	—							
3. PL Self	**0.331**	**0.521**	—						
	<.001	**<.001**	—						
4. Movement Valuation	**0.219**	**0.357**	**0.249**	—					
	0.016	**<.001**	**0.006**	—					
5. Activities	**0.258**	**0.369**	**0.290**	**0.268**	—				
	0.005	**<.001**	**0.001**	**0.003**	—				
6. PL Parent	**0.405**	0.086	**0.296**	0.052	0.158	—			
	<.001	0.446	**0.007**	0.647	0.164	—			
7. Teacher NRS	**0.601**	0.066	**0.256**	**0.208**	0.104	**0.392**	—		
	<.001	0.476	**0.005**	**0.024**	0.264	**<.001**	—		
8. Teacher	**0.609**	0.158	**0.259**	**0.205**	**0.334**	**0.267**	**0.806**	—	
	<.001	0.085	**0.004**	**0.025**	**<.001**	**0.017**	**<.001**	—	
9. Creativity	-0.036	-0.020	-0.088	0.173	0.026	-0.136	-0.152	-0.124	—
	0.689	0.831	0.337	0.057	0.779	0.226	0.095	0.171	—

Note: Environmental participation sub-score is from PLAY*self* tool; PL Self sub-score is from PLAY*self* tool; Movement valuation sub-score is from PLAY*self* tool; Activities sub-score is the total number of activities from PLAY*inventory*.

Table 2. Spearman correlation coefficients (p-value, $p<0.05$ bolded) for categorical movement competencies (transport, manipulation and body control) and features of movement creativity (Fluency, Imagination, Detail, Flow and Originality)

		1	2	3	4	5	6	7	8
Movement Competencies	1. Transport	—							
		—							
	2. Manipulation	**0.482**	—						
		< .001	—						
	3. Body control	**0.583**	**0.391**	—					
		< .001	**< .001**	—					
Movement Creativity	4. Fluency	-0.027	-0.004	0.101	—				
		0.769	0.964	0.267	—				
	5. Imagination	0.008	-0.144	0.029	**0.408**	—			
		0.929	0.113	0.748	**< .001**	—			
	6. Detail	0.009	-0.114	0.129	**0.590**	**0.735**	—		
		0.922	0.211	0.156	**< .001**	**< .001**	—		
	7. Flow	-0.153	**-0.276**	-0.146	**0.431**	**0.468**	**0.501**	—	
		0.090	**0.002**	0.108	**< .001**	**< .001**	**< .001**	—	
	8. Originality	0.105	0.005	**0.207**	**0.642**	**0.611**	**0.755**	0.267	—
		0.249	0.959	**0.021**	**< .001**	**< .001**	**< .001**	0.003	—

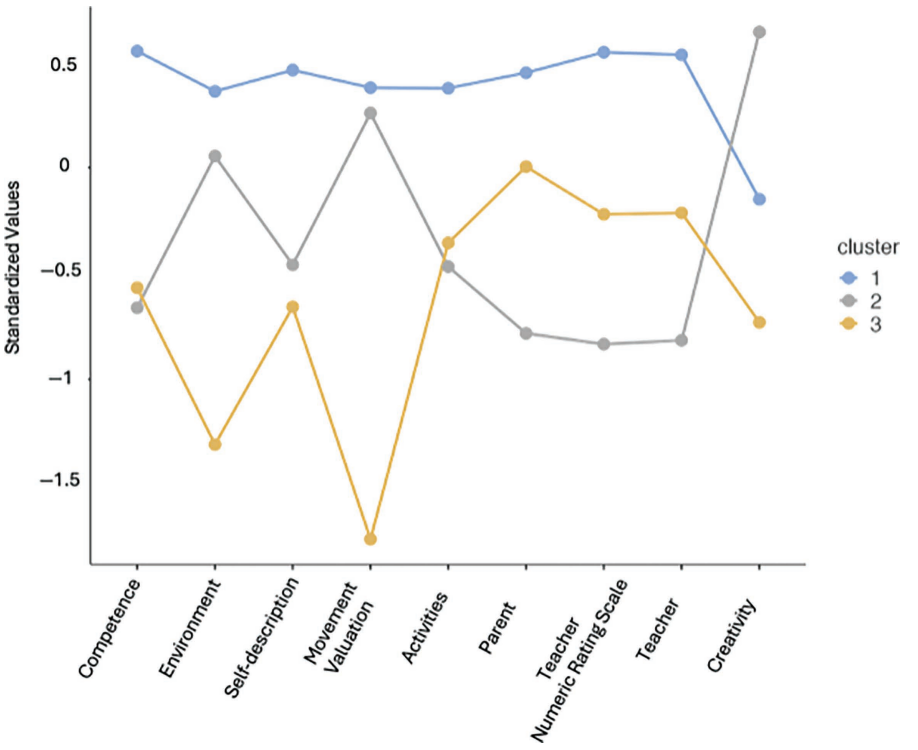

Figure 1. Plots of standardized variables for three clusters derived from K-means analysis showing a large separation of standardized creativity scores (0.64, -0.15 and -0.73) with associated physical literacy characteristics

expected, our findings revealed no associations between a comprehensive set of physical literacy measures and overall movement creativity; this likely indicates that the current delivery format (pedagogy and curricular content) of movement experiences is aligned with the deployment of a largely prescriptive and linear pedagogy rather than an exploratory and non-linear one that is thought to foster creativity.[2] Since creativity and innovation are valued outcomes of public education, this lack of associations is important knowledge that can provide a foundation for the intentional addition of movement-exploratory components to physical education curriculum standards, as well as the creation of professional development opportunities for teachers to learn enhanced pedagogical practices that foster movement exploration (e.g. dance, circus, parkour).

The cluster analysis revealed additional and novel insights into the relationship between physical literacy achievement and movement creativity levels. Notably, students with the highest physical literacy characteristics (about 0.5 SD above) revealed only average creativity scores (cluster one), while students with below-average physical literacy scores (with the exception of movement

valuation) had creativity scores that were 0.64 standard deviations above average (cluster two). A plausible explanation for this "inversion" may be that students, when driven by prescriptive sport-based technical development practices, will have limited exposure to creativity-fostering environments. Students in cluster two, who share a positive valuation of movement with cluster one, likely have a more diverse set of movement-based experiences beyond the sporting context, as seen by their positive environmental participation scores. It would be interesting to explore the differences between specific environmental participation sub-items (gym, water, ice, snow, outdoors, playground) and the specific activities that were self-reported by the students in these two clusters. In cluster three, the most notable element was a strong devaluation of movement (-1.75 SD lower), which likely manifests in behaviours consistent with lower scores in other variables, with the notable exception of the parental evaluation. Interestingly, valuation of movement is partly determined by emotional experiences associated with movement contexts,[22] so it is conceivable that this group of students may have been "turned off" from movement, perhaps by an over-emphasis on sport. Previous studies in circus,[23–25] dance[4,26,27] and parkour[28–30] have demonstrated the possibility of fostering creativity in children but did not investigate concomitant changes in physical literacy. However, a circus arts instruction intervention did reveal substantial improvements in physical literacy among children.[8] Future interventional studies deploying movement exploration-based programming should include measurements of physical literacy concurrent with creativity, as well as the impact of the interventions on movement valuation.

As suggested by Manuela Valentini et al., "Although there is no unique definition of circus pedagogy [or movement exploration pedagogy] as yet, scholars agree that such a discipline could provide a valid alternative to learn and deepen various mobility contents".[31] Similar propositions around circus arts instruction with a unique pedagogical approach are shared by Houser and Kriellaars in an exploration of physical literacy-enriched pedagogy.[9] In addition to the inclusive practices of circus arts instruction,[32] there is an opportunity for problem-solving and decision-making, which would provide a creativity-supportive environment.[33] It is important to note that the delivery of sport-centric and physical education-based content can be informed by the pedagogical practices deployed in circus and parkour that support problem-solving and decision-making. The disconnect between physical literacy and movement creativity in the standard delivery practices assessed in this study could be remedied by the adoption of the movement exploration-based content and pedagogy described above.[2]

Although overall creativity was not correlated with physical literacy variables in this dataset, there were some notable associations between sub-components (significant or trending). In Table 2, the creativity feature of Flow (the ability to seamlessly sequence original movements) was inversely correlated with

manipulation skills. Highly prescriptive approaches are often applied to the development of sport-specific upper and lower body manipulation skills (catching, striking, throwing, dribbling), which may inadvertently limit the ability to derive and sequence original movements.[2,7] Consistent with this observation, a similar inverse association (albeit trending) was observed between teacher physical literacy NRS and overall creativity. We observed positive associations with originality, body control and the number of activities involving creativity, as well as a significant likelihood of a child's movement valuation being associated with higher creativity (regression). These findings can be interpreted from two perspectives—a formative one (e.g., variables causally impacting a person's creativity) and a reflective one (e.g., variables being associated with a creative person). However, readers are cautioned to avoid the formative interpretation that simply increasing the number of activities will increase movement creativity.

As this was a cross-sectional study, the reported associations and clusters do not infer a causal relationship between variables. However, these preliminary findings support future studies exploring causal relationships between creativity and physical literacy. This study had a relatively small sample size that may have inadequate power to detect smaller associations. It was conducted in multiple schools, in school divisions where PE is mandatory from K-12 and taught by physical education specialists; this context is unique compared to other jurisdictions in Canada. However, similarly to other jurisdictions, the participating schools, teachers and students had minimal physical literacy and creativity/artistic training.

Despite identical physical education curricular outcomes for males and females in fifth grade across all eighteen movement competencies tested in this study (but consistent with prior studies),[34] our analysis reveals substantial sex-based differences in motor competence (effect size=0.39) and teacher assessments of a child's physical literacy. The gender gap in overall movement competence likely arises from gender bias in various movement contexts manifesting in non-inclusive movement opportunities, as the influences of sex are negligible at this pre-pubertal age. Interestingly, the implementation of movement-exploratory programming has already been shown to address non-inclusive practices. In fact, it can ameliorate the gender gap in movement competence[8] and provide challenges for participants with different physical[32] and psychological abilities.[35]

The intended outcome of a quality physical education program is physical literacy,[36] and general public education goals are geared toward the development of creative and innovative children. This study reveals a general lack of associations between physical literacy and movement creativity, which is concerning in the context of these two important educational goals. Our analysis provides preliminary evidence supporting the need to consider the addition of movement-exploratory components to physical education, as well as the need for interventional trials comparing movement-exploratory physical education units to standard delivery.

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Contributions

NH writing, analysis, interpretation. AW writing, analysis, interpretation. DK conceptualization, writing, analysis, interpretation.

Disclosures

The authors indicate that they do not have competing interests.

References

1. Bremer E, Jefferies P, Cairney J, Kriellaars D. A cross-sectional study of Canadian children's valuation of literacies across social contexts. Front Sports Act Living. 2023 Mar 15;5. doi:10.3389/FSPOR.2023.1125072.
2. Richard V, Lebeau JC, Becker F, Boiangin N, Tenenbaum G. Developing Cognitive and Motor Creativity in Children Through an Exercise Program Using Nonlinear Pedagogy Principles. Creat Res J. 2018;30(4):391–401.
3. Richard V, Halliwell W, Tenenbaum G. Effects of an Improvisation Intervention on Elite Figure Skaters' Performance, Self Esteem, Creativity, and Mindfulness Skills. Sport Psychol. 2017 Jan;31(3):275–287. doi:10.1123/tsp.2016-0059.
4. Neville RD, Makopoulou K. Effect of a six-week dance-based physical education intervention on primary school children's creativity: A pilot study. Eur Phys Educ Rev. 2021 Feb;27(1):203–220. doi:10.1177/1356336X20939586.
5. Wyrick W. The Development of a Test of Motor Creativity. Res Q Exerc Sport. 1968;39(3):756–765. doi:10.1080/10671188.1968.10616608.
6. Pagona B, Costas M. The Development of Motor Creativity in Elementary School Children and Its Retention. Creat Res J. 2008;20(1):72–80. doi:10.1080/10400410701842078.
7. Ennis CD. What Goes Around Comes Around . . . Or Does It? Disrupting the Cycle of Traditional, Sport-Based Physical Education. Kinesiol Rev. 2014 Jan;3(1):63. doi:10.1123/KR.2014-0039.
8. Kriellaars D, Cairney J, Bortoleto MAC, Kiez TKM, Dudley D, Aubertin P. The Impact of Circus Arts Instruction in Physical Education on the Physical Literacy of Children in Grades 4 and 5. J Teach Phys Educ. 2019 Apr;38(2):162–170. doi:10.1123/jtpe.2018-0269.

9. Houser N, Kriellaars D. "Where was this when I was in Physical Education?" Physical literacy enriched pedagogy in a quality physical education context. Front Sports Act Living. 2023 May 24;5:1185680. doi:10.3389/FSPOR.2023.1185680.
10. Sport England. Physical Literacy Consensus Statement for England published [Internet]. London (UK): Sport England; 2023 Sep 28 [cited 2024 Feb 1]. Available from: https://www.sportengland.org/news-and-inspiration/physical-literacy-consensus-statement-england-published.
11. ParticipACTION, Sport for Life Society, the Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute, Physical and Health Education Canada, Canadian Parks and Recreation Association, Ontario Society of Physical Activity Promoters in Public Health. Canada's Physical Literacy Consensus Statement [Internet]. Victoria (BC): Sport for Life Society; 2015 [cited 2019 Jan 6]. Available from: https://physicalliteracy.ca/wp-content/uploads/2016/08/Consensus-Handout-EN-WEB_1.pdf.
12. Cairney J, Dudley D, Kwan M, Bulten R, Kriellaars D. Physical Literacy, Physical Activity and Health: Toward an Evidence-Informed Conceptual Model. Sports Med. 2019 Feb 19;49: 371–383. doi:10.1007/s40279-019-01063-3.
13. Carl J, Barratt J, Töpfer C, Cairney J, Pfeifer K. How are physical literacy interventions conceptualized? – A systematic review on intervention design and content. Psychol Sport Exerc. 2022 Jan;58:102091. doi:10.1016/J.PSYCHSPORT.2021.102091.
14. Cuschieri S. The STROBE guidelines. Saudi J Anaesth. 2019 Apr;13(Suppl 1):S31-S34. doi:10.4103/sja.SJA_543_18.
15. Government of Manitoba. Manitoba Physical Education/Health Education Curriculum Overview [Internet]. Manitoba: Government of Manitoba; 2024 [cited 2023 Aug 19]. Available from: https://www.edu.gov.mb.ca/k12/cur/physhlth/c_overview.html.
16. Richard V, Aubertin P, Yang YY, Kriellaars D. Factor Structure of Play Creativity: A New Instrument to Assess Movement Creativity. Creat Res J. 2020 Sep 27;32:383–393. doi:10.1080/10400419.2020.1821567.
17. Cairney J, Veldhuizen S, Graham JD, Rodriguez C, Bedard C, Bremer E, Kriellaars D. A Construct Validation Study of PLAYfun. Med Sci Sports Exerc. 2018 Apr;50(4):855–862. doi:10.1249/MSS.0000000000001494.
18. Bremer E, Graham JD, Bedard C, Rodriguez C, Kriellaars D, Cairney J. The Association Between PLAYfun and Physical Activity: A Convergent Validation Study. Res Q Exerc Sport. 2020;91(2):179–187. doi:10.1080/02701367.2019.1652723.
19. Jefferies P, Bremer E, Kozera T, Cairney J, Kriellaars D. Psychometric properties and construct validity of PLAYself: a self-reported measure of physical literacy for children and youth. App Phys Nutr Metab. 2021 Jun;46(6):579–588. doi:10.1139/apnm-2020-0410.
20. Sport for Life. Physical Literacy Assessment for Youth [Internet]. Victoria (BC): Sport for Life Society; 2024 [cited 2019 Jan 8]. Available from: https://play.physicalliteracy.ca/play-tools.
21. Hartigan JA, Wong MA. Algorithm AS 136: A K-Means Clustering Algorithm. J Royal Stat Society-Series C (Appl Stat). 1979;28(1):100–108. doi:10.2307/2346830.
22. Simonton KL, Garn AC. Negative emotions as predictors of behavioral outcomes in middle school physical education. Eur Phys Educ Rev. 2020 Nov;26(4):764–781. doi:10.1177/1356336X19879950

23. Richard V, Glăveanu V, Aubertin P. The Embodied Journey of an Idea: An Exploration of Movement Creativity in Circus Arts. J Creat Behav. 2023 Jun;57(2):221–236. doi:10.1002/jocb.571.
24. Agans JP, Davis JL, Vazou S, Jarus T. Self-Determination Through Circus Arts: Exploring Youth Development in a Novel Activity Context. J Youth Dev. 2019 Sep;14(3):110–129. doi:10.5195/JYD.2019.662.
25. Tucunduva BBP. An integrative methodology for circus training based on creativity and education on physical expression. Theatre Dance Perform Train. 2021;12(4):499–513. doi:10.1080/19443927.2021.1899973.
26. Schwartz P. Creativity and Dance: Implications for Pedagogy and Policy. Arts Educ Pol Rev. 1993;95(1):8–16. doi:10.1080/10632913.1993.9936943.
27. Torrents Martín C, Ric Á, Hristovski R. Creativity and emergence of specific dance movements using instructional constraints. Psych Aesthet Creat Arts. 2015;9(1):65–74. doi:10.1037%2Fa0038706.
28. Bavinton N. From Obstacle to Opportunity: Parkour, leisure, and the reinterpretation of constraints. Annals Leisure Res. 2007;10(3–4):391–412. doi:10.1080/11745398.2007.9686773.
29. O'Loughlin A. A door for creativity – art and competition in parkour. Theatre Dance Perform Train. 2012;3(2):192–198. doi:10.1080/19443927.2012.689131.
30. Yolcu O, Altunsöz IH, Levent İnce M, Kriellaars D. Use of parkour in primary school physical education to develop divergent thinking, motor creativity, coordination, and perceived competence. Phys Educ Sport Pedagogy. 2024 Sep 9;1–14. doi:10.1080/17408989.2024.2400094.
31. Valentini M, Cesauri A, Schembri R, Federici A. Circus-mobility: The value of a circus laboratory at school. J Human Sport Exerc. 2020;15(Proc4):S1081-S1092. doi:10.14198/JHSE.2020.15.PROC4.10.
32. Bortoleto MAC, Ross JJ, Houser N, Kriellaars D. Everyone is welcome under the big top: a multiple case study on circus arts instruction in physical education. Phys Educ Sport Pedagogy. 2022 Dec 7;1–12. doi:10.1080/17408989.2022.2153820.
33. Agans JP, Stuckey MI, Cairney J, Kriellaars D. Four domains for development for all (4D4D4All): A holistic, physical literacy framework. J App Sport Psychol. 2024. doi:10.1080/10413200.2024.2342323.
34. Barnett LM, Lai SK, Veldman SLC, Hardy LL, Cliff DP, Morgan PJ, Zask A, Lubans DR, Shultz SP, Ridgers ND, Rush E, Brown HL, Okely AD. Correlates of Gross Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. Sports Med. 2016 Feb 19;46:1663–1688. doi:10.1007/s40279-016-0495-z.
35. Houser N, Spiers J, Ross JJ, Kriellaars D. SENSE-ational schools: physical literacy enriched opportunities for students with neurodiversity. Phys Educ Sport Pedagogy. 2024 May 16;1–14. doi:10.1080/17408989.2024.2352824.
36. UNESCO, McLennan N. Making the case for inclusive quality physical education policy development: a policy brief [Internet]. Paris, France: United Nations Educational, Scientific and Cultural Organization; 2021 [cited 2023 Sept 3]. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000375422.