EXAMINING THE EVIDENCE FOR IMPROVED EDUCATIONAL AND LEARNING OUTCOMES THROUGH PHYSICAL EDUCATION IN SCHOOLS

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- Mikael Quennerstedt (Professor in Physical Education and Health at Örebro University, Sweden)
- Phillip Morgan (Professor School of Education and co-deputy Director of the Priority Research Centre for Physical Activity and Nutrition, University of Newcastle, Australia)
EXECUTIVE SUMMARY

In 2019, the Commonwealth Department of Education (DoE) commissioned researchers within the Faculty of Education at Monash University to conduct a literature review of relevant available research and evidence in Australia (and if appropriate overseas), where improved learning outcomes for school students have been demonstrated to result from effective implementation of the physical education element of the curriculum. The project sought to determine the benefits/impact that physical education\(^1\) (PE) may have on academic achievement\(^2\) (AA) in other curriculum learning areas\(^3\) (CLA). This process was guided by the following research question:

**Does physical education\(^4\) have measurable educative benefits/impact on student academic performance and meeting of learning outcomes in other curriculum learning areas?**

Methodology

The scope of this project was both national and international and involved the following research methods to gather data:

- Literature review
- Program/project audits
- Surveys of key stakeholders

**Literature review**

A preliminary review was conducted of key authors and literature on the topic to determine appropriate search terms. These terms were then reviewed by the expert panel for relevance and completeness. A list of databases was also reviewed by the panel, and their suggestions regarding both search terms and database selections were incorporated into the search strategy.

Six databases/database platforms were searched: Informit, Scopus, Web of Science, SPORTDiscus, ERIC and Ovid (including AMED, DARE, Cochrane CCTR and CDSR, and PsycINFO). Draft inclusion and exclusion criteria were established before searching commenced, and then refined based on results from the first 100 articles. A total of 5379 unique articles were returned from the searches and alerts, after duplicates were removed.

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1. The curriculum learning area, also part of content within the Australian Curriculum Health and Physical Education.
2. Academic success with regards to the attainment of learning outcomes and/or improvement of grades.
3. The eight disciplinary curriculum learning areas (or subjects) of the Australian Curriculum, namely English, Mathematics, Science, Health and Physical Education, Humanities and Social Sciences, The Arts, Technologies and Languages. This project also considered links to the General Capabilities numeracy and literacy.
4. Note the original research question also included ‘physical activity’ research, which was then omitted due to extremely large sample size and drift away from the key focus of the project i.e. physical education.
Articles were then screened against inclusion and exclusion criteria in three stages: title screening; abstract screening; and full-text screening. In the final stage, the remaining 78 articles were split between all three researchers, with approximately even distribution. Each researcher extracted data as they read, and flagged each article for inclusion or exclusion in the final review.

**Program/project audits**

An audit of current and recent past physical activity\(^5\) (PA) and/or physical education (PE) projects, programs, initiatives or interventions was conducted in order to gather information about on-the-ground activity in schools and in support of the research question. This was done initially via emails to key stakeholder informants and organisations known to the research team. Via snowballing of responses, a collection of additional key informants and projects was generated.

**Surveys of key stakeholders**

In the original project brief, surveys were suggested as a way to determine the impact of physical education/activity projects and programs from the point of view of key stakeholders across Australia. The assumption was that stakeholders' perspectives of such projects/programs would be able to provide a snapshot of the most recent activities of relevance to the remit of this project, and hence value-add to the data collected. Unfortunately, initial data collected via emails with key stakeholders was not able to justify a broader survey and the stakeholder survey method was abandoned in consultation with DoE.

**Literature review findings**

This literature review reports on 40 peer-reviewed research articles and seven literature reviews published in English between 2004 and 2019:

- Collectively, these articles have conducted research in approximately 1159 schools involving 71593 participants from 13 different countries.
- The countries in which research was conducted are: United States of America (n=15); Sweden (n=6); Italy (n=4); Australia and Germany (n=3); Spain (n=2); Denmark, Norway, Switzerland, Greece, China, England, Scotland (n=1).
- The school site in which the research was conducted are: twenty-seven (n=27) in primary schools only; ten (n=10) in secondary schools only; three (n=3) in combined primary-secondary schools.

\(^5\)'Physical activity includes exercise as well as other activities which involve bodily movement and are done as part of playing, working, active transportation, house chores and recreational activities' (WHO, 2019, para. 4).
Existing studies have used a variety of methodologies and, for the purpose of the review, was split into experimental studies (including randomised control trials [RCT], cluster randomised control trials [CRCT], and quasi experimental design [QE]); non-experimental studies (including cross-sectional and correlational studies, qualitative studies); and, longitudinal studies (which may also be experimental or non-experimental).

The review suggests mixed findings regarding the impact of PE on student academic performance. Studies can be split by identifying/designating the degree of effect of each study as EFFECT, INCONCLUSIVE EFFECT or NO EFFECT. Findings of effect are as follows:

- **EFFECT**: A total of twelve (n=12) studies were assessed to have clearly reported significant positive effect (2, 7, 16, 17, 18, 21, 24, 26, 29, 33, 39, 42). This equates to 30% of the reviewed articles.

- **INCONCLUSIVE EFFECT**: A total of eighteen (n=18) studies were assessed to have reported either unclear, vague, partial, small and/or modest effect (5, 6, 9, 10, 19, 22, 23, 27, 28, 30, 31, 32, 35, 36, 37, 38, 43, 45). This equates to 45% of the reviewed articles.

- **NO EFFECT**: A total of ten (n=10) studies were assessed to have clearly reported no significant positive effect. This equates to 25% of the reviewed articles.

Collectively, the effect studies indicate that relationships exist between PE, AA and executive function\(^6\) (EF). This conclusion is consistent across school setting, study methodology and intervention design. However, the no effect studies indicate that there is no relationship between PE, AA and EF. This conclusion is irrespective of methodology or intervention design, regardless of the approach used and measurement tools the findings were the same. It is important to note that this is no relationship in either direction. Studies that increased the amount of PA students were undertaking by increasing time dedicated to PE did not report any negative impact of student achievement and grades. These studies therefore do not justify reduction or removal of PE from the curriculum. The inconclusive effect group collectively indicate an array of inconclusive relationships between a variety of indices associated with PE/PA, AA and/or EF, this conclusion is irrespective of methodology or intervention design, regardless of the approach used and measurement tools.

In this regard, the evidence is highly mixed as to the potential impact PE can have, what is certain from the studies reviewed is that participation in PE does not have any negative impact on student academic performance.

The review highlights a number of limitations with existing literature including a lack of randomised controlled trials, a lack of accountability for known confounders, no consistency in measurement of PE or AA and limited consideration of how PE is taught and quality of delivery. There is also a general lack of reporting of effect size in studies that do indicate a positive effect of PE on AA.

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\(^6\) ‘The group of complex mental processes and cognitive abilities (such as working memory, impulse inhibition, and reasoning) that control the skills (such as organizing tasks, remembering details, managing time, and solving problems) required for goal-directed behaviour’ (Merriam-Webster.com Dictionary, 2019)
Stakeholder Audit Findings

The referrals and examples from key stakeholders range from government initiatives to Apps, literature reviews, project evaluations, in/out of school interventions, health promotion plans, online professional learning, and future research proposals. All stakeholder referrals were directly linked to PA in schools (n=24), mainly as teacher professional learning and/or resourcing, this sits in contrast to the research literature where direct in school interventions dominate. Three (n=3) projects/programs were in some way linked to PE with Sporting Schools providing PE resources, the LOOK study focussing on generalist/specialist PE teachers, and the PEPL project to be piloted in South Australia from 2020.

Two current projects/programs of relevance to this project are Thinking While Moving (TWM) and Transform-Us!

- **Thinking While Moving** (TWM) is a teacher professional learning initiative that integrates PA with numeracy and more recently with literacy with evidence of improved AA (see Riley, Lubans, Morgan, & Young, 2015; Mavilidi, Lubans, Morgan, Miller, Eather, Karayanidis, … Riley, 2019).
- **Transform-Us!** is an online product that includes training and resources for teachers and school leaders to integrate movement into classrooms, schools and homes (see Salmon, Arundell, Hume, Brown, Hesketh, Dunstan, … Crawford, 2019).

Conclusions and Recommendations

The overall finding of the review in relation to the research question is that none of the studies have reliably spoken to the ability of PE to improve AA in general or in other CLA. This is because none of the studies directly measured PE as a CLA that involves more than the manipulation of PA variables or as a site for conducting interventions and/or testing.

Therefore, based upon the studies systematically reviewed the overall conclusion of this review is that:

- There is insufficient robust and consistent evidence to suggest that physical education has a measurable educative benefit/impact on student academic performance or the meeting of learning outcomes in other curriculum learning areas.

However, whilst PE was not strongly featured as a key variable in the literature reviewed, PA and many variations of it were. The key findings of the systematic process of reviewing literature are as follows:

- There was no evidence of negative impact on student AA, grades or EF/cognitive ability.
- The dominant way in which the studies examine PE is through PA interventions delivered in PE class time.
• In the studies reviewed, PE is predominantly used as a site/space for PA interventions or to test if PA interventions have worked or not.
• The studies may offer guidance with regards to the ways in which frequency, intensity, time and type of activity might be manipulated in order to enhance PA delivered in PE, or in other CLA and/or recess.

Therefore, based upon the studies systematically reviewed a second conclusion of this review is that:

• The studies collectively indicate an array of positive, neutral or inconclusive relationships between a variety of indices associated with PE/PA, AA and/or EF, this conclusion is irrespective of methodology or intervention design, regardless of the approach used and measurement tools.

However, what can be stated with some certainty from these studies, as well as the literature reviews examined in this report is that participation in Physical Education does not have a negative impact on children’s or adolescent’s academic achievement or executive function. This report shows that a substantial collection of available data from national and international research suggests that there is no detrimental effect to increasing any combination of frequency, intensity, time or type of activity in or as physical education.

Audit key takeaways

With regards to the audit of programs/projects, it is evident that there are a number of research interventions that are maturing into PA oriented products in the PE-school space. None focus on or seek to link PE with AA/EF in general or AA/EF in other learning areas. Nor do they speak to how they might improve the educative nature or quality of either PE or other learning areas. Instead, they each variously aim to upskill and provide resources to teachers (especially primary teachers), facilitate and support PA in schools, promote PA as part of an active and healthy lifestyle, build community capacity, indirectly influence health outcomes, and create supportive environments.
**Recommendations and future research**

The following are recommendations from this project and along with the report provide key stakeholders with evidence, information and insights as to the current and future role, impact and educative value of physical education in schools and for students.

**Recommendation 1:** Policy directives and policy actors should continue to advocate for curriculum time for PE as there is no evidence to suggest that either PE or PA has a detrimental effect on student AA or EF.

**Recommendation 2:** Avoid allocating future funding to research seeking to find an association between PE/PA and AA as such research is likely to result in inconclusive and/or neutral findings.

**Recommendation 3:** Greater attention and/or funding could be directed towards research that uses robust methods to examine the value of PE as a curriculum learning area with educative purpose in and of itself.

**Recommendation 4:** Greater attention and/or funding could be directed towards collecting a strong evidence base of what makes for quality PE programs as well as quality teaching and learning in PE.

**Recommendation 5:** View with some caution and scepticism the rise of school-based PA products and programs emerging in schools as PE as evidence from this review questions the effectiveness of PA interventions in schools.
INTRODUCTION

In 2019, the Commonwealth Department of Education (DoE) commissioned researchers within the Faculty of Education at Monash University to conduct a literature review of relevant available research and evidence in Australia (and if appropriate overseas), where improved learning outcomes for school students have been demonstrated to result from effective implementation of the PE element of the curriculum. This report details some of the findings from key academic literature examining the link between PE and AA from the last 15 years. Furthermore, the report provides an overview of current PA projects and programs operating in Australian schools that may or may not link to PE and/or AA. In particular, the report aims to provide evidence of what works, elements of success, relevant contextual factors, and how Australian education authorities could use this evidence to improve educational and health outcomes for their students in their schools.

The project sought to determine the benefits/impact that PE may have on AA in other curriculum learning areas. The following research question was supportive of this aim:

Does physical education\(^7\) have measurable educative benefits/impact on student academic performance and meeting of learning outcomes in other curriculum learning areas?

The following objectives guided the scope of the project, with the primary tasks of the research being to:

- Examine research and grey literature\(^8\) from Australia and overseas that explores links between physical education and improved educational and learning outcomes for students in other curriculum learning areas.
- Identify and audit projects and programs in Australia and overseas that explore links between physical education and improved educational and learning outcomes for students in other curriculum learning areas.
- Provide key stakeholders with evidence, information and insights as to the current and future role, impact and educative value of physical education in schools and for students.

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\(^7\) Note the original research question also included ‘physical activity’ research which was then omitted due to extremely large sample size and drift away from the key focus of the project i.e. physical education

\(^8\) During the development of inclusion and exclusion criteria ‘grey literature’ by way of three theses was omitted from the final full texts for the following reasons: a) difficulty in verifying quality of theses, b) authors did not appear in research articles, c) size of final full text list given scope of the project, d) desire to focus on quality research, e) acknowledgment that the project/program audit picked up Australian grey literature found to be worthwhile to include as part of the final report
This report focuses on sharing some possible answers to the research question above. It is structured in four sections:

- Section 1 introduces the research methodology
- Section 2 identifies and discusses findings from the literature review
- Section 3 identifies and discusses findings from the project and stakeholder audit
- Section 4 offers conclusions and recommendations
SECTION 1: RESEARCH METHODOLOGY

The scope of this project was both national and international and involved the following research methods to gather data:

- Literature review
- Program/project audits
- Surveys of key stakeholders

Literature review

A literature review was undertaken in order to identify, evaluate and synthesise literature of relevance to the stated research question. This process served to provide background information about the field of study with a focus on what has already been done, what is generally accepted, what is emerging and what is the current state of thinking on the topic. Importantly, the literature review also identified research limitations and hence provides insights with regards to further research.

In the context of this project, literature refers to a collection of published journal articles of academic value to the research question.

Specific details of the literature review methodology are provided in Section 2.

Program/project audits

An audit of current and recent past PA and/or PE projects, programs, initiatives or interventions was conducted in order to gather information about on-the-ground activity in schools and in support of the research question. This was done initially via emails to key stakeholder informants and organisations known to the research team. Via snowballing of responses, a collection of additional key informants and projects was generated.

Specific details of the program/project methodology are provided in Section 3.
Surveys of key stakeholders

In the original project brief surveys were suggested as a way in which to determine the impact of PA/PE projects and programs from the point of view of key stakeholders across Australia. The assumption was that stakeholders’ perspectives of such projects/programs would be able to provide a snapshot of the most recent activities of relevance to the remit of this project, and hence value-add to the data collected. Unfortunately, initial data collected via emails with key stakeholders was not able to justify a broader survey and the stakeholder survey method was abandoned with DoE advised accordingly. This decision was made for pragmatic reasons, there was simply not enough information from the literature review, grey literature and key informants that identified projects/programs or interventions with a specific PE + AA (or EF) link, focus or outcome.

This is likely an important finding in itself as it warrants investigations of whether outsider driven interventions, a) are or are not being conducted in PE time, b) have an educational focus or imperative, and/or c) are linking to or making claims about AA/EF.
SECTION 2: FINDINGS FROM LITERATURE REVIEW

As a curriculum learning area that has continually struggled to gain status within an increasingly crowded curriculum, questions are often asked about the capacity of PE to contribute to broader learning within the school context. Whilst the links between PA more broadly and cognitive performance and brain development have been recognized (although are also contested), the specific role PE has on student's academic performance is less well established. As Donnelly et al. (2016) outline, ‘the perceived importance of PE and its contribution to children’s academic success has varied considerably over the history of the modern educational system’ (p. 2). The drive for schools to focus on standardised testing, both in Australia and internationally has frequently led to a reduction in available time within the curriculum for what are considered to be peripheral subjects, such as PE. Consequently, scholars and educational professionals have sought to evidence the ‘value add’ of PE in order to justify its relevance and importance in the curriculum. This development of a rationale for the importance of PE has tended to fall into two broad categories: Firstly, the importance of PE in addressing physical inactivity and associated health and wellness concerns e.g. obesity through the direct provision of PA but also through supporting students to develop skills and knowledge that will enable them to live physically active lives. Secondly, and where the current literature review focus sits, the contribution that PE can make to enhancing students’ capabilities in other learning areas and specifically how it can support the achievement of academic outcomes.

The objective of the following review was to undertake a systematic process of identifying and analysing research literature to address the following question,

**Does physical education have measurable educative benefits/impact on student academic performance and meeting of learning outcomes in other curriculum learning areas?**

The process by which relevant literature has been systematically identified and analysed is discussed in the methodology sections below. It is important to note that this review is contained to literature that examines the relationship between PE, as a curriculum learning area, and academic outcomes and does not therefore examine literature analysing PA or sport delivered within a school setting but outside of PE contexts and/or PE time. Whilst there are no existing reviews that answer this specific question, there have been a number of literature reviews undertaken that have relevance to the current study. These are overviewed in Table 1.
### Table 1: Summary of Findings of Literature Reviews Examining the Influence of Physical Education on Academic Achievement (n=7)

<table>
<thead>
<tr>
<th>NO.</th>
<th>AUTHOR / JOURNAL / QUAL</th>
<th>REVIEW APPROACH</th>
<th>AIM OF THE REVIEW</th>
<th>KEY FINDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Basch (2011) (J Sch Hea)</td>
<td>Literature review (methods of review unclear)</td>
<td>Examine whether low levels of PA and fitness impact AA in urban youth.</td>
<td>Physical inactivity is highly and disproportionately prevalent among school-aged urban minority youth and has a negative impact on AA through its effects on cognition. Increasing students’ PA and physical fitness can best be achieved through a comprehensive approach that includes PE.</td>
</tr>
<tr>
<td>14</td>
<td>Donnelly et al. (2016) (Med &amp; Sc in Sp &amp; Ex)</td>
<td>Systematic literature review, 1990-2014, 137 articles included</td>
<td>Examine influence of PA and physical fitness on cognition, brain structure and brain function and whether PA, PE and sport programs influence achievement in standardized achievement tests.</td>
<td>Majority of the research supports the view that physical fitness, single bouts of PA, and PA interventions benefit children’s cognitive functioning. Limited evidence available concerning the effects of PA on learning. The studies that have examined relations between PE and AA have generally found no association or null results.</td>
</tr>
<tr>
<td>34</td>
<td>Rasberry et al. (2011) (Prev Med)</td>
<td>Systematic literature review 43 articles included 1985-2008</td>
<td>To synthesise the scientific literature that has examined the association between school-based PA (including PE) and academic performance (including indicators of cognitive skills and attitudes, academic behaviours, and AA).</td>
<td>The results suggest PA is either positively related to academic performance (50.5% of the associations summarized) or that there is not a demonstrated relationship between PA and academic performance (48% of the associations summarized). Study results suggest school-based PE either leads to a positive result or is associated with no change in academic performance.</td>
</tr>
<tr>
<td>41</td>
<td>Tomporowski et al. (2007) (Ed Pysch Rev)</td>
<td>Literature review</td>
<td>To enhance understanding of the linkages between PA and specific types of cognitive functioning.</td>
<td>Exercise facilitates children’s executive function. Exercise may prove to be a method of enhancing those aspects of children’s mental functioning central to cognitive development. At best, the studies reviewed demonstrate that time spent in PE classes does not have a deleterious impact on children’s academic progress.</td>
</tr>
<tr>
<td>44</td>
<td>Trudeau &amp; Shephard (2010) (Am J LS Med)</td>
<td>Systematic literature review 1996 - 2007</td>
<td>To examine the link between academic achievement and involvement in PE, school PA and sport programmes.</td>
<td>With competent teachers, PA can be added to the school curriculum by taking time from other subjects without risk of hindering student AA. On the other hand, adding time to &quot;academic&quot; or &quot;curricular&quot; subjects by taking time from PE programmes does not enhance grades in these subjects and may be detrimental to health.</td>
</tr>
<tr>
<td>47</td>
<td>Zach et al. (2017) (J Cur St)</td>
<td>Literature review 1997-2015, 25 articles included</td>
<td>To organise the results of studies conducted during the last 18 years into a body of knowledge concerning the link between PE and AA.</td>
<td>PE classes do not hinder school children’s academic achievements.</td>
</tr>
</tbody>
</table>
In total there have been seven (n=7) peer reviewed, published literature reviews, three of which are systematic (14, 15, 34). Collectively these reviews cover studies from 1985-2017. As would be anticipated, each review has a slightly different focus that provides valuable context to the current review of literature. Five have reviewed links between AA, performance and cognitive functioning across PA, PA and sport within schools (3, 14, 34, 41, 44). Two specifically examined the relationships between student learning, AA and PE. One, (15) focused on the impact of increasing curriculum time for PE on student learning, whilst the second collated a broad range of studies examining the impact of various variables in the context of PE (such as time, intensity) on AA (47). The main conclusions of these reviews are summarised below:

- There is no evidence to support a reduction in PE time as a strategy to increase AA (3).
- Time can be taken from other curriculum subjects to increase levels of PA without impacting on AA (15). Conversely, taking time from PE and using it for other subjects was not found to improve student grades (44).
- Physical activity and PE have a neutral effect on academic performance and there is no evidence that increasing the time of PE has a detrimental effect on student learning (14).
- Physical activity, delivered in school time may have positive links to AA but this is not conclusive across studies (34).
- Systematic PA may enhance development of specific types of mental processing that are important in academic context (41).

These reviews highlight an ambiguity in determining the connections between PA, PE and academic outcomes. The review by Zach and colleagues (2017) seeks to synthesis studies examining multiple variables and contexts, making it challenging to draw any collective conclusions from the synthesis. The majority of these reviews have concluded that there is limited evidence to determine a link between PE, PA and school sport participation and academic performance. At best, the conclusions of the reviews suggest that regular participation in PE, PA and school sport does not adversely affect student’s academic achievements. The current report builds on the knowledge developed in these previous reviews.

**Literature review search strategy**

A preliminary review was conducted of key authors and literature on the topic to determine appropriate search terms. These terms were then reviewed by the Expert Panel for relevance and completeness. A list of databases was also reviewed by the Panel, and their suggestions regarding both search terms and database selections were incorporated into the search strategy.

Six databases/database platforms were searched: Informit, Scopus, Web of Science, SPORTDiscus, ERIC and Ovid (including AMED, DARE, Cochrane CCTR and CDSR, and PsycINFO). Search terms included those focussed on physical exercise and activity, school levels, and outcomes. A mixture of keyword and database thesaurus (MESH) terms were used (see Table 2) to obtain as many articles as
possible. No filters were used at this stage to ensure a broad spread of articles was obtained. Exercise and outcome terms were combined with 'OR'; school terms were added in with 'AND' to limit searches to those relevant to education, as far as possible.

Searches were conducted on 16<sup>th</sup> August 2019, with alerts set up in each database to ensure additional articles published during the project would also be identified. An additional 90 citations were obtained between 17<sup>th</sup> August and 25<sup>th</sup> October 2019, when full-text reviewing commenced.

Table 2: Search Terms Used (terms ending with / were database subject headings/thesaurus/MESH terms)

<table>
<thead>
<tr>
<th>EXERCISE AND ACTIVITY TERMS</th>
<th>SCHOOL TERMS</th>
<th>OUTCOME TERMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>“physical education” OR “physical activity”</td>
<td>“school”</td>
<td>“academic achievement” OR “academic attainment” OR “academic performance” OR “academic impact” OR “academic outcome” OR “education achievement” OR “education attainment” OR “education performance” OR “education impact” OR “education outcome” OR “educational achievement” OR “educational attainment” OR “educational impact” OR “educational performance” OR “educational outcomes” OR “cognitive ability” OR “cognitive abilities” OR “cognitive outcome”</td>
</tr>
<tr>
<td>Physical education/Elementary schools/</td>
<td>Educational attainment/</td>
<td></td>
</tr>
<tr>
<td>OR High schools/</td>
<td>OR Academic achievement/</td>
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<td>OR Secondary schools/</td>
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<td>OR Cognitive ability/</td>
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<td>OR Thinking skills/</td>
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Inclusion and exclusion criteria

Draft inclusion and exclusion criteria were established before searching commenced, and then refined based on results from the first 100 articles.

Articles were included in the review if they:

- Focussed on activities occurring within PE sessions designed for all students,
- Were published after December 2003,
- Focussed on activities within primary, middle or high schools (or their equivalents),
- Included interventions run by teachers in the schools,
- Included measures of AA, such as grades, performance on school-based or standardised academic tests,
- Included measures of EF, such standardised cognitive ability tests,
- Were published in English.

Articles were excluded if they:

- Were predominantly focussed on activities taking place outside of PE classes, such as other subject-specific classes, after-school clubs, recess, adventure education, or walking to school activities,
- Were published before January 2004,
- Focussed on activities or cohorts in kindergarten/pre-school/nursery classes, tertiary environments, or classes targeted at adults,
- Primarily evaluated activities run by external providers from outside the school,
- Included only physiological, behavioural or perceptual measures unrelated to academic performance (such as BMI, nutrition, blood lipid levels, smoking cessation),
- Were focussed on student athletes or sporting teams,
- Had full text published in languages other than English.

After consideration at the full-text stage, theses, dissertations and grey literature were excluded, as much of their content was related to the primary studies already included.

Seven literature reviews were included, and considered separately, as they provide useful context and chronology behind the research in this space (see Table 1).
Search results

A total of 5379 unique articles were returned from the searches and alerts, after duplicates were removed. Articles were then screened against inclusion and exclusion criteria in three stages: title screen; abstract screening; and full-text screening.

Two researchers, Karen Lambert (KL) and Allie Ford (AF) independently screened articles at the title stage. Articles were flagged for inclusion, exclusion or as ‘unsure’, where insufficient information was available to inform a decision. If either researcher flagged an article as ‘unsure’ or ‘include’, it was carried forward to the next screening stage. Due to time constraints, abstract screening was performed by KL only. Again, articles were flagged as ‘include’, ‘exclude’ or ‘unsure’, and only those which clearly fell into the ‘exclude’ category were removed.

In the final stage, the remaining 78 articles were split between all three researchers, with approximately even distribution. Each researcher extracted data as they read, and flagged each article for inclusion or exclusion in the final review. During this process the final forty-seven (n=47) full text articles were identified by KL and advanced to the stage of further synthesis in readiness for preparing the report. The final 47 articles appear in the Reference List in alphabetical order (inclusive of literature reviews). Figure 1 presents a PRISMA diagram showing the systematic flow of information through the different stages of screening and review.
Findings

In seeking to examine the measurable AA links between PE and other curriculum learning areas this literature review contributes to a large body of work exploring the value of PA in and for learning. The review provides an integrative narrative that critiques and synthesises current research and thinking around this topic. In doing so, it provides a broad context for determining what research contributes to the investigation and what does not. As discussed above, it has done this by making decisions about inclusions and exclusions in critical ways and so as to maintain the efficacy of the project in relation to the specific research question as posed. For example, in this literature review the specific focus was PE so during the review PA as a search term was excluded, though in being critical of the literature this exclusion is worthy of discussion and appears later in this section of the report.
The section below reports on evidence from Australian and international research published in peer reviewed journals from 2004-2019 by firstly providing a summary of the final forty (n=40) full text research studies included in the literature review, and then synthesizing these findings into three categories. The categories are:

a) Research sample, which identifies features of the locations and participants, as well as journal quality.
b) Study design, which identifies features of the research design.
c) Literature results/findings, which identifies findings from the literature in relation to the research question and effect.

Category 1: Research sample

Given the research question relates to schools and school students it is important to report upon features of the locations and participants. In this regard, where the research occurred and who was researched are important to note:

- This literature review reports on forty (n=40) peer-reviewed research articles and seven (n=7) literature reviews published in English between 2004 and 2019.
- Collectively these articles have conducted research in approximately 1159 schools involving 71,593 participants from 13 different countries.
- The countries in which research was conducted are: United States of America (n=15); Sweden (n=6); Italy (n=4); Australia and Germany (n=3); Spain (n=2); Denmark, Norway, Switzerland, Greece, China, England, Scotland (n=1).
- The school site in which the research was conducted are: twenty-seven (n=27) in primary schools only; ten (n=10) in secondary schools only; three (n=3) in combined primary-secondary schools. Note this includes the sites where four (n=4) articles report upon nationally sampled data.

Gauging study quality via journal quality and metrics

Where research articles are published is important to identify as it is likely to signal the quality of the publication. This is often judged based upon the journal and information about coverage and relevance in the field, quality and impact, and dissemination of the journal relates to the veracity of the results. In Tables 1, 3 and 4 information about each journal is provided by way of two journal quality metrics in the Source Normalised Impact per Paper or SNIP and the CiteScore. The SNIP is ‘SNIP is the ratio of a source's average citation count per paper and the 'citation potential' of its subject field’ (Monash University Library, 2019, para. 6). The CiteScore is ‘the number of times documents published in the previous 3 years have been cited in the year of reporting, divided by the number of documents’ (Monash University Library, 2019, para. 3). In the Faculty of Education at Monash University quality of publications are measured based on a SNIP >1.0. This amount is chosen because a SNIP of 1.0 has the median (not mean) number of citations for journals in that field.
Applying this measure of quality to the literature reviewed, the following emerges:

- Quality publications (SNIP >1.0) include (2, 6, 7, 8, 9, 10, 12, 13, 16, 17, 18, 19, 23, 24, 27, 28, 30, 32, 33, 36, 37, 39) (n=22) (55%)
- Low quality publications (SNIP <1.0) include (1, 4, 5, 20, 21, 22, 25, 26, 29, 31, 35, 38, 40, 42, 45, 46) (n=16) (40%)
- Two journal metrics could not be found (11, 43) (n=2) (5%)
- A number of Open Access journals also appear in the review (5, 23, 24, 25, 32, 46) and when compared to the SNIP and CiteScore it could be concluded that OA availability will not affect results
- Six of the seven literature reviews consulted in this review are also high quality (3, 14, 15, 34, 41, 47)

Another important observation from the collection of journal titles is that very few come from journals typically associated with publishing research in the discipline of PE. In fact, only 10% of the articles were published in PE discipline specific journals (13, 18, 33, 43), with the other 90% being made up from a variety of journals situated broadly in health, psychology, medical, sport science and education disciplines. This might indicate that the authors/researchers are less concerned with examining PE as a curriculum area and more on the processes that occur within PA, and/or other imperatives (e.g. obesity prevention). As noted further on, this has led to limited consideration of how PE is taught, the educative value of PE, or the plethora of other benefits to be gained from PE because the research in general, is not being conducted by academics within education.
Category 2: Study design

This review process has highlighted that a great deal of research exploring the links between PA/PE/sport and AA/EF is conducted in schools around the world. In this regard, how this research is conducted is important to note as it helps to indicate and determine the quality of the research process as well as the validity and generalisability of the findings. For the purpose of this review the research consulted has been divided into two tables.

- Table 3 records the experimental studies (including randomised control trials [RCT], cluster randomised control trials [CRCT], and quasi-experimental design [QE]) and, longitudinal studies (which may also be experimental or non-experimental).
- Table 4 records the non-experimental studies (including cross-sectional and correlational studies, qualitative studies).

Table 1 which provides a summary of the literature reviews (3, 14, 15, 34, 41, 44, 47) appeared earlier in this report and will not feature in this section.

**Measures and variables**

Below the key variables measured and discussed in the research studies are clarified as they are the focus of the research question and are central to the research studies. It should be noted that not all research studies measured all variables all of the time.

**Physical activity variables:** PA was manipulated in various ways across the research studies in terms of frequency, intensity, time, and type of activity (often known as training effects). It was measured in equally diverse ways ranging from self-reporting to observation and anthropometric data (e.g. height, weight, BMI, maturity) and on to physical fitness tests (e.g. cardio-respiratory endurance, speed, power, flexibility, balance motor skills, use of accelerometers) - and any combinations of these. These tests may or may not have been conducted by researchers.

**Academic achievement variables:** AA was assessed in a variety of ways across the research studies though in the main this data comes from standardised tests (e.g. national or state tests) for numeracy/Mathematics, literacy, and mother language (e.g. Swedish, English). In Australia NAPLAN data is an example. In the research studies AA was also assessed from end of year grades/GPA, school reports, teacher assessment, and student self-reporting.

**Executive function variables:** EF was assessed in a variety of ways across the research studies with data coming mainly from standardised EF/cognitive functioning tests (e.g. Cognitive Assessment System, Simon Task, Flanker test, Rey Auditory Verbal Learning). Data is recorded in relation to any combination of the following: cognition, attention, concentration, inhibition, working memory, random number generation, perception, processing speed. Brain structure and function tests also appear in the studies. These tests were usually conducted by researchers.
Experimental study design

In experimental studies the aim is to determine causation. Researchers set up the environment and manipulate or control the predictor variables and subjects, as such this type of study design is considered to be highly valid, though generalisability of results may be hard. The following information was gleaned from the experimental studies reviewed and appears in Table 3:

- Eleven (n=11) experimental research studies were identified (1, 2, 4, 23, 24, 26, 27, 30, 39, 40, 46)
- Of the eleven experimental studies, five (n=5) were cluster randomised control trials [CRCT] (1, 24, 30, 40, 46), two (n=2) were randomised control trials [RCT] (2, 23), and four (n=4) were quasi-experimental [QE] (4, 26, 27, 39) design
- Two (n=2) or the experimental studies were also longitudinal (4, 39), and one (n=1) was conducted over 2 years though did not claim to be longitudinal though has been recorded as such (30)
- Experimental studies published in quality journals (2, 23, 24, 27, 30, 39)
- Experimental studies published in low quality journals (1, 4, 26, 40, 46)

Longitudinal study design

In longitudinal studies the aim is to analyse change over time. Researchers might employ a) a prospective design (continuous or repeated measures of the same individuals over time), b) repeated cross sectional design (continuous or repeated measures of the different individuals over time), or c) retrospective design (uses data previously acquired via other longitudinal methods). The following information was gleaned from the longitudinal studies reviewed and appears in Table 3:

- Eleven (n=11) longitudinal research studies were identified (4, 6, 9, 12, 16, 17, 18, 19, 30, 38, 39)
- Three (n=3) longitudinal research studies were identified as prospective studies (9, 17, 19); two (n=2) as having repeated measures design (16, 39); three (n=3) as retrospective having drawn data from previous longitudinal studies (6, 12, 38); two (n=2) studies do not state a specific type of longitudinal style (4, 30)
- Three (n=3) of the longitudinal studies were also experimental (4, 30, 39)
- Longitudinal studies published in quality journals (6, 9, 12, 16, 17, 19, 30, 39)
- Longitudinal studies published in low quality journals (4, 38)
### Table 3: Summary of Findings from Experimental and Longitudinal Research Studies Examining the Influence of Physical Education on Academic Achievement and/or Executive Function

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<tr>
<th>#</th>
<th>AUTHOR/ YEAR/ JOURNAL</th>
<th>SAMPLE</th>
<th>AIMS</th>
<th>STUDY DESIGN</th>
<th>INTERVENTION</th>
<th>MEASURES</th>
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<tr>
<td>1</td>
<td>Aadland et al. 2019 (Scand J of Edu Res) SNIP=0.972; CS=1.43</td>
<td>Primary n=57; Participants n=1145 (10 yo); Norway</td>
<td>To examine impact of a PA intervention on executive functions of 10-year olds</td>
<td>Experimental; CRCT; 7-month Intervention (time &amp; frequency)</td>
<td>The Active Smarter Kids [ASK] intervention has three PA elements: PA educational lessons, PA breaks, and PA homework, adding 165 minutes of PA to the mandatory 135 min of PA and PE</td>
<td>• EF - inhibition, working memory, cognitive flexibility pen paper tests • PA - accelerometer, fitness tests (CRF, motor skills). Other - height, weight, BMI, pubertal status, SES</td>
<td>No effect of the intervention on executive functions</td>
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<td>2</td>
<td>Ardoy et al. 2014 (Scand J Med Sci Sports) SNIP=1.628; CS=3.89</td>
<td>Secondary n=1; Participants n=67 (12-14 yo); Spain</td>
<td>To analyse the effects of an intervention of increasing the time and intensity of PE on adolescents’ cognitive performance and AA</td>
<td>Experimental; RCT; 4-month intervention (time &amp; intensity)</td>
<td>Three groups: CG received usual PE (2 sessions/week), EG1 received 4 PE sessions/week and EG2 received 4 PE sessions/week of high intensity</td>
<td>• AA - school grades core subjects Math, Spanish + others • EF - Spanish Overall and Factorial Intelligence Test of cognitive performance. • PA - fitness tests (CRF, strength, speed, agility) • Other - weight, height, BMI, sexual maturation</td>
<td>Effect. Increasing the number and intensity of PE sessions per week has a positive effect on both cognitive performance and academic achievement</td>
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<td>4</td>
<td>Bugge et al. 2018 (Scand J Med Sci Sports) SNIP=0.972; CS=1.43</td>
<td>Primary n=6; Participants n= 1888 students; Denmark</td>
<td>Does increase in PE time impact on AA?</td>
<td>Quasi experimental; Longitudinal; Intervention (frequency &amp; time)</td>
<td>CHAMPS study-DK. Involved tripling of PE lessons from two (90 minutes) to six lessons per week (270 minutes)</td>
<td>• AA - Danish national test maths and Danish • PA - CRF • Other - SES, BMI</td>
<td>No effect. No significant differences were observed between groups in the academic performance tests</td>
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<td>#</td>
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| 6  | Carlsson et al. 2008 (Am J of Public Health) | National sample primary n=5316 (K-Gr 5); USA | To examine the association between time spent in PE and AA in a longitudinal study of students in K-Year 5 | Non-experimental; Prospective; Multistage probability design (time); draws from Longitudinal data | Nationally representative sample from Early Childhood Longitudinal Study (1999-99) | • AA - standardized test for maths and reading  
• PA - time spent in PE collected from classroom teachers  
• Other - income, race/ethnicity, mothers’ education | Effect (girls). Small but significant benefit for AA in maths and reading was observed for girls |
| 9  | Coster et al. 2018 (Foundation Acta Pædiatrica) | Primary n=1; Participants n=1189 (6-7 yo); Sweden | Does increased PE lead to improved academic achievement? | Longitudinal (9 years); Prospective; Intervention | Changed the duration of PE from the Swedish standard of 60 minutes per week to 40 minutes per school day, totalling 200 minutes per school week, during all nine years of school (time) | • AA - final grade scores and the proportion of students eligible for upper secondary school | Effect (boys). Increasing PE weekly over 9 years was associated with improved AA in boys |
| 12 | Dills et al. 2011 (Economics of Ed Rev) | National sample Primary K-5 n=?; USA | To evaluate how recess and PE in elementary school influence children’s learning | Non-experimental (time); draws from Longitudinal data | Nationally representative sample from Early Childhood Longitudinal Survey Kindergarten Class (1998-9) | • AA - standardized tests for reading (language and literacy) and mathematical thinking  
• PA - PE time, recess | No effect. No statistically significant or economically significant impact of weekly recess or PE time on student learning |
| 16 | Ericsson 2008 (Br Edu Res J) | Primary n=1; Participants n=251; Sweden | To study effects of an extension of PE and motor training on MS | Longitudinal, Repeated measures; Intervention - MUGI (time, type, frequency) | Two intervention groups that have PA and motor training one lesson every school day plus one control group that has regular PE two lessons per week | • AA - National tests in Swedish and maths  
• EF - attention  
• PA - MUGI MS checklist | Effect. Improvement in Swedish & Maths. No improvement in attention |
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| 17 | Ericsson 2019 (Cur Pol and Econ of Eur) | Primary n=1; Participants n=251; Sweden | To investigate long-term effects on MS and scholastic performance of increased PEH and extra motor skills training according to the MUGI model | Longitudinal 9 years; Prospective; Pedagogical intervention (MUGI) (time, type, frequency, intensity) | Two groups. IG increased PEH from 2 to 5 times/wk. CG remained at 2 days/wk. IG also high intensity based + option for 60 min extra motor support (MUGI model) | • AA - National tests maths, Swedish, English  
• PA - MUGI MS checklist | Effect. Improvement in motor skills, AA, higher grades, and higher proportion of students who reached qualification for upper secondary school |
| 18 | Ericsson-Cederberg 2015 (Phys Ed and Sp Ped) | Secondary; Participants n=293 (147 male, 146 female); Sweden | To study relationships between PA and school performance among Swedish compulsory school students who fail to achieve sufficient grades to move on to upper secondary school | Non-experimental. Self-reported online questionnaire (part of 9-year prospective longitudinal study) | Online survey instrument | • AA - final grades, matriculation  
• PA - in PEH, out of PEH | Effect. Significant correlations were found between the level of PA and grade in PEH, as well as between PA and PEH and total grades |
| 19 | Ericsson-Karlsson 2014 (Scand J Med Sci Sports) | Primary n=1; Participants n = 220 (119 boys, 101 girls); Sweden | To study long-term effects on MS and school performance of increased PE | Longitudinal 9 years; Prospective; Controlled, exercise, intervention (MUGI) (time, type) | IG had daily PE (5x45 min/week) and if needed one extra lesson of adapted motor training (MUGI); CG had PE two lessons/week | • AA - National tests maths, Swedish, English  
• PA - MUGI MS checklist | Effect (boys). On the sum of marks in investigated school subjects in boys. Greater impact on students with impaired MS |
| 23 | Fisher et al. 2011 (BMC Pediatrics) OA | Primary n=6; Participants n=64; Scotland | To examine impact of PA intensity delivered through PE on children's cognition | Experimental; RCT; 10-week intervention (intensity) | A 10-week PE intervention which involved 2 hours/week of aerobically intense PE compared to 2 hours of standard PE (control) | • EF - multiple standardized cognitive performance tests  
• PA - Actigraph accelerometer | Inconclusive. Small changes in neurophysiology and attention; no significant changes in CAS scores |
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<td>24</td>
<td>Galotta et al. 2015 (Front Hum Neurosci) OA</td>
<td>Primary n=3; Participants n=150; Italy [SNIP=1.01; CS=2.96]</td>
<td>To examine the potential influence of varying types of exertion on immediate attentional performance</td>
<td>Experimental design; CRCT; Intervention 5 months (type &amp; mode)</td>
<td>Three cohorts. Traditional PA, Coordinative PA and a Control group (not attending any PA)</td>
<td>• EF - d2R test of attention pre-post • Other - weight, height, BMI</td>
<td>Effect. Improvement in cognitive performance. Coordinative PA linked to concentration, and accuracy and maybe academic achievement</td>
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<td>26</td>
<td>Jansen et al. 2018 (Edu Psych)</td>
<td>Secondary n=1; Participants n=144 (12-17 years); Germany [SNIP=0.475; CS=1.57]</td>
<td>To investigate the influence of an established school programme with a high amount of PE on visual-spatial ability</td>
<td>Quasi-experimental; Intervention (time)</td>
<td>Two groups. EG - In addition to regular PE classes, received 2 hours of daily PE. CG - received only 2 lessons of PE (90 min) per week. Intervention a bit unclear</td>
<td>• EF - number-connection-test (ZVT) &amp; mental-rotation test (MRT-A)</td>
<td>Effect. Mental rotation performance significant result. Improved cognitive processing speed of boys but no differences for girls.</td>
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<td>27</td>
<td>Kall et al. 2015 (J Sc Hea)</td>
<td>Primary n=4; Participants n=545; Sweden [SNIP=1.044; CS=2.11]</td>
<td>To investigate impact of PA intervention on AA, psychological wellbeing, health related quality of life, fitness and structural development of brain</td>
<td>Quasi experimental with control group; Intervention (time &amp; type)</td>
<td>IG -double PA + extra class consisted of “play and motion” activities designed to be engaging, enjoyable, health-promoting, and non-competitive (different sports and games with or without use of equipment)</td>
<td>• AA - Swedish national tests (English, Maths, Swedish, and Swedish as a second language) • PA - CRF • Other - socioemotional tests, brain volume</td>
<td>Inconclusive. A curriculum-based PA in school may improve the AA and psychological health of children, particularly for girls</td>
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| 30 | Lubans et al. 2018 (Med & Sci in Sp & Ex) | Secondary n=14; Participants n = 1173 (Gr 8); Australia | To test the effect of a school-based PA intervention on adolescent’s performance in maths | Experimental; Two-arm CRCT; Intervention (2yrs -likely longitudinal?) (intensity) | Activity and Motivation in Physical Education (AMPED). A multicomponent intervention to maximize students’ MVPA during physical education (PE) and enhance students’ motivation toward PE | • AA - NAPLAN maths  
• PA - Actigraph accelerometers  
• Other - demographics, height, weight, BMI, maturity, school engagement scale (Maths) | Effect (small-med). On maths performance. Students in IG were not outperforming those in the CG at the follow-up assessments |
| 38 | Simms et al. 2014 (Hea Edu J) | National sample primary n=10,210 (Gr 5); USA | Does PE matter? | Non-experimental; draws from Longitudinal data | Nationally representative sample from the Early Childhood Longitudinal Study-Kindergarten Cohort [ECLS-K] | • AA - standardized tests in reading, math, and science  
• Other – self-concept, social skills, BMI, diet, out of school activity, PE time | Effect (small). PE +ve but modest association with AA |
| 39 | Telford et al. 2012 (Am J of Pub Hea) | Primary n=29; Participants n=620 (Gr 3); Australia | Does PE taught by specialists contribute to AA and prevent obesity? | Multilevel, randomised quasi-experimental design; Intervention; Longitudinal (2yrs); Repeated measures (who/expert v gen) | Lifestyle of Our Kids study. All received 150 min/wk of PE. IG (specialist-taught PE) included 90 min/wk of PE from visiting specialists. CG (common-practice PE) received all PE from generalist classroom teachers | • AA - National standardized test NAPLAN (writing, numeracy, reading proficiency)  
• PA - CRF, pedometers, SOFIT  
• Other – height, body composition, obesity | Effect. Specialist-taught PE was associated with greater improvements in numeracy and writing scores. There was no evidence of a reading effect |
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| 40 | Thompson et al. 2016 (Mental Hea and Phys Act) | Primary n=7; Participants n=791 (Gr 5); USA | Does PA in a PE class before a maths test affect scores? | Experimental; CRCT; Intervention (time & intensity) | PE teachers provided at least 20 min of MVPA during a 40-min PE period directly before reading/math standardized tests | • AA - standardized tests reading and maths  
• PA - observation, accelerometry  
• Other - Children’s Test Anxiety Scale (CTAS) (student & teacher) | No effect. No difference in test scores between groups |
| 46 | Wassenaar et al. 2019 (Trials) OA | Secondary n=104; Participants n= 18, 261 (Gr 8); England | To investigate the impact of a one academic year VPA programme delivered during PE on academic performance in Year 8 pupils | Experimental; CRT; Intervention 1 year (time & intensity) | The Fit to Study project. Schools were randomised into an IG in which PE teachers delivered an additional 10 min of VPA per PE lesson for one academic year, or a 'PE as usual' CG | • AA - standardized test (Maths)  
• PA - CRF, accelerometer  
• EF - standardized tests of working memory, inhibition and cognitive flexibility  
• Other – other cognitive and mental measures; brain imaging | No effect reported, at best suggest inconclusive |

Legend: AA (academic achievement); BMI (body mass index); CAS (cognitive assessment system); CG (control group); CRCT (cluster randomized control trial); CRF (cardio-respiratory fitness); CS (CiteScore); EF (executive function); EG (experimental group); GPA (grade point average); IG (intervention group); M-ABC (movement assessment battery for children); MS (motor skills); MUGI (motor skills as ground for learning); MVPA (moderate to vigorous physical activity); PA (physical activity); PE (physical education); PEH (physical education and health); RCT (randomized control trial); SES (socio-economic status); SOFIT (system for observing fitness instruction time); SNIP (source normalised impact per paper); VPA (vigorous physical activity)
Non-experimental study design

In non-experimental studies the aim is to describe a phenomenon or a relationship between variables. Researchers do not control, manipulate or alter the predictor variables or subjects, as such it is hard to determine causality which raises questions about the validity of the measures, though results can be generalized to the broader population. The following information was gleaned from the non-experimental studies reviewed and appears in Table 4:

- Twenty-four (n=24) non-experimental research studies were identified (5, 6, 7, 8, 10, 11, 12, 13, 20, 21, 22, 25, 28, 29, 31, 32, 33, 35, 36, 37, 38, 42, 43, 45)
- Of the twenty-four non-experimental research studies, nineteen (n=19) were intervention studies (5, 7, 8, 10, 11, 13, 20, 21, 22, 25, 29, 31, 32, 33, 35, 36, 37, 42, 43) and four (n=4) were non-intervention studies i.e. survey/questionnaire, data from national data sets (13, 28, 37, 45)
- Four (n=4) of the non-experimental research studies were also longitudinal (9, 16, 17, 19)
- Non-experimental studies published in quality journals (6, 7, 8, 10, 12, 13, 18, 28, 32, 33, 36, 37)
- Non-experimental studies published in low quality journals (5, 20, 21, 22, 25, 29, 31, 35, 38, 42, 45)
### Table 4: Summary of Findings from Non-Experimental Research Studies Examining the Influence of Physical Education on Academic Achievement and/or Executive Function

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<tr>
<td>5</td>
<td>Butzer et al. 2015 (Evidence-Based Compl &amp; Alt Med) OA</td>
<td>Secondary n=1; Participants n=95 (Gr 9 or 10); USA</td>
<td>To examine the impact of a yoga intervention on student GPA</td>
<td>Non-experimental; Intervention (type)</td>
<td>PE classes were group randomized to receive either a yoga intervention or a PE-as-usual control condition for 12 weeks</td>
<td>• AA - GPA</td>
<td>Inconclusive. Yoga may have a protective effect on AA by preventing declines in GPA, however preventive effects may not persist</td>
</tr>
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<td>6</td>
<td>Carlsson et al. 2008 (Am J of Public Health)</td>
<td>National sample primary n=5316 (K-Gr 5); USA</td>
<td>To examine the association between time spent in PE and AA in a longitudinal study of students K-5</td>
<td>Non-experimental; Prospective; Multistage probability design (time); draws from Longitudinal data</td>
<td>Nationally representative sample from Early Childhood Longitudinal Study (1998-99)</td>
<td>• AA - standardized test for maths and reading</td>
<td>Effect (girls). Small but significant benefit for AA in maths and reading was observed for girls</td>
</tr>
<tr>
<td>7</td>
<td>Chomitz et al. 2009 (J of Sch Health)</td>
<td>Prim-sec; Participants n=1478 (Gr 4, 6, 7, 8); USA</td>
<td>To determine the relationship between physical fitness and AA</td>
<td>Non-experimental</td>
<td>Cross sectional (AA scores-Fitness scores)</td>
<td>• AA - standardized tests (English, Maths)</td>
<td>Effect. Statistically significant relationship between fitness and Math and English AA</td>
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<td>8</td>
<td>Coe et al. 2006 (Med &amp; Sc in Sp &amp; Ex) [SNIP=1.669; CS=4.34]</td>
<td>Primary n=1; Participants n=214 (Gr 6); USA</td>
<td>To determine the effect of PE class enrolment and PA on academic scores</td>
<td>Non-experimental</td>
<td>Two groups. One enrolled in PE during the first semester, the other enrolled in PE the second semester. During the semester of no PE participants did alternative exploratory class</td>
<td>• AA - school grades (Maths, Science, English, World Studies) + Terra Nova standardized test</td>
<td>No effect. Grades were similar regardless of whether students were enrolled in physical education during first or second semesters</td>
</tr>
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<td>10</td>
<td>Crova et al. 2014 (J of Sp Sc) [SNIP=1.342; CS=2.79]</td>
<td>Primary n=2; Participants n=70 (9-10yo); Italy</td>
<td>To test the association between aerobic fitness and EF and the impact of enhanced, cognitively challenging physical activity on EF in overweight and lean children</td>
<td>Non-experimental; Intervention (type)</td>
<td>Two groups. Assigned to either a 6-month enhanced PE programme including cognitively demanding (open skill) activities or curricular PE only</td>
<td>• EF - inhibition and working memory updating (random number generation task) • PA - pre- and post-aerobic capacity • Other - height, weight, BMI</td>
<td>Effect (overweight children). Overweight children in enhanced programme, compared to their lean peers, showed a higher improvement of inhibitory ability after the intervention period</td>
</tr>
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<td>11</td>
<td>Demetriou et al. 2018 (J Funct Morphol Kinesiol) [NA]</td>
<td>Primary n=2 Participants n=169; Germany</td>
<td>To examine the effects of school type on students' physical literacy and cognitive performance</td>
<td>Non-experimental (school type)</td>
<td>Direct comparison. One sports-orientated, one regular school</td>
<td>• EF - computer based cognitive performance tests • PA - German motor performance test (multiple tests); FMS; PA behaviour</td>
<td>No effect. There were no differences between the groups regarding cognitive performance</td>
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| 12 | Dills et al. 2011 (Economics of Ed Rev) | National sample Primary K-5 n=7; USA [SNIP=1.683; CS=2.25] | To evaluate how recess and PE in elementary school influence children’s learning. | Non-experimental (time); draws from Longitudinal data | Nationally representative sample from Early Childhood Longitudinal Survey Kindergarten Class (1998-9) | • AA - standardized tests for reading (language and literacy) and mathematical thinking  
• PA - PE time, recess | No effect. No statistically significant or economically significant impact of weekly recess or PE time on student learning |
| 13 | Dollman et al. 2006 (Eur PE Rev) | Primary n=117; Australia [SNIP=1.548; CS=2.41] | To investigate the relationships between PE curriculum time, literacy, and numeracy | Non-experimental (time) | Survey instrument. Regression modelling assessed the relationship between PE time and State LaN scores | • AA - standardized tests (StateLaN in maths, literacy)  
• PA - PE time  
• Other - SES, ethnicity, geographic location, staff age structure, and staff PE training | No effect. PE time unrelated to literacy and numeracy after controlling for other variables |
| 20 | Esteban et al. 2017 (J of Phys Act and Hea) | Prim-Sec n=45; Participants n=1780 (6-18 yo); Spain [SNIP=0.78; CS=2.12] | To compare PA in PE and recess with academic performance | Non-experimental | Cross sectional (AA-PA). Data were used from the UP&DOWN study which is a 3-year longitudinal study | • AA - school records (average math & language scores and GPA)  
• PA - ActiGraph accelerometer  
• Other - Age, sex, city, SES, gestational age, birth weight (kg), BMI | No effect. PA in PE and recess was not associated with academic performance. Time spent in PA does not impair academic performance in youth |
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| 21 | Etnier et al. 2014 (Ped Ex Sci) | Primary n=1; Participants n=43 (11-12 yo) | To examine the effects of an acute bout of exercise on learning, short-term and long-term memory | Non-experimental (intensity) | No-treatment control condition (performed the memory test then light PA. In the exercise condition (performing a warmup, completed the PACER test, perform the memory test)) | • EF - memory test (RAVLT)  
• PA - The PACER (Progressive Aerobic Cardiovascular Endurance Test) (part of FITNESSGRAM) | Effect. Acute bouts of exercise provide benefits for verbal learning and long-term memory |
| 22 | Eveland et al. 2009 (J of Phys Act and Hea) | Primary n=2; Participants n=134 (Gr 3-5) | To examine the relationship between fitness and AA in elementary school children | Non-experimental | Correlational (Fit-AA) | • AA - standardized test (TerraNova academic achievement scores)  
• PA - CRF, strength, flexibility  
• Other - height, weight, BMI | Inconclusive. Support a link between specific components of fitness and selected indices of AA |
| 25 | Granacher-Borde 2017 (Front Physiol) OA | Primary n=1; Participants n=45; Germany | To examine the effects of a 1-year sport-specific training and/or PE on physical fitness, body composition, cognitive and academic performances in youth athletes and their non-athletic peers | Non-experimental. Controlled study design with repeated measures (i.e., pre, post); Intervention (1 year) (type) | Youth athletes from an elite or age-matched peers from a regular class. IG elite sports class conducted PE and sport-specific training (i.e., gymnastics, swimming, soccer, BMX) during school time while the regular class attended PE only | • AA - standardized tests (reading, maths)  
• EF - d2 test (attention, concentration)  
• PA - speed, power, agility, flexibility, CRF, balance  
• Other - weight, height, BMI, age | No effect. No significant between-group differences were found after the intervention in measures of body composition, cognition and academics |
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<tr>
<td>28</td>
<td>Kern et al. 2018 (J Sc Hea)</td>
<td>Primary n=784; Gr 3; USA</td>
<td>To examine the relationship between school-based PA opportunities and third-grade reading ability relative to SES</td>
<td>Non-experimental (frequency &amp; time)</td>
<td>Electronic online and phone questionnaires (frequency and duration of PE class and recess)</td>
<td>• AA - State Board 3rd grade reading database • PA - minutes/time • Other - SES</td>
<td>Effect (small). School-based PA opportunities positively moderate the relationship between SES and third-grade reading</td>
</tr>
<tr>
<td>29</td>
<td>Lorenz et al. 2017 (Hea Edu J)</td>
<td>Primary n=2; Participants n = 80 (Gr 4); USA</td>
<td>To evaluate the relationship between physical fitness and teacher-assigned grades in fourth-grade students and examine whether the relationship is moderated by body composition, gender or ethnic background</td>
<td>Non-experimental</td>
<td>Cross sectional (Fitness-grades)</td>
<td>• AA - teacher-assigned grades (reading, writing, Maths, Social Studies, Science) • PA - FITNESSGRAM (CRF, strength, flexibility) • Other - height, weight, BMI</td>
<td>Effect. Aerobic fitness had a significant influence on reading, writing, Maths and Science grades</td>
</tr>
<tr>
<td>31</td>
<td>Pesce et al. 2013 (Mental Hea and Phys Act)</td>
<td>Primary n=3; Participants n=250; Italy</td>
<td>To investigate whether qualitatively different types of PA interventions in school settings may differently impact children’s executive function</td>
<td>Non-experimental; Intervention (teacher)</td>
<td>Two types of EG and CG standard PE program. The two experimental interventions were directed by PE specialist teachers (specialist-led, S-led), whereas standard PE was directed by classroom generalist teachers (generalist-led, G-led)</td>
<td>• EF – CAS (planning, attention, simultaneous and successive processes) • PA – M-ABC (manual dexterity, ball skills, and static and dynamic balance) • Other - height, weight, BMI, spontaneous play</td>
<td>Inconclusive. Differential effect of PA type and attention as a function of children’s motor developmental level</td>
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<td>AUTHOR / YEAR / JOURNAL</td>
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<td>32</td>
<td>Pesce et al. 2016 (Front Psychol) OA</td>
<td>Pre-primary n= 8 schools; Participants n=920; Italy [SNIP=1.03; CS=2.4]</td>
<td>To evaluate whether enriching PE quality without enhancing its quantity would lead to joint coordinative and cognitive benefits</td>
<td>Non-experimental. Intervention 6-month (type &amp; specialist/generalist)</td>
<td>Two groups. IG with playful coordinative and cognitive enrichment. CG without</td>
<td>As above</td>
<td>Inconclusive. Among indices of EF and attention, only that of inhibition showed a differential effect of intervention type. Ball skills were the only significant movement-related mediator of cognitive outcomes of the intervention</td>
</tr>
<tr>
<td>33</td>
<td>Phillips et al. 2015 (J of Teaching in PE)</td>
<td>Secondary n=1; Participants n=72; USA [SNIP=1.003; CS=1.82]</td>
<td>To examine associations between a single, vigorous bout of PA completed during PE on standardized maths test performance</td>
<td>Non-experimental (intensity &amp; type)</td>
<td>Translational design. Repeated measure design (no intervention-DVD, PE as usual)</td>
<td>• AA - standardized test (Maths) • PA - aerobic circuit; FITNESSGRAM (CRF)</td>
<td>Effect. The results suggest that VPA may be a cause of increased maths academic performance test scores up to at least 30 minutes after condition</td>
</tr>
<tr>
<td>35</td>
<td>Reed et al. 2013 (J of Phys Act and Hea)</td>
<td>Prim-sec n=3; Participants n=470; USA [SNIP=0.78; CS=2.12]</td>
<td>To examine the effects of 45 minutes of daily PE on the cognitive ability, fitness performance and body composition of African American elementary and middle school youth</td>
<td>Non-experimental. Intervention (time)</td>
<td>A pre/post-test design with repeated measures analysis of variance. Experimental and control schools</td>
<td>• EF - fluid intelligence and perceptual speed tests • PA - FITNESSGRAM (CRF, muscular strength, muscular endurance) • Other - height, weight, BMI, previous day PA recall</td>
<td>Inconclusive. Experimental elementary and middle school participants observed significantly greater improvements compared with control elementary and middle school participants on 8 of 26 cognitive measures</td>
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| 36 | Schmidt et al. 2015 (J of Sp & Ex Psych) | Primary; Participants n=181 (10-12 yo); Switzerland | To investigate the effects of two qualitatively different chronic PA interventions on EF in primary school children | Non-experimental; Intervention 6-weeks | Three groups. IG a PE program with a high level of physical exertion and high cognitive engagement (team games). IG a PE program with high physical exertion but low cognitive engagement (aerobic exercise). CG a PE program with both low physical exertion and low cognitive engagement | • AA - standardized (Maths, German)  
• EF - standardized tests (updating, inhibition, shifting)  
• PA - aerobic function  
• Other - height, weight, BMI, pubertal status, Physical Activity Questionnaire for Children | Inconclusive. Only the cognitively engaging intervention (team games) fostered pronounced increases in children's shifting performance. |
| 37 | Shen 2017 (Urban Education) | Secondary n=1; Participants n=184; USA | To examine African American girls’ participation in PE and its association with academic performance in an urban inner-city school | Non-experimental | Questionnaires (MVPA-engagement-AA) | • AA - school grades (Maths, Science, English)  
• PA - questionnaires (3-day PA recall; teacher reported engagement; student reported engagement) | Inconclusive. Participation in PE may facilitate academic performance. |
| 38 | Simms et al. 2014 (Hea Edu J) | National sample primary n=10,210 (Gr 5); USA | Does PE matter? | Non-experimental; draws from Longitudinal data | Nationally representative sample from the Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K) | • AA - standardized tests in reading, math, and science  
• Other – self-concept, social skills, BMI, diet, out of school activity, PE time | Effect (small). PE +ve but modest association with AA |
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<tr>
<td>42</td>
<td>Travlos 2010 (Int J of Sp and Ex Psych) [SNIP=0.957; CS=1.49]</td>
<td>Secondary n=2; Participants n=48 (Gr 8); Greece</td>
<td>To examine the effects of an intense PE class on students' cognitive performance during different hours of the daily school program</td>
<td>Non-experimental (intensity &amp; timing)</td>
<td>An interval aerobic run was employed to increase PA during four PE classes that met at different times during the school day. Ten minutes after the termination of exercise, students performed a 2-min maths task</td>
<td>• EF - processing speed and accuracy of simple addition • PA - aerobic task</td>
<td>Effect. EF first, third, and fifth hour of the daily classes was increased, while EF sixth-hour PE class decreased</td>
</tr>
<tr>
<td>43</td>
<td>Tremarche et al. 2007 (Physical Educator) [NA]</td>
<td>Primary n=2; Participants n=311 (Gr 4); USA</td>
<td>To determine the impact of increased quality PE time on state test scores</td>
<td>Non-experimental (time)</td>
<td>Compared average test scores from standard tests for two different schools in same district. One school had 28 hrs/year PE, one had 56 hours of PE/year</td>
<td>• AA - state based standardized tests (Maths, English, Language, Arts scores) • PA – number of hours</td>
<td>Inconclusive. Effect school 1 (with more PE) students did better on English test than School 2. No effect on Maths scores</td>
</tr>
<tr>
<td>45</td>
<td>Wang et al. 2019 (Res Quarterly for Ex and Sp) [SNIP=0.936; CS=1.93]</td>
<td>National sample secondary n=22,619 (Gr 8); China</td>
<td>To explore how PE curriculum implementation relates to maths achievement</td>
<td>Non-experimental</td>
<td>Uses data from China National Assessment of Education Quality (CNAEQ) survey</td>
<td>• AA - Maths + Maths interest, self confidence • PA – CRF • Other - PE curriculum, PE interest, healthy lifestyle</td>
<td>Inconclusive. PE curriculum implementation had an indirect, positive association with maths through CRF, HL-maths interest, and HL-maths self-confidence</td>
</tr>
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</table>

Legend: AA (academic achievement); BMI (body mass index); CAS (cognitive assessment system); CG (control group); CRCT (cluster randomized control trial); CRF (cardio-respiratory fitness); CS (CiteScore); EF (executive function); EG (experimental group); GPA (grade point average); IG (intervention group); M-ABC (movement assessment battery for children); MS (motor skills); MUGI (motor skills as ground for learning); MVPA (moderate to vigorous physical activity); PA (physical activity); PE (physical education); PEH (physical education and health); RCT (randomized control trial); SES (socio-economic status); SOFIT (system for observing fitness instruction time); SNIP (source normalised impact per paper); VPA (vigorous physical activity)
Category 3: Literature results/findings and effect

This literature review was guided by a very specific question: *Does physical education have measurable educative benefits/impact on student academic performance and meeting of learning outcomes in other curriculum learning areas?* It therefore requires some quite specific answers that might be able to shed new light on the issues associated with the investigation. In this regard what the research studies concluded and offer about links between PE and AA and/or EF is important. Such conclusions are detailed in Table 3 and 4, and condensed below in Table 5 where a snapshot of the studies is provided.

**Table 5: Snapshot of Research Study Findings Pertinent to PE-AA/EF**

| ARTICLE NUMBER | CONDUCTED IN PE TIME | AS PART OF REGULAR PE | AS AN INTERVENTION IN PE | LEARNING AREA (MATHS, NUMERACY) MALES | LEARNING AREA (LANGUAGE) FEMALES | AA AS MAIN FOCUS | EF AS MAIN FOCUS | JOURNAL QUALITY | SNIP >1.0 | CONCLUSIVE FINDINGS |
Table 5 shows that PE (PE classes/class time) is a popular site for conducting research about PA and PE, with all but five (n=5) studies using PE as the context for gathering research data (6, 12, 13, 38, 45). Those five studies took their data from nationally sampled studies so were not in schools at all. In the main the bulk of the remaining thirty-five (n=35) studies were not linked to regular programs of PE or the everyday teaching of PE, though some tenuous links have been made to five (n=5) studies in this regard (8, 13, 20, 38, 45), which are discussed in a moment. The vast majority of research (n=24) instead uses PE time/class as either an intervention site or as a time/space to conduct fitness/cognitive tests associated with the intervention or research (1, 2, 4, 5, 9, 10, 16, 17, 19, 23, 24, 25, 26, 27, 30, 31, 32, 33, 35, 36, 39, 40, 42, 46).

Next this report documents the specific results gleaned from the studies in terms of their measures and effects.

**Physical education as an independent variable**

Physical education variables commonly manipulated in the studies were sport and/or health and/or fitness specific, and tended to target one or more of the variables of frequency, intensity, time and type. These manipulations should be considered interventions which are conveniently delivered, monitored or measured in PE, though arguably not as PE. In short, the studies uniformly did not manipulate aspects of usual/regular PE programs, rather they designed interventions or measured variable that in some way altered the frequency of PE (more/less often), the intensity of PE (more/less exertion), the time doing PE (more/less class time), and/or type of activity in PE (more/less variety).
Across the studies manipulation of the various facets of PE as a learning area are poorly evidenced. In the present review five (n=5) studies were deemed to be examining PE as a school subject/learning area in some way as opposed to as a site for a PA intervention which manipulated PA variables (8, 13, 20, 38, 45). All five studies were non-experimental with one (n=1) examining enrolment in PE and AA and finding no effect (8); another used a school-based survey to collect data about PE curriculum time to compare with AA tests, again with no effect (13). These two studies were published in quality journals. The other three studies were direct comparisons which drew upon data already collected from longitudinal studies to compare: PA in PE (20); PE time allocated in school (38); and PE curriculum implementation (45) with AA in standardized tests. The latter two studies report inconclusive results with either small effect size or indirect effects, with the former having no effect. Additionally, these three studies have been published in low quality journals.

These five studies raise questions about the rigour and quality of findings that attempt to measure aspects of PE in relation to AA/EF. They also highlight that none of the studies reviewed manipulate ‘Physical Education’ as the independent variable, and hence the question as to whether PE itself improves AA and/or EF is highly debatable.

**Academic measures: AA or EF or both AA/EF**

The majority of studies structured the research around and reported on AA variables only (n= 24) (4, 5, 6, 7, 8, 9, 12, 13, 17, 18, 19, 20, 22, 27, 28, 29, 30, 33, 37, 38, 39, 40, 43, 45). This equates to 60% of the studies. The measures of AA ranged from student self-reported AA, to teacher observations, school reports, grade point average, and state or national standardised tests. Of the forty studies, eleven (n=11) structured the research around and reported on EF variables only (1, 10, 11, 21, 23, 24, 26, 31, 32, 35, 42). This equates to 27% of the studies. The measures of EF were all standardised cognitive performance tests with focusses on aspects of cognition perceived or assumed to be associated with learning or AA, for example attention, memory, on task behaviour, memory. Five (n=5) (13%) of the studies assessed both AA and EF (2, 16, 24, 36, 46).

The assumption of a one-way causal link between PA, EF and AA should be viewed with caution with a recent high-quality systematic literature review concluding that ‘there is currently inconclusive evidence for the beneficial effects of PA interventions on cognitive and overall academic performance in children’ (Singh, Saliasi, van den Berg, Uijtdewilligen, de Groot, Jolles, … Chinapaw, 2019, p. 640).
Curriculum learning area outcome measures

The most common AA outcome measure was a combination of Mathematics (including numeracy and mathematical thinking) and mother language (e.g. English, Swedish) (including reading, writing, literacy) with twenty-one studies focussed on this combination of measures (2, 4, 6, 7, 8, 12, 13, 16, 17, 19, 20, 22, 25, 27, 29, 36, 37, 38, 39, 40, 43). Of these studies six (n=6) report an effect (2, 7, 16, 17, 29, 39), eight (n=8) an inconclusive effect (6, 19, 22, 27, 36, 37, 38, 43), and seven (n=7) report no effect (4, 8, 12, 13, 20, 25, 40). Five further studies measured only Maths related concepts (26, 30, 33, 45, 46) and one study (28) measured only literacy related variables, in this case 3rd grade reading level. Effects of the Maths/numeracy only variable appear generally favourable, with the literacy only study having a small effect. Notable across these studies is the mixed findings with regards to PA and curriculum learning area AA associations. For example, some studies found positive associations between PA and Maths, though not for literacy or mother language, whilst others found the reverse. By way of another example, when gender was reported there was sometimes an effect for boys but not girls in relation to the same curriculum learning area. These variations and inconsistencies amongst the findings occur regardless of study design. Other curriculum learning areas examined include Science (8, 29, 37, 38), Language (12, 20, 27, 43), Art (43), Social Studies (29), and World Studies (8). Of these studies three (n=3) reported no effect (8, 12, 20), one (n=1) an effect (29), and four reported inconclusive findings (27, 37, 38, 43).

Collectively these findings suggest that PE/PA may have a more neutral effect on AA in other curriculum learning areas, though there may be sufficient evidence to claim a link between PA/PE and Mathematics which is supported by Singh et al. (2019).

When cross referenced with journal quality it might be reasonable to claim that studies such as 2, 7, 16, 17, 18, 39 might offer some useful future insights with regards to both overall findings and research study design. In fact, a quick glance at each study in Table 3 and 4 emphasises the importance of well-conceived, constructed and delivered longitudinal studies for robustly and vigorously examining the relationship between PE and AA in school settings.
Statistical effect of the findings

This section reports on main effect\(^9\) or final result/finding of each of the research studies. It does this by identifying/designating the degree of effect of each study as EFFECT, INCONCLUSIVE EFFECT or NO EFFECT. These appear in the coloured column of Table 3 and 4 in green, orange and red. Findings in relation to effect are as follows:

- **EFFECT**: A total of twelve (n=12) studies were assessed to have reported significant positive effect (2, 7, 16, 17, 18, 21, 24, 26, 29, 33, 39, 42). This equates to 30% of the reviewed articles
- **INCONCLUSIVE EFFECT**: A total of eighteen (n=18) studies were assessed to have reported either unclear, vague, partial, small and/or modest effect (5, 6, 9, 10, 19, 22, 23, 27, 28, 30, 31, 32, 35, 36, 37, 38, 43, 45). This equates to 45% of the reviewed articles
- **NO EFFECT**: A total of ten (n=10) studies were assessed to have reported no significant positive effect or neutral effect. This equates to 25% of the reviewed articles.

Given that much quality, validity and generalisability of research is gauged by the type of study design used to gather data, reporting on study design in relation to effect is provided in Table 6.

**Table 6: Summary of Overall Effect of Research for Each Study Design**

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<tr>
<th>Study Design</th>
<th>Experimental</th>
<th>Longitudinal</th>
<th>Non-Experimental</th>
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<tbody>
<tr>
<td>Effect</td>
<td>4 (33%)</td>
<td>2 (17%)</td>
<td>6 (50%)</td>
<td>12 (30%)</td>
</tr>
<tr>
<td>Inconclusive</td>
<td>3 (17%)</td>
<td>2 (11%)</td>
<td>13 (72%)</td>
<td>18 (45%)</td>
</tr>
<tr>
<td>No effect</td>
<td>4 (40%)</td>
<td>0 (0%)</td>
<td>6 (60%)</td>
<td>10 (25%)</td>
</tr>
</tbody>
</table>

**PE-AA/EF: EFFECT**

Studies linking PA or PE with AA or EF and having a positive effect have occurred almost equally in school settings with data collected in six primary schools (16, 17, 21, 24, 29, 39), five secondary schools (2, 18, 26, 33, 42) and one mixed cohort of primary-secondary school (7). The literature suggests an equal impact in primary and secondary settings. The studies also come from a variety of different countries.

A total of twelve studies were assessed to have clearly reported significant positive effect which equates to 30% of the reviewed articles. Of these articles four used an experimental randomised controlled trial methodology (2, 24, 26, 39), three report on longitudinal data (16, 17, 18), and five were non-experimental design (7, 21, 29, 33, 42). Six examined AA (7, 17, 18, 29, 33, 39) using either standardised test results from national/regional

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\(^9\) It is important to note that most of the studies do not report effect size in their findings and therefore it has not been included in this review. This limitation is noted as one of the limitations of the studies.
level or school achievement data. Of the remaining studies, four examined EF (21, 24, 26, 42) through a variety of cognitive performance tests, and two examined both AA and EF (2, 16). Academic achievement was most commonly measured in core subjects like Mathematics (2, 7, 16, 17, 29, 33, 39) and/or local mother language (e.g. English, Swedish) (2, 7, 16, 17, 29, 39). One study assessed literacy and numeracy (39), two examined other subjects (2, 29), and one used final grade as well as matriculation status (18), this latter study was also reporting upon an online survey conducted as part of a broader longitudinal study (16, 17).

Interventions mainly manipulated time by increasing the number of minutes devoted to PE (2, 16, 17, 18, 26) also in tandem with intensity or level of exertion (2) or focus on type of activity (16, 17). One study focussed only on intensity (21), another only on type of activity (24), and another on intensity and time of the day (42). One Australian study examined the impact of specialist PE teachers on AA (39).

Collectively these studies indicate that relationships exist between PE, AA and EF, this conclusion is consistent across school setting, study methodology and intervention design. These studies therefore justify the continued inclusion of PE in the curriculum.

A SUCCESSFUL PE-AA/EF CASE STUDY

The Bunkerflo Project is a nine-year intervention study conducted in Sweden, and a number of research articles about this project are included in the literature review (16, 17, 18, 19). In addition to the longitudinal nature of the project, which suggest quality and rigour, there are three very significant features of the Bunkerflo Project that are important in the context of this report. The first is that it only occurred in PE as PE, and built upon already mandated daily PEH. The second feature of relevance is that it did this through an intervention which manipulated PE time and type of activity. The key aspect of the intervention was its more pedagogical focus which posited that,

the relationships between PA and scholastic performance can be summarized as follows: Improvements and automatization of FMS lead to increased physical self-esteem, which give better prerequisites for attention and comfort in school, which lead to increased motivation to learn and to attend classes (17, p. 251).

In short, the MUGI intervention drew on social cognitive theory to link positive experiences (e.g. enjoyment, success, pleasure) through motor skill development and learning, to self-esteem, then attention and motivation, and finally scholastic achievement (17). Finally, the project had significant immediate and long-term gains including, ‘improved scholastic performances, higher grades, and higher proportion of students who reached qualification for upper secondary school’ and has had a proven health-economic benefit at the nine-year follow up (17, p. 271). The Bunkerflo Project shows that effectively structured and delivered PEH programs that have a distinct educative focus, purpose and value have measurable and sustainable long-term health and academic benefits for young people, as well as broader social, economic and health benefits to communities and in this case countries.
**PE-AA/EF: NO EFFECT**

A total of 10 studies were assessed as having no significant positive or negative effective. This equates to 25% of the reviewed articles. Of these articles four studies utilised an experimental RCT methodology (1, 4, 40, 46) an approach considered to be of high quality and methodologically robust. One of these was also longitudinal (4), with the remaining studies utilising a non-experimental design (8, 11, 12, 13, 20, 25). Two examined EF (1, 11) through cognitive performance tests, the remaining AA. Academic achievement was assessed using either standardised test results from national/regional level or school achievement data. Most examined academic achievement using numeracy and literacy whilst a small number looked at combinations of other CLA (8, 13). The majority (n=8) collected data from primary schools, with one examining a mixed cohort of primary and secondary aged children and one examining secondary school students.

All studies involved an intervention that usually increased the number of minutes students engaged in PA through increasing time dedicated to PE or having PA breaks throughout the school day. One study contained a cohort who did no PE during their school week and were compared to a cohort that undertook PE (8).

The studies collectively indicate that there is no relationship between PE, AA and EF, this conclusion is irrespective of methodology or intervention design, regardless of the approach used and measurement tools the findings were the same. It is important to note that this is no relationship in either direction. Studies that increased the amount of PA students were undertaking by increasing time dedicated to PE did not report any negative impact on student achievement or grades. These studies therefore do not justify reduction or removal of PE from the curriculum.

**PE-AA/EF: INCONCLUSIVE EFFECT**

One of the important observations to come from the studies reviewed is the mixed findings with regards to effect or impact for most types of study design (i.e. experimental, non-experimental and longitudinal). Whilst there is evidence that 55% of the studies can report either an effect or no effect, there remains a large number of studies that cannot do this conclusively. A total of eighteen (n=18) studies were assessed to have reported unclear, vague, partial, and/or small and/or modest effect (5, 6, 9, 10, 19, 22, 23, 27, 28, 30, 31, 32, 35, 36, 37, 38, 43, 45). This equates to 45% of the reviewed articles. Of these articles 13 utilised a non-experimental design (5, 6, 10, 22, 28, 31, 32, 35, 36, 37, 38, 43, 45). Three studies utilised an experimental RCT methodology (23, 27, 30) one of these was also longitudinal (30), the remaining two studies were longitudinal (9, 19).

Twelve studies examined AA using either standardised test results from national/regional level or school achievement data (5, 6, 9, 19, 22, 27, 28, 30, 37, 38, 43, 45). Of the remaining studies, five examined EF (10, 23, 31, 32, 35) through a variety of cognitive performance tests, and one examined both AA and EF (36). Academic achievement was most commonly measured in core learning areas like Mathematics (6, 19, 27, 36, 38, 43, 45) and/or local mother language (e.g. English, Swedish) (19, 27, 36, 43). Three studies examined
literacy (6, 28, 38), one numeracy (30), and three examined other subjects (2,37, 38, 43). One longitudinal study reported on matriculation status (9), and one large national sample from China also reported on Maths interest and self-confidence (45). The majority (n=14) of studies collected data from primary schools (6, 9, 10, 19, 22, 23, 27, 28, 321, 32, 36, 38, 43, 45), this included three large national samples (6, 38, 45). Three studies occurred in secondary schools (5, 30, 37) and one was mixed primary and secondary (35).

Interventions typically manipulated time by increasing the number of minutes devoted to PE (5, 9, 19, 27, 43), also in tandem with a focus on type of activity (27). Two studies focussed only on intensity (23, 30), another only on type of activity (5), and another on intensity and type of activity (36). One Italian study reported on type of activity as well as provision of specialist or generalist teacher on EF (32), and another Italian study examined the impact of specialist/generalist PE teachers on EF (31). A variety of other research methods such as national sampling from previously collected data (6, 38, 45) as well as questionnaires may have also contributed to the inconclusive results (28, 37).

The studies collectively indicate an array of inconclusive relationships between a variety of indices associated with PE/PA, AA and/or EF, this conclusion is irrespective of methodology or intervention design, regardless of the approach used and measurement tools.

Limitations of the literature

The review undertaken by the research team and the examination of existing literature reviews point to numerous limitations in studies examining the relationship between PE, PA and AA. The following are synthesised limitations from across studies and summarised:

- There is a lack of randomised controlled trials and research containing control groups more broadly, making it challenging to assess accurately the impact of interventions.
- Published studies generally provide limited specific details about the participant characteristics making synthesis and comparisons difficult because it is unclear whether studies are examining similar types of young people and contexts.
- Studies generally have only focused on the time dedicated to PA as one variable of PA, the amount of PA undertaken by young people (as measured by accelerometers) is rarely considered and the intensity of this activity. Consequently, it is difficult to determine a ‘dose response’ for what levels of PA are necessary to have impact on cognitive function.
- Within many studies, there is a lack of accountability for known confounders, or the mixing of effect. For example, students socioeconomic background, parental education of which are known to have a significant impact on student AA.
- There is no consistency in the measurement of either cognition, cognitive capacity, PA, PE or AA, again making synthesis and comparison difficult as well as limiting the possibility of building on existing studies. Similar constructs are often defined/measured differently across studies.
• There are gaps in how many studies explain their design, making accurate assessment of their rigour challenging.
• Examining specifically the impact of PE, studies generally do not discuss the context in which PE is taught or how it is taught, making it challenging to assess how PE explicitly influences impact.
• Several of the reviews point to the issues of publication bias, suggesting that positive findings are more likely to be published, potentially resulting in an overestimation of the impact of PA on AA.
• Studies that report significant changes due to an intervention tend not to report effect sizes.
SECTION 3: FINDINGS FROM THE AUDIT OF PROGRAM/PROJECTS FROM KEY STAKEHOLDERS

The use of schools as setting for health-related activities and/or research is not new. Schools provide a captive audience bound by gates, fences and buildings; they also often want/seek out support from the outside to meet educational goals, create supportive environments, and to nurture the health and wellbeing of communities. Schools are also situated within broader social, economic and political discourses which frame the health of young people and the role of schools in that, in particular ways; for example discourses of obesity, risk-taking, mental health, and physical inactivity regularly appear in the media making the health of young people everybody’s business. By virtue of these discourses and this positioning, schools and especially (H)PE are viewed as sites to influence the current and future health of young people, this includes the recording of fitness levels and body composition, as well as the development of lifelong PA habits. In schools this concern for the health for young people is also tied to cognitive development, building intellectual capacity, and improved academic performance. Thus, the very real coupling of health with/to education both inside and outside schools is viewed as both a ‘smart thing’ and ‘a good thing’. This goes some way to explain why PA interventions in schools dominant the literature in this report, and why most of these interventions occur in primary schools. In the interests of expanding the research data gathered for this report a broader net was cast to determine if there were any on the ground projects, programs, initiatives or interventions operating in schools that were beyond those identified in the literature review. The aim of this part of the project was to identify and audit projects and programs in Australia that explore links between PE and improved educational and learning outcomes for students in other curriculum learning areas. Below the methods for doing this and findings are presented.

Method

Data were gathered via a snowballing of emails and phone calls to key individuals of relevance to the investigation during the period 3rd July-30th October, 2019. It began with fifteen (n=15) emails to individuals known to the research team, who then provided details of more individuals and/or organisations in the field and across the country. Using this method another thirty-three (n=33) emails were sent, and three (n=3) phone calls were made. Follow up emails were sent to twenty-three (n=23) individuals who did not respond, and five (n=5) additional calls were made. In total fifty-six (n=56) emails were sent and eight (n=8) phone calls were made.

The purpose of the emails/calls were to conduct an informal audit of Australian, state and/or local programs, projects, initiatives or interventions that each informant might be aware of that was trying to link or making claims of linking movement/PA/PE to academic performance/improvement in other learning areas. As the snowballing of key informants progressed a consistent collection of programs/projects emerged from a broad range of key informants who contributed their knowledge of and/or direct experience with such programs/projects. A total of thirty-eight (n=38) key informants from thirty (n=30) different organisations and/or involved directly in ten (n=10) different programs/projects contributed. The key stakeholders were education system leaders, researchers, and
members of peak organisations in the HPE field in Australia. The complete list of key stakeholder informants and organisations who contributed to this project appears in Appendix 1.

In addition to gathering valuable information about key stakeholder individuals and organisations of relevance to this project, the data gathering process also yielded details of a number of national and state-based programs, projects, initiatives and/or interventions that informants suggested might be useful to include in the audit. The final collection of twenty-four (n=24) programs/projects appears in Table 7. Note this is not an exhaustive list of programs/projects of relevance to the research question or this project, it is the collection that emerged from this particular data gathering process and from the individuals providing the advice.

Table 7: Audit of Australian Programs/Projects Based on Stakeholder Feedback

<table>
<thead>
<tr>
<th>STATE</th>
<th>PROJECT NAME</th>
<th>PROJECT URL</th>
<th>PE</th>
<th>PA/PL</th>
<th>AA</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUST</td>
<td>Sport Australia</td>
<td><a href="https://www.sportaus.gov.au/physical_literacy">https://www.sportaus.gov.au/physical_literacy</a></td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active Healthy Kids</td>
<td><a href="https://www.activehealthykidsaustralia.com.au">https://www.activehealthykidsaustralia.com.au</a></td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active Early Learning (AEL)</td>
<td><a href="https://www.aelproject.com.au/research">https://www.aelproject.com.au/research</a></td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sporting Schools</td>
<td><a href="https://www.sportaus.gov.au/schools">https://www.sportaus.gov.au/schools</a></td>
<td>•</td>
<td>•</td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td>PEPL pilot from 2020 (Dick Telford)</td>
<td><a href="https://www.peplapproach.com.au">https://www.peplapproach.com.au</a></td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New project and research to begin 2020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACT</td>
<td>LOOK study (Dick Telford)</td>
<td><a href="http://www.look.org.au/v2/about-us">http://www.look.org.au/v2/about-us</a></td>
<td>•</td>
<td>•</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Specialist/generalist PE teachers</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Completed research project</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QLD</td>
<td>iAIM</td>
<td><a href="https://southwestschoolssport.eq.edu.au/Calendarandnews/News/Pages/iAIM-Program.aspx">https://southwestschoolssport.eq.edu.au/Calendarandnews/News/Pages/iAIM-Program.aspx</a></td>
<td>•</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some claims made re learning outcomes; not evaluated; no research</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>NT</td>
<td>Move More Learn More</td>
<td>No website; project is incomplete as AA/EF data was not forthcoming (private correspondence)</td>
<td>•</td>
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<td>○</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Mov3 program</td>
<td><a href="https://mov3.com.au">https://mov3.com.au</a></td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSW</td>
<td>iPlay (Dave Lubans, UNEW; Chris Lonsdale, ACU)</td>
<td><a href="https://iplay.org.au">https://iplay.org.au</a></td>
<td>•</td>
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<tr>
<td></td>
<td></td>
<td>PA professional learning product for primary teachers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burn2Learn (Dave Lubans)</td>
<td><a href="https://www.newcastle.edu.au/research-and-innovation/centre/cpan/research/physical-activity-and-nutrition-in-schools">https://www.newcastle.edu.au/research-and-innovation/centre/cpan/research/physical-activity-and-nutrition-in-schools</a></td>
<td>•</td>
<td>•</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Fitness, wellbeing &amp; AA resource targeting senior students + App</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thinking While Moving (Nick Riley, UNEW)</td>
<td><a href="https://www.newcastle.edu.au/research-and-innovation/centre/cpan/research/physical-activity-and-nutrition-in-schools">Link</a></td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integration of PA with numeracy or literacy in primary schools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formally known as ‘Encouraging Activity to Stimulate Young (EASY) Minds’ program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT for Teens - APP (UNEW)</td>
<td><a href="https://www.faqinteractive.com.au/portfolio/rtteens/">Link</a></td>
<td>●</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Resistance fitness program for teens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premiers Sporting Challenge (DET)</td>
<td><a href="https://app.education.nsw.gov.au/sport/Page/1513">Link</a></td>
<td>●</td>
<td>○</td>
<td></td>
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</tr>
<tr>
<td>10-week PA &amp; fitness program claims to improve concentration (EF link) (resilience &amp; wellbeing)</td>
<td></td>
<td></td>
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<tr>
<td>NSW regional health</td>
<td><a href="https://nswregionalhealthpartners.org.au/our-work/physical-activity/">Link</a></td>
<td>●</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Ikifit</td>
<td><a href="http://ikifit.com.au/Teach/positive-behaviour-management-workshops">Link</a></td>
<td>●</td>
<td>○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher PL using PA, claims to promote cognitive performance &amp; concentration (EF)</td>
<td></td>
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<tr>
<td>WA</td>
<td>Kiddo</td>
<td><a href="https://www.kiddo.edu.au/">Link</a></td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animal Fun</td>
<td><a href="https://animalfun.com.au">Link</a></td>
<td>●</td>
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<tr>
<td><a href="http://csrr.info/collection/brain-boost-brochure/">Link</a></td>
<td></td>
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</tr>
<tr>
<td>Literature review commissioned by DSR &amp; Curtin Centre for Sport &amp; Recreation Research (CSRR)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Education State targets and initiatives (policy)</td>
<td><a href="https://www.education.vic.gov.au/about/educationstate/Pages/targethappyhealthy.aspx">Link</a></td>
<td>●</td>
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</tr>
</tbody>
</table>
Findings around PE-AA in Australia

The referrals and examples from key stakeholders ranged from government initiatives to Apps, literature reviews, project evaluations, in/out of school interventions, health promotion plans, online professional learning, and future research proposals. They informed of anything that they thought might be of relevance to the research question, though most were not aware of any programs/projects specifically trying to link or making claims of linking PE to academic performance/improvement in other learning areas.

The referrals identified projects/programs that were predominantly linked to PA in schools (n=24), and mainly delivered as teacher professional learning and/or resourcing, this sits in contrast to the research literature where direct in school interventions dominate. Three (n=3) projects/programs were in some way linked to PE with Sporting Schools providing PE resources, the LOOK study focussing on generalist/specialist PE teachers, and the PEPL project to be piloted in South Australia from 2020. This latter research project is also linked to AA and will likely provide robust research informed advice regarding the links between PE and AA. A number made claims that the project/program or perhaps more precisely ‘product’ was linked to AA (or EF) (n=11), though five (n=5) were unsubstantiated by project evaluations, research or citations (see Table 7). The other six (n=6) projects/programs might be considered robust and rigorous in that they have been developed from quality research processes exploring links between PA and AA and/or EF. Many of these researchers and their associated research centres are driving knowledge in this field in Australia and internationally. However, in light of the inconsistent results from the literature review, it might logically follow that research-based projects/programs should be viewed with some wariness and/or scepticism.

Two current projects/programs of relevance to this project are Thinking While Moving (TWM) and Transform-Us!

- **Thinking While Moving** (TWM) is a teacher professional learning initiative that integrates PA with numeracy and more recently with literacy with evidence of improved AA (see Riley et al., 2015; Mavilidi et al., 2019).
- **Transform-Us!** is an online product that includes training and resources for teachers and school leaders to integrate movement into classrooms, schools and homes (see Salmon et al., 2011).
It should be noted that neither of these products are intended to be used in or replace PE classes. As previously mentioned, a project/program of future interest will be the **PEPL Project conducted by Professor Dick Telford in South Australia.**

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**Are PA interventions in PE effective health promotion strategies?**

Physical Education is a site-space commonly targeted for increasing child/youth PA levels. This function is predicated on the idea that physical inactivity is associated with multiple health problems later in life (e.g. obesity, cancer, cardiovascular disease, and osteoporosis) and is a highly modifiable risk factor. By association PE emerges as a popular setting for PA and fitness interventions because it is a convenient and cost-effective way to reach a large and diverse audience. Whilst there is a great deal of research data that links physical inactivity to poor/low health outcomes, there is less convincing research that evaluates the effectiveness of interventions in PE that claim to influence PA levels enough to have lasting effects on weight or fitness or outside school or into adulthood with measurable adult health outcomes (Errisuriz, Golaszewski, Born, & Bartholomew, 2018; Polet, Hassandra, Lintunen, Laukanen, Hankonen, Hirvensalo, ... Hagger, 2019; van Sluijs, McMinn, & Griffin, 2007). Findings from a systematic literature review by van Sluijs and colleagues (2007) suggested that there is limited evidence of an effect on children and some evidence of the effect of multicomponent interventions on adolescents. They concluded by suggesting a ‘multilevel approach to promoting PA, combining school-based interventions with family or community involvement and educational interventions with policy and environmental changes, is likely to be effective among adolescents and should be promoted’ (van Sluijs et al., 2007, p. 13). A more recent systematic review by Errisuriz et al., (2018) also speaks to the inconsistent effects and evaluation of PE-based PA interventions in primary schools, concluding that ‘the heterogeneous nature and lack of appropriate evaluation of the intervention designs reviewed make it difficult to determine which programs or components are most effective’ (p. 323).
SECTION 4: CONCLUSIONS AND RECOMMENDATIONS

The intent of this project was to examine available national and international literature that has reported upon the benefits/impact that physical education (PE) may have on academic achievement (AA) in other curriculum learning areas (CLA). The following research question guided this project:

**Does physical education have measurable educative benefits/impact on student academic performance and meeting of learning outcomes in other curriculum learning areas?**

The report aimed to provide evidence of what works, elements of success, relevant contextual factors, and how Australian education authorities could use this evidence to improve educational and health outcomes for their students in their schools. To collect data in response to the research question the project used two research methods. The first, and primary method involved the systematic identification and review of relevant literature. The second was an audit of current projects and programs operating in Australian schools that may or may not link to PE and/or AA.

**Literature review key takeaways**

The review of literature expands upon seven (7) high quality literature reviews of relevance to the research question and project aims more broadly. It does this by identifying forty (40) key research studies from the last 15 years assessed to have examined the link between PE and AA (or EF). Summary details of each of these studies was presented in Table 3 and Table 4 with analysis of the studies in terms of research sample, journal quality, study design, and findings/results also provided.

The overall finding of the review in relation to the research question is that none of the studies have reliably spoken to the ability of PE to improve AA in general or in other CLA. This is because none of the studies directly measured PE as a CLA that involves more than the manipulation of PA variables or as a site for conducting interventions and/or testing. As one of the key aspects of the original RFQ was to identify literature ‘where improved learning outcomes for school students has been demonstrated to result from effective implementation of the physical education element of the curriculum’ (p. 2), this report has deemed ‘effective implementation of physical education’ to be the effective implementation of the learning area of PE as PE (or HPE as is the case in Australia). This means that the literature examined has given insufficient attention to measuring PE as PE and/or the multiple various dimensions that distinguish PE as a CLA in its own right. In this regard missing measures might be expanded to include for example, researching the effect of PE specific content knowledge and skills, pedagogies, practices, teaching and learning activities, assessment mechanisms or the educative purpose/value of PE in relation to AA/EF. Also omitted if PE was considered as a CLA with an educative purpose/value might be the measuring of teacher understandings of learner diversity, appreciation of the many
socio-cultural influences on PA choices, and/or other professional standards associated with improving student health and wellbeing, school environments, carer relationships and a plethora of other school and individual variable that may impact upon AA and/or EF of children and adolescents in and through PE. These omissions could guide future research seeking to examine a relationship between PE and AA in general and in other CLA.

Therefore, based upon the studies systematically reviewed the overall conclusion of this review is that:

**There is insufficient robust and consistent evidence to suggest that physical education has a measurable educative benefit/impact on student academic performance or the meeting of learning outcomes in other curriculum learning areas**

This conclusion is also supported by two high quality literature reviews (14, 34).

However, whilst PE was not strongly featured as a key variable in the literature reviewed, PA and many variations of it were. The literature indicates that across each type of study design there were some favourable, positive and even robust effects related to AA and/or EF, however there were also as many findings reporting little or no effect, and many more inconclusive findings. This finding is consistent with all other literature reviews consulted for this report (3, 14, 15, 34, 41, 44, 47). By way of a summary the key findings of the systematic process of reviewing literature are as follows:

- There was no evidence of negative impact on student AA, grades or EF/cognitive ability.
- The dominant way in which the studies examine PE is through PA interventions delivered in PE class time.
- In the studies reviewed PE is predominantly used as a site/space for PA interventions or to test if PA interventions have worked or not.
- The studies may offer guidance with regards to the ways in which frequency, intensity, time and type of activity might be manipulated in order to enhance PA delivered in PE, or in other CLA and/or recess.

Therefore, based upon the studies systematically reviewed a second conclusion of this review is that:

**The studies collectively indicate an array of positive, neutral or inconclusive relationships between a variety of indices associated with PE/PA, AA and/or EF, this conclusion is irrespective of methodology or intervention design, regardless of the approach used and measurement tools**

The biggest question then, given the amount of research reviewed and available, quality of the research design and publications, decades of high-quality literature reviews, and seemingly endless and ongoing interest in the association between PA and AA is, *WHY?* Why are these inconsistent findings so commonplace? Why, regardless of what is measured, how it is measured, by whom, and in what context, are the findings generally
neutral? At least two explanations might be viable. The first is the lack of consistency in study design protocols and about what specifically is being measured. For example, there are a number of different ways and combinations for measuring the same PA, AA and/or EF variable as well as the multiple associations between them. A second possible explanation is that there are many other socio-cultural, political and environmental variables that are uncontrollable within school-based settings, even in robust experimental studies. For example, a child’s (or teachers) background, health, motivation, capacities and skills, programs and activities run in the school, and use of equipment (e.g. accelerometers) to name a few. In short there are many other variables that are often un-accounted for in the studies and this makes comparing results and seeking cause-effect very difficult.

However, what can be stated with some certainty from these studies, as well as the literature reviews examined in this report is that participation in Physical Education does not have a negative impact on children’s or adolescent’s academic achievement or executive function. This report shows that a substantial collection of available data from national and international research suggests that there is no detrimental effect to increasing any combination of frequency, intensity, time or type of activity in or as physical education. In fact, amongst the flux and inconsistencies one point remains constant from the studies reviewed, neither PA or PE impede academic or cognitive development, thus there are few arguments for decreasing PE or PA time in the pursuit of improved academic outcomes. These 47 studies therefore justify the continued inclusion of PE in the primary and secondary school curriculum. Additionally, a great deal of research outside the current review points to many other short and long-term benefits of PE term benefits of PE (see for example work by Bailey, Armour, Kirk, Jess, Pickup, Sandford, & BERA Physical Education and Sport Pedagogy Special Interest Group, 2009; Beni, Fletcher, & Ní Chróinín, 2017; Dalziell, Booth, Boyle, & Mutrie, 2019; Fisette, 2011; Lambert, 2018; Luguetti, Kirk, & Oliver, 2019), thus highlighting that PE has educative value beyond the prevention of disease. This additional research alongside the findings of this review further justifies PE as a curriculum learning area with intellectual, social, emotional, and physical benefits for young people both now and in their future.

**Audit key takeaways**

With regards to the program/project it is evident that there are a number of research interventions that are maturing into PA oriented products in the PE-school space. This is likely to continue as many researchers have successfully coupled health (by way of physical inactivity) with/to education (and increasingly more AA) (see 30, 39). This has likely come in response to broader social, economic and political discourses which make the health of young people everybody’s business, and if the examples in Table 7 are any indication also an emerging commercial business. Whilst it could be argued that the projects/programs assembled in Table 7 have the potential to be included in PE programs or delivered in PE time, none claim or aim to do this. Additionally, none focus on or seek to link PE with AA/EF in general or AAVEF in other curriculum learning areas. Nor do they speak to how they might improve the educative nature or quality of either PE or other curriculum learning areas. Instead, they each variously aim to upskill and provide resources to teachers (especially primary teachers), facilitate and support PA in schools, promote PA as part of an active and healthy lifestyle, build community...
capacity, indirectly influence health outcomes, and create supportive environments. There is little doubt these are worthwhile endeavours, though the overreliance on ad hoc, outsider delivered PA interventions in schools as a long term ‘solution’ to current health challenges might prove an expensive and unsustainable venture, especially for schools. Given a scant few claim links to AA and/or EF it might be argued schools will be less inclined to drift away from their core business of learning. However, given the amount of research found in this review this doesn’t seem likely. A more obvious scenario is that while PA research continues to be linked to health and education/academic achievement through well-funded health interventionist approaches it is likely that school settings will remain a fertile testing ground.

Recommendations/future research

The following are recommendations from this project and along with this report provide key stakeholders with evidence, information and insights as to the current and future role, impact and educative value of physical education in schools and for students.

Recommendation 1: Policy directives and policy actors should continue to advocate for curriculum time for PE as there is no evidence to suggest that either PE or PA has a detrimental effect on student AA or EF.

Recommendation 2: Avoid allocating future funding to research seeking to find an association between PE/PA and AA as such research is likely to result in inconclusive and/or neutral findings.

Recommendation 3: Greater attention and/or funding could be directed towards research that uses robust methods to examine the value of PE as a curriculum learning area with educative purpose in and of itself.

Recommendation 4: Greater attention and/or funding could be directed towards collecting a strong evidence base of what makes for quality PE programs as well as quality teaching and learning in PE.

Recommendation 5: View with some caution and scepticism the rise of school-based PA products and programs emerging in schools as PE as evidence from this review questions the effectiveness of PA interventions in schools.
REFERENCES

All Reviewed Articles


**All Other References**


### APPENDIX 1: LIST OF KEY AUSTRALIAN STAKEHOLDER INFORMANTS AND ORGANISATIONS CONSULTED AND SUPPLYING INFORMATION

#### Academics/Researchers
- Fraser Keegan (for Dick Telford) (LOOK; Geelong project; PEPL)
- Natasha Schranz (Uni SA Active Healthy Kids Australia (AHKA) Co-Chair and Research Fellow
- Tony Okely (UOW Author of the Australian Governments 0-5 years & young person’s physical activity guidelines; Early Start research)
- David Lubans (UNEW Priority Research Centre for Physical Activity and Nutrition, UNEW; iPlay; Burn to Learn)
- Nick Riley (UNEW Priority Research Centre for Physical Activity and Nutrition, UNEW; Thinking While Moving)
- Michalis Stylianou (iAIM; AHKA)
- Karen Martin (UWA Active Schools project; Brain Boost)
- Joe Scott (ECU, WA; RT for teens)

#### Education Sector
- Natalie Jonas (ACARA, HPE)
- Rachael Whittle- (Curriculum Manager, VCAA)
- Will Hanley Advisor (ISV, VIC)
- Karen Ingram (NESA, NSW)
- Renee West (DET, NSW)
- Katrina Mostyn & Nicky Sloss (AISNSW)
- Jason Evans (DET, QLD)
- Jenene Rosser (ISQ, QLD)
- Nikky Howson (DET, WA)
- Kris Stafford (AIS, WA)
- Fiona Campbell (DET, NT)

#### Peak Bodies
- Gareth Evans (for Pierre Comis) (Sport Australia)
- Matthew Calf (Ass Dir, Sporting Schools)
- John Stokes (ACHPER, Nat)
- Bernie Holland (ACHPER, VIC)
- Tracy Puckeridge (ACHPER, NSW)
- John Williams (ACHPER, ACT)
- Rick Baldock (ACHPER, SA)
- Donna Barwood (ACHPER, WA)
- Beth Blackwood (Association of Heads of Independent Schools of Australia, AHISA)
- Phil Lewis (Catholic Secondary Principals Australia, CaSPA)

#### Others
- Janet Atkin (writer Australian Curriculum HPE; PDHPE consultant)
- Glenn Amezdroz (Former HPE consultant QCAA; HPE textbook author)
- Michael Watkins (Move More Learn More, NTDSR)
- Tim Ellison (Mov3 program; Triathlon NT)
- Nicole Nathan (NSW Health)
- Tim Leadbetter (QLD, iAIM)
- Amanda Derbyshire (Kiddo)